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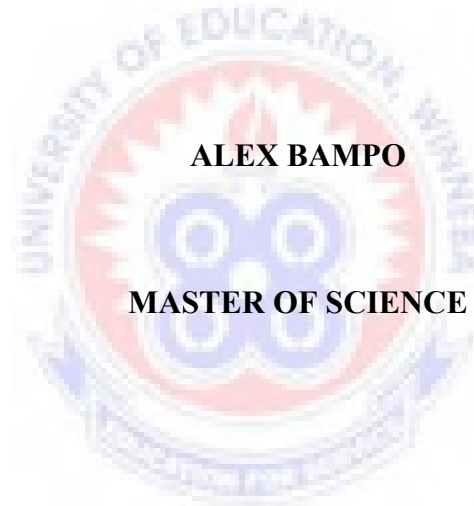
# EVALUATION OF THE QUALITY OF 4G MOBILE NETWORK IN THE GREATER ACCRA REGION

**ALEX BAMPO**

**MASTER OF SCIENCE**

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# UNIVERSITY OF EDUCATION, WINNEBA

# EVALUATION OF THE QUALITY OF 4G MOBILE NETWORK IN THE GREATER ACCRA REGION

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**A dissertation in the Department of Information Technology Education,
Faculty of Technical Education, submitted to the School of
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Master of Science
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**MAY 2020**

# DECLARATION

## STUDENT DECLARATION

I, **ALEX BAMPO,** declare that this Dissertation, with the exception of quotation and references contained in published works which all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE:…………………………………..

DATE:………………………………………..

## SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this Dissertation was supervised in accordance with the guidelines for supervision of Dissertation as laid down by the University of Education, Winneba.

## DR. EBENEZER BONYAH

SIGNATURE:…………………………………..

DATE:………………………………………..

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## DEDICATION

I dedicate this research work to my Grandparents Mr. and Mrs. Bampo for how far they have brought me to this level of education. Also, to my wife Evelyn Twum and my son Duke Darko Bampo for their support throughout this period.

Lastly, to my mother Emma Bampo, all my aunties especially, Judith Bampo, my immediate cousin Albert Bampo, my sisters and brother, my cousins, as well as all my great friends. I say thank you all for the support that you have all given to me.

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**ABBREVIATIONS AND ACRONYMS**

| | |
|---|---|
| ICT | Information Communication and Technology |
| 3GPP | 3rd Generation Partnership Project |
| 1G | First generation |
| 2G | Second generation |
| 3G | Third generation |
| 4G | Fourth generation |
| BWA | Broadband Wireless Access |
| RAC | Remote Administrator Control |
| TCP | Transmission Control Protocol |
| TAM | Technology Acceptance Model |
| DOI | Diffusion of Innovations |
| BPSM | Bounded Power Save Mode |
| IP | Internet Protocol |
| GPRS | General Packet Radio Service |
| IEEE | Institute of Electrical and Electronics Engineers |
| IMASH | Integrated Mass Announcement System |
| WIMAX | Worldwide Interoperability for Microwave Access |
| LTE | Long-Term Evolution |
| DL | Downlink |
| FDD | Frequency Division Duplex |
| SERVPERF | Service Performance |
| SERVQUAL | Service Quality |
| ACSI | American Customer Satisfaction Index |
| MTN | Mobile telephone network operator |

GSM             Global System for Mobile Communications

QOS             Quality of service

ATM             Asynchronous Transfer Mode

HTTP            HyperText Transfer Protocol

WLAN            Wireless Local Area Network

DHT             Distributed Hash Table

P2P             Peer to Peer

SC-FDMA         Single Carrier-Frequency Division Multiple Access

GPS             Global Positioning System

Mbps            Megabits Per Second

## ABSTRACT

The purpose of the study was to evaluate the Quality of 4G Mobile Network in the Greater Accra Region. For the time being, the services supplied by the telecommunications industry in Ghana are not encouraging in the sense that clients who are far from the Exchange have trouble in using the service. The foreseeable benefits of 4G could improve people's experience of using their cell phones and web services. A qualitative research study was used by the researcher and the research design chosen for the study was a narrative research. The study population consists of customers from the telecommunications industry in the Greater Accra region and purposive sampling was used to select sixty (60) participants. The researcher used an interview guide as the research instrument for the study. The responses from the interview were transcribed into text to support the discussion of the results. The study revealed that people in Accra Metropolis in the Greater Accra Region of Ghana experience network problems which make them put their phones down for a while or move to areas where the network is good or sometimes switch their phones off and switch it on again to see if the network will be stable. Others switch to another network so that they can do their work or do what they have to do with the network. The findings of the study was that, telecom companies presumed they have 3g and 4g meanwhile, in realty, it was not working as customers were supposed to enjoy it. The study recommends that customers should use devices such as weBoost Drive Reach (470154) and weBoost Drive 4G Sleek (470135) to boost their network signal.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Introduction

In the field of telecommunications, service providers are operators providing network related services to users of the network in the form of calls and internet services. In this dissertation, the author undertakes a project to find out the quality of the service provided by these operators. The chapter deals with the background to the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, delimitation of the study, limitation of the study and the organization of the study.

## 1.2 Background to the Study

The evolution of Information Communication and Technology ICT has accelerated as technological breakthroughs have changed the way individuals interact with each other (Ericsson, 2015). Alongside the evolution of network technology, a wide range of industries have appeared (Ericsson, 1998). With each generation of networks offering better ability for quicker data communication, communication opportunities have been extended (Olsson, 2013). People are now using their mobile devices to a much bigger extent than before, with a sharp rise in mobile information consumption. For the 2015 Mobile World Congress, Ericsson released its latest Mobility Report, which shows a 55% increase in worldwide mobile information traffic between 2013 and 2014 (Ericsson, 2015). Growth in mobile information consumption is evident when we look at sectors such as music streaming, video streaming and e-commerce, all of which are demonstrating a marked increase in the popularity of their mobile alternatives. Mobile video traffic is expected to increase by 45 percent annually (Ericsson, 2015) and more

than 30 percent of global e-commerce sales are currently being made on mobile devices (Criteo, 2015). As mobile solutions gain popularity, customers in every service require more advanced features (Olsson, 2015). These features are given within the supply chain by performers for the quickly changing digital content distribution. Following this fast evolution, the positions of the actors change, generating variable value chains for the distribution of digital material.

Due to the dependence on ICT solutions, regulators and stakeholders discussed the extent to which the ICT sector should be regulated (Crews, 2014). Depending on the outcome of such a debate, it could have an impact on the way in which business is handled within the ICT industry, potentially threatening current business solutions and creating new opportunities. As developments in the ICT industry have progressed rapidly in latest years, study has not been able to maintain pace with developments. Most of the research describing what actors and value chains exist in digital content distribution is either fairly old in view of rapid developments or rather narrow in their descriptions. However, understanding the value chain of digital content distribution for mobile end-user is crucial in assessing both present and future threats and possibilities within the ICT sector. This thesis is a useful contribution to both scholars and businesses by offering ideas that benefit both scientists and stakeholders in the ICT value chain. The present era of telecommunications are classified by the capacity of people to have free and immediate access to data, referred to as the digital era or the data age.

This is the era of the web and social network, where individuals are continually joined to applications that enable them to interact with each other immediately, through the use of information facilities, at this generation, people need to have the option to make

video calls, send multimedia messages, watch recordings or TV over the web, send emails, complete online studies, and so on and above all, individuals need to be connected whenever, any place, and 4G is relied upon to furnish 4G end-users with the fourth Generation Mobile Communication Standard created by 3GPP (3rd Generation Partnership Project), 3G or UMTS. 4G is required to be an Internet Protocol (IP) packet switched network, to give gigabit speed (ultra-broadband) access, to address capacity exhaustion issues by helping more clients per cell, and to convey high-quality multimedia systems, for example, IP telephony, gaming and streamed multimedia (Meier, 2010).

## 1.3 Statement of the Problem

The fast increase in demand for data services has led many of the clients who have registered in the multiple network facilities to access data owing to the era of the computer. At the same time, operators must ensure that appropriate services are provided to the customer. Users are expected to experience the highest possible level of service quality. Efficient allocation of assets is a main contributor to economic growth and success in handling the telecommunications sector (Malisuwan, 2015). Network resources are becoming scarce owing to increased demand for wireless services (Ramli, 2013). For the time being, the services supplied by the telecommunications industries in Ghana are not encouraging in the sense that clients who are far from the exchange have trouble in using the service.

The Attenuation is becoming very big and the signal-to-noise ratio is also decreasing because the distance from the main distribution frame (Exchange) to the end of the customer is becoming very long and the electronic signal passing through the cable is becoming very small. Before the client can use broadband, the individual should not be

roughly nine (9) kilometers from the main distribution center as the signal strength starts to decline as it moves a lengthy distance. And if the customer is within nine kilometers, the drop wire from the Distribution point to the end of the customer should not be more than 300 meters. Some of the clients who stay within nine kilometers, but are a little far away, find it very hard to have complete access to telecommunications facilities. This is because the attenuation continues to increase as the wires get longer.

Endeavours have been made to give Quality of service (QoS) and to control congestion. In any case, owing to the following factors, present research does not provide an adequate and thorough solution for QoS in Broadband Wireless Access (BWA) networks. There is no effective congestion relief system in place. Current load balancing approaches are either founded on thresholds or are appropriate to a particular protocol. For example, TCP-only (Qiu., 2011) QoS threshold-based provisioning schemes, which cannot provide QoS for links. It's because they're only active when the network is already highly loaded. They don't work when the network is moving toward congestion. This operation results in an inefficient use of network resources. Parameters that have been described and used in current systems are mostly set manually (Kwan, 2010). These systems lack the basis behind the selection of thresholds and the impact of differences in parameter environments on network performance. These systems are therefore not immediately relevant to networks that are dynamically evolving.

In addition, present methods do not consider a fair distribution of resources between flows of the same sort of service. Current Remote Administrator Control (RAC) approaches consider just network resources and do not take into account the load on the core network. The majority of these schemes (Anas, 2008) are not capable of distinguishing

between different types of service connections when resources are limited in the network. A few systems offer service distinction (Delgado, 2010), yet used thresholds and reserve resources and regularly lead to inefficient use of network resources. Current pre-emptive or degrading systems rarely guarantee a reasonable distribution of bandwidth between service flows at the same and distinct priority rates (Kwan, 2010). Some of the RAC systems use a set size degradation step and do not provide a rationale for value choice (Wang, 2005). In addition, these RAC systems do not consider the present congestion status of the core network in the admission phase. RAC systems, which reserve extra funds with an incoming link to offset changes in customer demand owing to differences in channel circumstances, are also suggested in the literature (Mehdi, 2012). None of these schemes can be straightforwardly suggested to be applied to 4G BWA networks, which already enable current connections to use extra funds above their minimum demands in order to achieve their highest rate. Existing methodologies along these lines are not adequate to guarantee QoS for connections and to adapt to dynamic changes in the 4G BWA networks.

## 1.4 Purpose of the Study

The purpose of the study was to evaluate the Quality of 4G Mobile Network in the Greater Accra Region.

## 1.5 Objectives of the Study

The objectives of this research are to:

1. Identify the 4G wireless network and the bad facilities provided by the multiple networks.

2. Identify factors that account for the bad facilities supplied by the networks.

3. Examine how to improve services for users of the 4G network.

**1.6 Research Questions**

The aim of the study was to answer the following research question:

1. How are users of 4G network coping with the poor services rendered by the various networks?

2. What accounts for the poor services provided by the networks?

3. How can the services be improved for the users of the 4G network?

**1.7 Significance of the Study**

Mobile phones and the Internet are things that are a consistent piece of many individuals' lives, some of which are things they can't survive without, on the grounds that they are at the core of their expert and social lives. The predictable advantages of 4G could improve individuals' understanding of using their phone and web services. As we move increasingly more towards the ever-connected communication environment, it is imperative to have the correct infrastructure and technologies set up that will give the most ideal experience of its use and, in this way, consider innovation and further improvement. 4G is a significant step towards the future of the Internet and telecommunications, and an exciting possibility for all.

**1.8 Delimitation of the Study**

The research was based on a case study of quality of service (QoS) for mobile operators and users of the network, and it was simple to obtain data from these users, so the researcher was able to obtain the most from them. The researcher designed an interview guide or protocol to interact with the customers (users of the network) in order to obtain the average quality of service experience from customers. Another good experience was the willingness of users to provide relevant information on the quality of service (QoS) of end users. Because of the difficulties of project time management and project

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cost management, the study must be finished within a short period of time. In this manner, the researcher will concentrate on the latest development in the given subject just as the previously mentioned objectives and research questions.

## 1.9 Limitations of the Study

The limitation of the study was the willingness on the part of the technicians / engineers of the network operators to provide information in their respective departments without considering compliance with the oath signed between the employers and employees, and even went ahead to provide me with more details unknown to me. The population for the study was so big. Collecting information on all the components is prohibitively costly so the researcher couldn't collect information from the population but sampled from the population was used for the study.

## 1.10 Organization of the Study

The study is organized into five chapters. Chapter one is the introduction and it covers the background to the study, statement of the problem, the purpose of the study, research objectives, research questions, the significance of the study, delimitation of the study, limitation and the organization of the study. Chapter two deals with the related literature of the study. The review involves empirical studies and the conceptual framework and theoretical review of the problem under study. Chapter three presents an overview of the research methodology. It covers introduction, research design, population, sample and sampling technique, instrumentation, data collection procedure, the procedure for the analysis of the data and ethical consideration. Chapter four deals with the presentation and results of data and the discussion of the research findings. Chapter five summarizes the research findings and provides recommendations from the findings including suggestions for future studies and conclusions.

## CHAPTER TWO

## LITERATURE REVIEW

### 2.1 Introduction

The purpose of the study was to evaluate the quality of 4G Mobile Networks in the Greater Accra Region. Mobile telecommunications operators have recently played a significant role in improving social interactions among groups, organizations, governments, people, and eventually creating a powerful worldwide environment network. That is why Deutsch (1953) this trend is described as "a web of countries". The development of communication technology today ignores the global border and makes the world a "global village" (McLuhan, 1964). This chapter will examine the evolution and development of mobile communications, the literature relevant to the study on quality of service in the telecommunications industry in Ghana, the case of the Greater Accra Region. The study will also examine some theoretical structure within which the investigator adjusted the Technology Acceptance Model (TAM), the conceptual framework adjusted and modified to suit the empirical research from Dehghan, 2006 as cited in (Agyapong, 2010) using the Service Quality (SERVQUAL) Model taken by the researcher, the meaning of the Broadband Wireless Access Networks (BWA) as well as the Quality of Service.

### 2.2 Theoretical Review

#### 2.2.1 Diffusion of Innovations

The primary aim of this theory is to explore how and why an innovation or a thought has spread to distinct people and cultures. According to Rogers (2003), 'diffusion is a method through which technology or innovation is transmitted over time between individuals in a social scheme.' In addition, Rogers argued that innovation,

communication channels (the way a message passes from one person to another), time (the time it takes for a member of the social group to adopt innovation) and the social system (a set of interrelated units with a common goal) are key elements in the diffusion of research. According to the Theory of Diffusion of Innovations (DOI), there are five significant phases in the diffusion process:

1. Knowledge: is a phase where a person is acquainted with innovation, but there is a lack of complete information.

2. Persuasion: is a phase in which individuals genuinely become acquainted with innovation and become concerned, thus attempting to obtain more data on innovation.

3. Decision: is a very critical stage in the acceptance or rejection of innovation. At this point, individual choices are made on the basis of their intuitions, bearing in mind the benefits or disadvantages of innovation.

4. Implementation: at this point, the person effectively takes on innovation and seeks to discover the usefulness of innovation.

5. Confirmation: is a critical stage in the acceptance or rejection of innovation. At this point, the person makes the final choice whether or not to continue to make use of technology.

In the Diffusion of Innovation (DOI) theory, a number of important variables have been recognized for individual decision-making to embrace or dismiss innovation. These factors are briefly neglected below:

1. Relative Advantage: demonstrates how the fresh innovation improved compared to the earlier version. It implies that the person seeks to discover the benefits of a fresh innovation over the older one.

2. Compatibility: demonstrates how consistent a fresh innovation is with the everyday lives of a person.

3. Complexity or simplicity: demonstrates how complicated the use of fresh technology is. If the use of fresh technology requires a great deal of effort on the part of the person, it is more probable that innovation will be dismissed.

4. Trialability: demonstrates how simple a fresh innovation is. If it does not require a great deal of effort on the part of the person to test and examine innovation, there is a strong possibility that innovation will be embraced.

5. Observability: demonstrates how visible innovation is between individuals and members of the social system. The more noticeable the innovation, the more probable the innovation will be.

The final significant problem with respect to Roger's theory is the categorization of people among members of social systems. Rogers, divided the people into five groups:

1. Innovators: the first to embrace a fresh innovation.

2. Early adopters: who are the second biggest group of people, primarily youth, with higher schooling and earnings.

3. Early majority: those who have long been needed to embrace a fresh innovation and people who are above average social status.

4. Late majority: who generally adopt an innovation after the social system average of the participants have embraced an innovation.

5. Laggards: is the last group of members to adopt a fresh innovation in the social system. Individuals in this group are generally concerned with traditions.

### 2.2.2 Theory of Cognitive Dissonance

Festinger's (1957) initial theory of cognitive dissonance stressed cases in which people had two cognitions that were relevant to one another yet contradictory with one another. Theoretically, cognitions were any snippets of data that people may have. Cognitions could be significant or insignificant to one another. In the event that they were pertinent to each other, they could be perfect or incompatible with one another. Festinger's classic instance was the conflicting cognition of a smoker who realized that smoking was unhealthy. Having proper and conflicting cognitions causes mental torment or discord. The measure of cacophony relies upon the significance of the perceptions and whether different comprehensions the individual holds are steady or conflicting with a specific cognition, alluded to as the generative cognition (Beauvois, 1996). Generative perception is the individual who is generally impervious to transform; it is frequently a cognition of one's conduct, as conduct is difficult to fix. However, it could likewise be a demeanor or a future duty. The degree of discord is proportionate to D / D+C, where D is the aggregate of cognitions dissonant to generative cognition, and C is the total of discernments consonant with generative comprehension, with every cognizance weighted for centrality. Festinger (1957) contended that, dissonance propels psychological job to diminish irregularity. A dietitian who has quite recently eaten a fattening meal is probably going to encounter dissonance. Since it is difficult to reverse the intake of technology, the understanding that it uses technology would be generative insight.

The theory predicts that it could lessen discord by including consonant cognitions ("This technology was great!"), by taking away conflicting discernments ("I don't need to be on a bureaucracy"), by raising the significance of consonant cognitions ("We live

only once, so we should appreciate fantastic technology!"), or by reducing the significance of dissonant cognitions ("technology is unimportant"). The main part of the theoretical tests used one of the three processes. In the induced-compliance paradigm, people are given the perception that they have a low choice or a high decision to take an interest in an activity that is in opposition to their methodology. People who take an interest in high-decision activity have little defense for doing as such (few consonant cognitions) and along these lines experience dissonance. To diminish dissonance, they modify their attitudes so as to be more in accordance with their conduct (Festinger, 1959). In a free-decision or troublesome choice worldview, individuals pick between two unmistakable choices that are either far separated (simple decision) or close (hard decision) in perceived desirability. Dissonance happens following the choice on the ground that the great highlights of the rejected alternative and the unfriendly highlights of the alternative elective are contradictory with the decision. People decrease dissonance by evaluating the choice all the more emphatically and the option excused more adversely than they did before the choice (when the alternatives were considered almost equally favorable). As a result, options were spread apart (Brehm, 1956). In the effort-justification paradigm, individuals are occupied with an effort to accomplish a goal. Dissonance is the result of the irregularity between the horrendous effort that the individual applies and the ability not to apply. In order to decrease this dissonance, individuals evaluate all the more well the explanation behind partaking in active practice (Aronson, 1959).

### 2.2.3 Technology Acceptance Model

In the view of Marangunic (2015), the continuous improvement and progression of technology, specifically ICT-related applications, settles on the choice to choose acknowledgment and dismissal gives a dilemma. On this premise, numerous models

and theories have been made to reveal more insight into the successful utilization of innovation and out everything being equal. The Technology Acceptance Model (TAM) hangs out in analyzing issues influencing users' acceptance of contemporary technology. Without a significant knowledge of the foundation, development and adaptation, alongside the limitations of the model, there can be no wide and systematic study in the sector. The Technology Acceptance Model (TAM) is an expansion of Ajzen's Theory of Reasoned Action (TRA) and Fishbein's Theory of Reasoned Action (TRA) (Priyanka, 2013), a theory introduced by Fred Davis in 1986 and which has since experienced a few changes and approvals.

The objective of the theory is to characterize factors that decide the adoption of technology, the behavior of the use of information technology and to give a close-fisted theoretical explanatory system (Bertrand, 2008). Ducey (2013) portrays that TAM involves Perceived Ease of Use and Perceived Usefulness, which are significant determinants of the adoption of technology and user behavior. Teo (2013) perceived various elements that support the use and adoption of technology. It records individual differences, social impacts, perspectives, attitudes and situational impacts as factors that urge the desire to use technology and improve the ability to acknowledge or excuse it. In addition, Teo (2013) contended that, a person's conduct is influenced by the expectation to execute the conduct, as it were, the real accomplishment of the conduct is proclaimed by an individual's goal to take an interest in the event. The Technology Acceptance Model (TAM) is a noticeable theory that looks to examine the characteristics that impact the usage of technology. Ducey (2013) likewise characterized it as a parsimonious theory of the implementation of technology in an institution that believes that individual reactions to a technology may cause an intention

or curiosity to use a technology that may, in due course, impact genuine use (Aggorowat, 2012). The expectation that can likewise be used to visualize and anticipate the enthusiasm and inspiration to direct conduct and various capacities is additionally vital to TAM. Such an aim is controlled by three factors: the first is close to home that represents human attitudes; the second is a subjective norm that demonstrates social influence; and the third is perceived behavioral control (Huda, 2012). Thus, the expectation of the individuals to grasp a particular aptitude can be secured in the three critical factors set out above. Various researches have been performed to check the legitimacy of TAM. For instance, Aypay (2012) the theory tried anticipating the power of technology acceptance among pre-service instructors and the outcomes showed that there is a connection between model acquisition and technology acquisition.

Jiang (2010) additionally found that the individual practices of technology adoption are valuable yet deficient without thinking about social components and the private condition, which are two of the components implied in the first passage. Thakur (2013) tended to issues impacting the consumer's desire to grasp mobile payment systems and discovered that "performance expectations, effort expectations, social impact are encouraging conditions with regards to e-finance and mobile finance". Garg (2013) proposes that, in formulating perceptions of new procedures, subjective and social norms influence customers just as perceptions of service quality. A number of theories have been made that are important to technology studies. These include: the diffusion of innovation by Rogers (1983), Theory of Reasoned Action (TRA) by Ajzen, quoted by Priyanka (2013) and Theory of Cognitive Dissonance (Festinger's, 1957). In any case, in my point of view, the Technology Acceptance Model is most appropriate on

the grounds that it predicts client behavior by considering the three sections proposed by Huda (2012) and embraced by Shroff (2011) research. The legitimacy of the theory has additionally been assessed and found to be great.

The TAM, which depends on the two key variables Perceived Ease of Use and Perceived Usefulness, has been recognized as a key determinant of technology adoption and efficiency and is one of the most regularly used theoretical models in the field of the Telecommunication System. TAM is additionally one of the most significant and generally acknowledged theories for characterizing the individual's acceptance of technology systems (Bagozzi, 2007). With cautious perception, the factors that make up TAM are likewise the normal individual abilities of individuals using the fourth generation (4G) portable system. Suki (2011) noticed that, to a major degree, the two clear feelings of Perceived Usefulness and Perceived Ease of Use are legitimately connected to attitudes that decide the use of technology.

Perceived Usefulness is seen by Pantano (2012) and Teo (2013) as an emotional possibility that particular application schemes will improve job performance within a specific organization, also known as "efficiency expectations." Wen (2010) noted that Perceived Ease of Use depends on the conviction that it would be easy and bother allowed to acquire a particular ability otherwise called "experience of effort." In the view of (Bagozzi, 2007), the TAM expected that mentalities would have a favorable effect on the mind-set that would guide human attempts towards the use of technology. The TAM has proved to be helpful in the discovery of certain weaknesses in society. In (Portera, 2009) research, it was found that despite the increase in the use of data, proof has shown that there is a substantial decrease among older, unskilled, lower-

salary workers than more youthful, accomplished and high-pay workers. The implementation of the TAM has helped to verify that age, education, income and ethnicity are linked to the belief that data and belief can affect attitudes towards and use of abilities that will improve access to data. In the view of Davis (1989), the creator of the Technology Acceptance Model (TAM), the two significant variables, Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), affect attitudes that determine the implementation of technology and suggest the user's intention to create new abilities. The extent to which fresh abilities are acquired can be considerably influenced by both extrinsic and inherent motivations (Davis 1989). Extrinsic inspiration identifies with the performance of an action since it is considered to be useful in attaining specific results that are distinct from the action itself (Davis, 1989). On the other hand, the inherent motive, Davis describes further, relates to the performance of a job without any obvious strengthening other than the operation of carrying out an activity per se. The method of reasoning why Perceived Usefulness is important to the adoption of technology is that it is grasped above all else in light of the fact that it is instrumental in attaining particular goals which are not intrinsic in the utilization of the expertise itself. The central guideline for every factor in the model is talked about underneath.
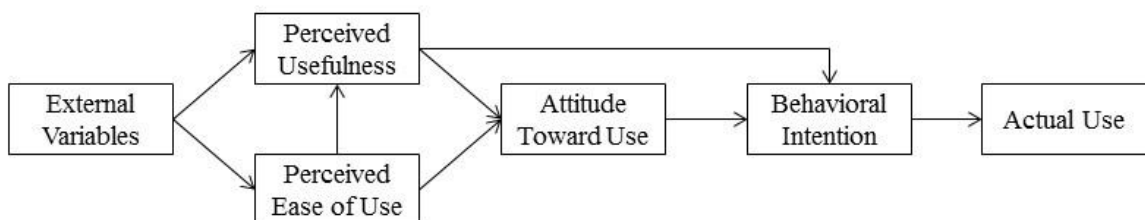


**Figure 1: Technology Acceptance Model (Davis, 1986)**

The two significant TAM constructions, Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are demonstrated above. The Technology Acceptance Model provides a succinct technique for modeling the effect of external factors on people's views, attitudes and intentions. External factors refer to quality outside the person, such as practice, computer experience, system quality, etc. External variables essentially contribute to attitudes towards the use of specific technology and the ultimate use of technology.

## 2.3 Conceptual Framework

Various models have been created to assess the nature of administration dependent on these methods, either attitude-based measures or disabling models. According to Shahin (2010) it is very essential to assess the quality of service because it enables comparisons before and after modifications, identifies issues linked to quality and helps to develop clear norms for service delivery. The model created by Service Performance (SERVPERF) Cronin (1992) utilizes a presentation approach that estimates administration quality dependent on the client's general feeling of administration. This model is useful for measuring service quality, but it does not provide data on how clients prefer service to improve service providers. Teas (1988), created an Evaluated Performance model that measures the gap between the perceived performance and the optimal quantity of the service quality dimension rather than the expectations of the customer. This was to resolve some of the criticisms of earlier designs (Gronroos, 1983) (Parasuraman, 1985). Parasuraman (1985) created a service quality model after conducting a survey of four service environments: retail banking, loan card services, fix and support of electrical gear, and significant distance telephone utilities. The SERVQUAL model mirrors the nature of the services as an inconsistency between the

client's desires for the administration offering and the client's view of the service got (Parasuraman, 1985).

This makes it a measure of attitude. The objective of this model is to measure precisely the perception by the consumer of the quality of the service, which relies upon the size of the hole between the normal assistance and the apparent help, which thus relies upon the holes heavily influenced by the specialist co-op, for example, administration conveyance, promoting (Parasuraman, 1985). This proportion of administration quality depends on both the shopper's appraisal of the administration conveyance technique and the result of the service (Parasuraman, 1985). Buttle (1996) refers to a number of scientists who have used the SERVQUAL model in multiple sectors (retail, restaurants, banking, telecommunications, airline catering, local government, hotels, hospitals, and education). It also indicates that service quality has become a significant issue due to its obvious connection with expenses, profitability, customer satisfaction, customer retention and favorable word of mouth, and is commonly viewed as a driver of corporate marketing and economic results. Good quality of service is also regarded to meet or exceed the consumer's expectations of service (Parasuraman, 1985). The SERVQUAL model was made up of ten aspects of service quality when it was developed; tangible, reliable, responsive, communication, credibility, safety, expertise, courtesy, client comprehension and access (Parasuraman, 1985).

However, these dimensions were subsequently decreased to five because certain dimensions overlapped (communication, credibility, safety, expertise, courtesy, customer comprehension and access) and included,

- Tangibles-physical installations, equipment and appearance of personnel.

- Reliability-Ability to provide the promised service in a reliable and accurate manner.

- Responsiveness-a willingness to assist clients and provide timely service.

- Assurance-knowledge and courtesy of staff and their capacity to inspire trust and trust.

- Empathy-care, personal attention provided by the company to its clients (Parasuraman, 1988).

These dimensions concentrate primarily on the human elements of service delivery (responsiveness, reliability, certainty and sympathy) and the tangible aspects of service. In this research, the investigator is increasingly keen on service quality and consumer loyalty by utilizing the SERVQUAL model to evaluate these reactions in the telecommunications sector, to be accurate. The framework for this research is therefore accepted and taken from the modified empirical research (Dehghan, 2006) as quoted in (Agyapong, 2010) as shown in Figure 1. The figure shows the connection between quality of service and customer satisfaction and the features or factors that determine each of them. As indicated by a research carried out by Ladhari, (2009), it is suggested that the SERVQUAL model be a good measure to be used in the measurement of service quality in a variety of specific sector. However, that it be reasonable to pick the most critical elements of this model suit that specific help to be estimated so as to guarantee exact and substantial results. In this regard, the researcher will use this model because it takes into account the expectations of the customer for the service as well as the perception of the service that is the best way to measure the quality of service in the service sector (Shahin, 2010).

The structure shows that perceived quality is deemed an antecedent to client satisfaction (Woodside, 1989). It shows that the quality of service measured by the factors SERVQUAL may lead to customer satisfaction. A large number of particular designs have been used in conceptual debates and empirical customer satisfaction reviews, but they seem to have at least one thing in common (at a very elevated rate of aggregation): they refer to the connection of the client over time to a particular item (seller, brand, service provider, etc.) (Soderlund, 1998). In addition, (Mittal, 1998) discovered that there was a connection between quality of service and customer satisfaction. Elnan (1999) has shown a favorable connection between service quality and customer satisfaction in the bus sector in Norway. A latest research by Ojo (2010) in the telecommunications sector has shown that there is a favorable connection between quality of service and customer satisfaction. The same connection has been proved (Cook, 2008) and (Oyeniyi, 2008).

Fornell (1996) asserted that perceived quality, described as having experienced a latest consumption assessment of the market served, would have a direct and positive effect on general customer satisfaction. In developing the American Customer Satisfaction Index (ACSI), they found that general customer satisfaction, particularly for ACSI, had three antecedents: perceived service quality, perceived value and client expectations.
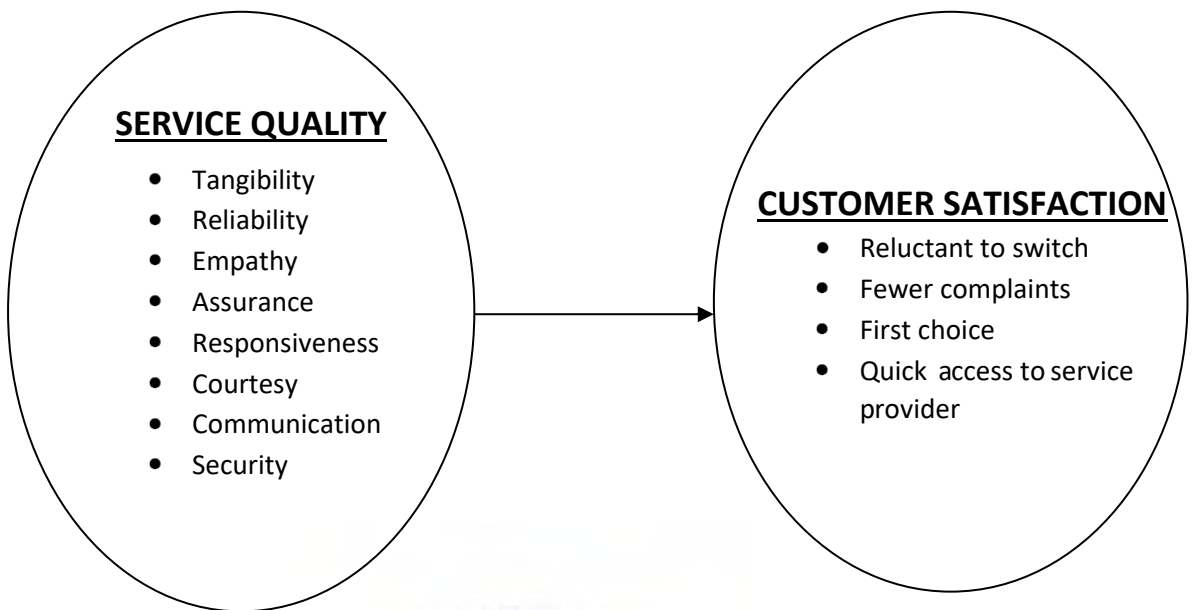
**SERVQUAL Model**



**Figure 2: Relationship between service quality and customer satisfaction**

Source: Adopted from (Dehghan, 2006)

## 2.4 Empirical Review

Rahaman (2011), studied the quality of service provided by private commercial banks in Bangladesh. The results of their research have shown that one of the main causes of failure in service quality design is a lack of comprehension of the changing needs and preferences of targeted clients. Ilhaamie (2010) reviewed the level of service quality, expectations and customer perception of Malaysian public services using the SERVQUAL tool. The research discovered the most significant dimension to be tangible. It also has the smallest perception ratings. On the other hand, the quality of service gap is neither the lowest nor the highest. Finally, these clients have the greatest expectations of the reliability of the Malaysian public service. Ojo (2010) researched the connection between service quality and customer satisfaction in the telecommunications industry with a focus on the Nigeria Mobile Telecommunications Network (MTN). A total of 230 participants took part in the research. The regression

analysis and the Pearson product moment correlation coefficient were used to analyze the 26 information. The research disclosed a favorable connection between quality of service and customer satisfaction.

The investigator therefore proposes that organizations concentrate more attention on service quality as it has a direct impact on customer satisfaction. In order to guarantee that the standard of customer satisfaction is high, organizations must first of all pre-determine the expectations of clients and how they can satisfy those expectations. Customer satisfaction enables with customer loyalty and retention. It has been found that the cost of attracting fresh clients far exceeds the cost of keeping ancient clients. Kheng (2010) used the five-dimensional SERVQUAL model created by Parasuraman (1988) to assess the effect of quality service on customer loyalty among bank clients in Penang, Malaysia. Customer satisfaction has been used as an intermediate variable. The results indicate that improving the quality of service can improve customer loyalty. The quality of service aspects that play an important part in the equation are reliability, sympathy and assurance.

The results show that the general participants rate the bank favorably, but there is still room for improvement. Sammons (1982) as cited by Iddrisu (2015) performed an exploratory survey of customer satisfaction at high end restaurants in Singapore. The article seeks to identify the service dimensions of service quality that lead to greater rates of customer satisfaction. The results of the 27 research showed that the service dimensions of certainty, empathy and tangibles are the most important for the customer's assessment of service quality and could therefore have a beneficial impact on customer satisfaction.

**2.5 Service Quality**

Service quality is a notion that has increased interest and discussion in the universe of research literature due to the problems of both identifying and evaluating it without any general agreement (Wisniewski, 2001). Service quality began as a global trend in the 1980s, when marketers realized that only a quality service could ensure and retain a competitive advantage. Service quality began as a global trend in the 1980s when marketers realized that only a quality service could ensure and retain a competitive benefit (Boshoff, 2004). The concept of quality may differ from individual to individual and from scenario to scenario. Parasuraman (1988), describes the performance of the service as the degree and direction of the difference between the perceptions and expectations of the consumer or the extent to which the service meets or exceeds the expectations of the client. Mevvis (2002) as referred to in (Bahia, 2000) says that the quality of the service depends on that service, consistent with the expectations of the customer. In the service marketing literature, service quality is usually described as the general evaluation of the customer service (Eshghi, 2008) or the extent to which the service meets the customer's requirements or expectations (Asubonteng, 1996). Parasuraman (1985), defines quality of service as a discrepancy between customers and perceptions of the services provided by a specific company and expectations of companies providing such services.' If what is considered to be below expectations, the performance of the customer is judged to be small and if what is perceived meets or exceeds expectations, then the performance of the customer is seen to be heavy. Service quality is once again seen as a distinction between client expectations of service and perceived service. If expectations are higher than performance, then perceived quality is less than adequate and as a result, client discontent happens (Parasuraman, 1990). The quality of the service is also subjectively viewed by clients during their

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relationships with the company (Grönroos, 2000). Parasuraman (1988) again described service quality as the consumer's judgement on the general excellence or superiority of companies. What occurs and is viewed by clients in the interaction process will clearly have a critical impact on the quality of service assessment of clients (Grönroos, 2000).

Definitions of service quality also vary only in terms of wording, but typically require determining whether perceived service delivery meets, exceeds or fails to satisfy client expectations (Cronin, 1992). Service quality is frequently seen as a critical prerequisite and a determinant of competitiveness for the establishment and maintenance of fulfilling customer relationships. Previous studies have shown that service quality is a significant measure of client satisfaction (Spreng, 1996). Lewis (1990) and Asubonteng (1996) define the quality of the service as the extent to which the service meets the needs or expectations of the customer. Attention to service quality can create an organization distinct from other organizations and have a long-term competitive benefit (Boshoff, 2004). This has become a separate and significant element of the product and service offering (Caruana, 2002). According to Brady (2001), service quality helps to generate the needed competitive advantage by being an efficient differentiator. Again, according to Parasuraman (1985), the quality of service can be described as a consumer comparison between service expectations and service performance. They suggested service quality as a function of pre-purchase client expectations, perceived process quality and perceived output quality. On the basis of their declaration in 1985, they then proposed that the quality of the service should be determined by the distinctions between the customers' expectations of the service and their perceptions of the service experience. Parasuraman (1988), describes service quality as the degree and direction of discrepancy between consumer attitudes and expectations or the extent to which a service meets or exceeds client expectations.

Parasuraman (1988 & 1990), estimated a service quality model that recognized perceived service quality in five aspects: tangibility, reliability, responsiveness, certainty and sympathy. There is general consensus that these constructions are significant elements of service quality, but many academics have been skeptical as to whether these dimensions are relevant in the assessment of service quality in other service sectors (Cronin, 1992). Firms with a high quality of service present a challenge to other companies. According to Douglas (2003), Parasuraman (1985), and Ladhari (2009), the intangible aspects of the service (inseparability, heterogeneity and perishability) are critical determinants of the quality of the service perceived by the customer. This implies that a service must be well defined by the supplier in terms of its features in order to comprehend how the quality of the service is viewed by customers. According to Johns (1999), a service could imply a sector, a performance, an output, an offering or a process and is described differently in different service industries. Differences in the service industries are based on service features, including intangibility, heterogeneity, perishability and inseparability. Intangibility implies that there is no physical product, nothing to be touched, tasted, smelled or heard prior to purchase, which implies that it is hard for consumers to comprehend the nature of what they receive. An instance would be a telecommunications firm providing mobile services to customers, where customers make just calls and do not receive any physical products. There is always a significant question, why should the quality of the service be evaluated? Measurement enables for comparison before and after modifications, for the place of issues linked to quality and for the establishment of clear norms for service delivery. Edvardsen (1994) argue that, in their experience, the starting point for creating quality in services is through assessment and measurement as cited in (Johns, 1999).

Service quality can be evaluated in terms of client perception, client expectations, customer satisfaction and client behaviour (Sachdev, 2004) as cited in (Bahia 2000) points out that the assessment of service quality leads to client satisfaction. Gronroos (1982) created the first service quality measurement model to be considered in this section. It recognized three parts of service quality; the technical quality concerns what is provided (result), the functional quality deals with the service delivery method (how it is delivered) and the image quality that is recognized as the corporate image of the business arising from the technical and functional quality of the service parts. The SERVPERF model created by (Cronin, 1992), utilizes a performance strategy that measures service quality based on the customer's general sense of service. (Teas, 1988) created an Evaluated Performance model that measures the gap between the perceived performance and the optimal quantity of the service quality dimension rather than the expectations of the customer. This was to resolve some of the criticisms of past designs (Gronroos, 1984) (Parasuraman, 1985, 1988). For Parasuraman (1985), after conducting a survey on four service settings, also created a service quality model: retail banking, loan card services, repair and maintenance of electrical equipment, and long-distance telephone services. The SERVQUAL model represents the quality of service as a discrepancy between the customer's aspirations of the product offering and the customer's perception of the service received (Parasuraman, 1985). In the context of the telecommunications industry, the researcher is not only interested in learning more about the factors associated with the quality of service perceived by customers and how the quality of service is measured, but is also interested in providing a direction for improving the quality of service in order to bring customer satisfaction.

Organizations can achieve business excellence through quality control of services (Shahin, 2010). Customers are demanding better services and the aim of all telecommunications operators must be to make customers feel special. This will lead to customer perceptions that exceeds their expectations and to greater customer satisfaction. According to Saravanan (2007), the need for survival and growth in ever-increasing competitive markets are key factors in the pursuit of superior service quality and customer satisfaction. Researchers have shown that the provision of good service quality to customers retains them, attracts new ones, enhances corporate image, positive word-of-mouth recommendations and, above all, guarantees survival and profitability (Negi, 2009), (Ladhari, 2009). Organizations that consistently satisfy their customers enjoy higher levels of retention and higher profitability due to increased customer loyalty (Wicks, 2009). That is why it is vital to keep consumers satisfied and this can be done in a variety of ways. One way is by trying to understand their expectations and perceptions of the services offered by service providers. In this way, the quality of the service could be assessed and thus the customer satisfaction could be assessed.

### 2.5.1 Customers' Expectations compared to Perceptions

Gronroos (1982) and Parasuraman (1985), proposed that the customer's perception of service quality be based on a comparison of their expectations (what they feel should be offered by service providers) with their perception of the service provider's performance. Parasuraman (1988), points out that expectations are viewed differently in both content and service quality literature. In the Satisfaction Literature, expectations are considered to be customers' predictions of what is likely to happen during a particular transaction, while in the Service Quality Literature, they are seen as the wishes or wishes of consumers, that is, what they feel should be offered rather than

*2.5.2 Customer Satisfaction*

Customer satisfaction (CS) as a word has gained significant attention and interest among academics and professionals, perhaps because of its significance as a main component of business strategy and as an objective for all company operations, particularly in today's competitive market (Anderson, 1994). This is because a number of scientists have looked at the notion from distinct angles. According to Rust (1994), client satisfaction or discontent with a "behavioral or affective response" emerges as a response to a single or prolonged set of service encounters. In the words of Giese (2000), customer satisfaction consists of three fundamental parts, including the type of reaction (cognitive, affective or conative) at the core of concern or the topic to which the reaction is directed and the timing of the assessment. But Anderson (1994), believes that the literature is not very evident about the difference between quality and happiness. Satisfaction is a person's sense of enjoyment or disappointment as a result of comparing product performance (result) with his or her expectations (Kotler, 2006). Satisfaction is a psychological notion that includes a sense of well-being and enjoyment resulting from the achievement of what one hopes for and expects from an attractive product and/or service (WTO, 1985). Satisfaction can be conceptualized as either an emotional or cognitive reaction. Satisfaction is seen as a judgement that depends on cognitive frames of reference. These frames of reference are culturally distinctive. There is an alternative emotional perspective that maintains that satisfaction is based on hedonic experiences. Satisfaction is a psychological word widely understood to describe gratification that one feels when one's desires, needs, or expectations are fulfilled.

A clear perception of fulfillment is (a) for the purpose of conceptualization and understanding, (b) for the purpose of understanding. Various theorists have tried to explain the notion of fulfillment. Day (1980) said, "While everyone understands what satisfaction implies, it obviously does not mean the same thing to everyone". Geise (2000), recognized three overall satisfaction elements. They said that;

1. Satisfaction is a reaction (either emotional or cognitive);

2. The reaction concerns a specific focus (expectations, product experience, consumption experience, etc.)

3. Response happens at a given moment (after consumption, after selection, based on accumulated knowledge, etc.) there is no single notion of fulfillment.

There has been a discussion on fulfillment, whether it is a method of fulfillment or an outcome. Several scientists have asserted that satisfaction is an assessment method (Fornell, 1992). Others regarded satisfaction to be a reaction to the process Howard, 1969, Oliver 1981. Howard (1969) quoted in (Day, 1984) regarded satisfaction to be a mental state of buyers while the state of fulfillment depends on both psychological and physical factors. Satisfaction is seen as a latent structure that is not immediately observed and can only be estimated by means of indices. Customer satisfaction "as an attitude of judgement following a buy act or a series of consumer product interactions" (Yi, 1990) quoted in (Lovelock, 2007). To be sure, satisfaction is more complicated to describe in order to suit every context and measure precisely. In the words of Oliver (1997), "everyone understands what fulfillment is until he has been asked to offer a definition. Well, it seems, nobody understands."

From a marketing perspective, customer satisfaction is multidimensional. Customer satisfaction may vary and may be linked to distinct aspects of various product/service provider experience (Surenshchandar, 2002) as cited in (Satara, 2007). Customer satisfaction is also conceptualized as a transaction-specific significance relying on the customer's experience of a specific service encounter (Cronin, 1992) and also some believe that client satisfaction is cumulative based on the general assessment of the service experience (Jones, 1995). Customer satisfaction was also considered to be a key performance indicator in the marketing literature on the quality of the connection between the service provider and the client. Customer satisfaction retains the ability to increase the client base of the organization, increase the use of a more volatile client combination and improve the reputation of the company (Fornell, 1992).

One way to achieve client satisfaction is through client service. Customer services vary by product, sector and client. However, it assumes a significant dimension in the delivery of services and sales of the item. This is because service companies, such as telecommunications companies, do not have an inventory of finished goods in order to buffer manufacturing from random demand fluctuations (Dutta, 2006). However, it is a demand for the survival, profitability and development of a corporation that service companies maintain their own in competition. However, it has been recognized that human needs, the quality of facilities and products, the user-friendly nature of products and services, and comfort assurance (Bailey, 1983), although distinct clients will require distinct concentrations and combinations of these variables, they are usually significant factors that influence customer satisfaction. Matzler (2002) as cited in (Day, 1994) took a step forward in classifying the variables affecting customer satisfaction into three factors systems  are some of the significant determinants of customer satisfaction.

1. Basic factors: these are the minimum conditions that are needed in a product in order to avoid the client from being unhappy. They do not necessarily cause fulfillment but, if present, lead to discontent. These are the variables that contribute to the satisfaction of the basic requirement for the production of the item. These are the fundamental characteristics of the product or service.

2. Performance factors: these are factors that lead to satisfaction if they are met and may lead to discontent if they are not met. They include reliability and friendliness.

3. Excitement factors: these are factors that boost customer satisfaction if met, but do not trigger discontent if not met, including project management.

That is why it is essential to maintain customers' satisfaction. This can be achieved in distinct ways, and one way is by attempting to understand their expectations and perceptions of the services provided by service suppliers. In this manner, the quality of the service could be evaluated and the customer satisfaction evaluated. In this research, the researcher will use clients to assess service quality by considering a number of significant quality characteristics in the telecommunications industry, and believe that companies need to take action to improve characteristics that have a reduced level of satisfaction. This implies that customer satisfaction will be regarded on particular dimensions of service quality in order to define which aspects clients are satisfied with.

## 2.6 Mobile Telecommunications: Evolution and Development

Mobile telecommunications are going through a huge revolution that is going to alter the world. Mobile telecommunications networks will move from traditional desktops to consumer-oriented computing using smart wireless personal multimedia devices that

communicate with each other (Danneels, 1998). Mobile telecommunications services have been accessible since the early 1960s, and their diffusion has been influenced by technological developments such as the shift from analog to digital technology, competition within the sector, licensing of spectrum and harmonization to common technical norms (Gruber, 2001). Mobile telecommunications technologies have developed in successive generations, including the first generation (1G) technology, the second generation (2G) technology or the global mobile communications system (GSM) technology that has been widely used to date, the third generation (3G) technology that is critically dependent on the integration of multimedia facilities and fourth generation (4G) technology that generates 200 Mbps data (Dunnewijk, 2007).

Mobile phones have become a commodity for millions of individuals all over the globe and are increasingly being used in the most advanced and developing nations (Beaubrun, 2001). In addition, the regulators in the European Union have chosen to impose a common standard, i.e. GSM. It was initially criticized but, in the long run, everyone was inspired by the decision. Today, GSM has one of the widest ranges of standards in the world of technology and has spread across the continent in a short period of time, achieving penetration rates that no other technology has ever achieved before (Fuentelsaz, 2008). New telecommunications services include: computer communications, facsimile, mobile and voice telephony, video telephony, conference television, viewing data, cable television, remote metering, monitoring and alarm services (Reid, 1978). The drive for universal telecommunications is mainly ascribed to rapid technological growth and a progressively more liberal policy climate. It is recognized that, over the last decade, a number of emerging countries have embarked on reform routes and witnessed significant development in their telecommunications

networks and significant productivity improvements (Fink, 2003). The amount of mobile and fixed-line telecommunications subscribers have increased from less than one billion to nearly four billion globally between 1996 and 2006. The telecommunications sector has experienced tremendous growth and rapid structural change (Djiofack, 2009). Telecommunication has turned the world into a global village, resulting in deep modifications in the social structure that rival those of the industrial revolution (Pitroda, 1976) quoted in (Yang, 2006). The role of mobile telecommunications technology in social relations has become increasingly crucial. Ajiboye (2007), indicated that the application of GSM norms has a direct and indirect contribution to worldwide economic growth, has led to the development of fresh jobs possibilities and has improved the Gross Domestic Product (GDP) of several countries.

4G (fourth generation) mobile network communication, 4G standard very quick and efficient compared to 3G network, 4G communication is very fast and reliable and distinctive. It has a nice Voice quality and video quality, a very reliable and multimedia messaging service, guaranteed to deliver destination information. 1G was an analog signal, 2G was a digital signal and 3G was a multimedia aid. 4G is essentially the extension of 3G technology with more bandwidth and velocity. The prospect of 4G technology is high speed internet connection and high velocity and accurate speech quality. According to the report Mudit (2010), the word Magic also refers to 4G wireless technology, which stands for Mobile multimedia, worldwide mobility solutions over and above, embedded wireless and tailored services (Patil, 2012). A number of study projects in recent years have concentrated on problems linked to a single device type connection through a distinctive network interface. Wireless accesses have been researched from a number of points of view: hand-offs, efficiency,

fresh protocols, maintenance of QoS, safety, etc. However, the area of multiple wireless interfaces has not yet been fully addressed in the scientific literature (Zhao, 2001). It falls within this area but mostly deals with IP issues just mentioning, without providing any factual algorithm, possible support for QoS through the use of multiple interfaces. Furthermore, this project does not address energy problems resulting from the use of various interfaces. In literature, we discover many examples of wireless specialized transport protocols (Huston, 2001) Inter-arrival times between data packets are used in (Biaz, 1999) as an interpretive metric to discriminate between congestion and error losses.

In order to face issues linked to disconnections and hand-offs, Goff (2000) recommends to use the conventional Transmission Control Protocol (TCP) feature of sending a zero advertised window to the source, which, if obtained in time, will stop transmissions and therefore losses until complete connectivity is restored. Special testing packets are used in (Sinha, 1999) after each loss to determine the situation of the channel, only if their delay suggests congestion, then the transmitting rate decreases. In case of bad channel circumstances, one of the two scanning packets is likely to be lost, the scanning cycle is thus expanded with an exponentially increasing departure interval. Because of the tiny size of the screening packets, this system also saves energy in the event of temporary disconnections. A fresh end-to-end transport protocol is also suggested (Sinha, 1999). This research is confronted with the large amount of mistakes and variable latency of the wireless setting, eliminating the timeout system, using regular SACK packets (Fall, 1996) to know when retransmission is suitable, and estimating the channel capacity to set the data transmission rate. The main innovative concept behind (Mascolo, 2001) is the use of information recognized in the time unit in order to assess

the efficient bandwidth available on the link. This bandwidth estimation is calculated by sampling and exponential filtering techniques and then used to properly set the slow start limit after a loss or during a slow beginning. Much research has also been performed on the Single Interface Power Saving Mechanisms (Feeney, 2002) and (Jung, 2002). Precise instances include research on the Bounded Power Save Mode (BPSM) (Krashinsky, 2002) and measurement of the power consumption of tiny machines (Feeney, 2001). When using various devices such as 802.11 and Bluetooth, meddling problems arise from using the same frequency band. Interference between 802.11 and Bluetooth has been explored in (Golmie, 2001) and methods to solve it have been suggested in (Kamerman, 2000).

On the other side, how each device should be switched on / off to minimize this issue when these devices are being used on the same terminal has not yet been studied. However, low-power Bluetooth modes could be very helpful when implementing such power-saving and interference-aware algorithms. The transfer idea has begun with links in cellular networks and concerns a terminal that moves from one cell to another. This general situation of horizontal handover between networks using the same access technology was also explored in the 802.11 domain. There have been countless documents dealing with horizontal hand-offs across homogeneous cellular Asynchronous Transfer Mode (ATMs). We're talking about vertical hand-offs when we focus on switching connectivity between networks that use different access technologies. The BARWAN project (Stemm, 1998) carried out seminal work in this area, also taking into account various access technologies: infrared, Wavelan and Richocet and other proposed techniques to reduce hand-off latency across technologies. A session layer is implemented in (Ghini, 2004) to efficiently tackle disconnections

owing to horizontal and vertical disconnects during seamless music delivery to mobile consumers. The research described involves some measurements to calculate the quantity of energy consumed by the distinct interfaces and looks at application-oriented power-saving methods. Although this work explored a plethora of issues related to the quality of mobile network services, there are still many open problems, some of which have arisen as a result of the emergence of technologies such as Bluetooth, 2.5G and 3G. Vertical hand-offs in these technologies led to the development of the open field of the 4G communication scheme at the heart of this job. At the end of the day, mobile extensions for Internet Protocol (IP) telephony have been proposed, but the seamless vertical handover of a telephone call is still an open issue (Feigin, 2000). They try to ensure that the client has a pleasant link experience passes through effective and scalable content adaptation and distribution in wireless networks. This has resulted in a number of alternatives that rely on information transcoding (Mohan, 1999). Depending on the channel circumstances, the information is sent at distinct compression / quality levels, thus restricting the byte transferred when needed at the expense of some extra computational job.

Adapting content to channel conditions can also be achieved by using proxies (Kim, 2000). Indeed, many alternatives have championed the use of proxies in particular to enhance efficiency in wireless networks (Zhao, 2001). In addition, Chakravorty (2002) researched the conduct of HTTP and TCP on General Packet Radio Service (GPRS) networks, their impact on web browsing on such networks, and the use of proxies to address this issue. It was also suggested that proxies be used for caching and/or prefetching in wireless networks (Gitzenis, 2002). Enhanced proxies could also help to enforce the QoS requirements in wireless networks (Jiang, 2001). However, the transfer

of QoS information, particularly where transfers occur between dissimilar networks, has not been studied in detail. Indeed, the state of the art of the suggested processes enables for the differentiation of QoS but does not guarantee the level of QoS (Pattara, 2003). The emerging idea in this field is to replace the hard QoS guarantee utilized for wired connection with a soft QoS scheme (Wong, 2003) Focusing on the QoS support in the currently leading WLAN standard, it will be noticed that the IEEE802.11a, b, and g, version do not have any QoS management unless extended with the IEEE802.11e. In addition, QoS support in the IEEE802.11e still introduces a number of open problems to be resolved. Session mobility between heterogeneous terminals is a fairly fresh subject and the methods to tackle it come from continuing work such as the Integrated Mass Announcement System (iMASH) project (Phan, 2002).

The scalability of the mechanisms presented is based on a Distributed Middleware Service layer that maintains the consistency of the application session even in the case of a large number of clients. Even if the particular aim of this project is to apply for healthcare, the suggested solutions can be expanded to a general mobile application. Another feasible method is to use Virtual Socket on top of the real ones, in order to resume transmissions after a session. Much research has been performed in the field of wireless security. In order to provide authenticated end-to-end safety, the iMASH project (Skow, 2002) already mentioned uses multiple methods, such as the Bell-LaPadula models combined with the Public Key Infrastructure. The symmetric key solutions are equally safe and less expensive than the public ones in a wireless setting. However, the use of a specific set of protocols for the test does not allow this statement to be generalized with certainty. A security protocol specifically intended for a WLAN setting is provided in the use of tokens, which enables a straightforward safety system to be used, avoiding overly advanced and resource-consuming cryptographic methods,

taking into consideration the features of wireless media such as restricted bandwidth and computational energy. The security protocols for IEEE 802.11b and the consequences for the privacy and use of users in both Peer to Peer (P2P) and Grid have raised a good deal of concern in the scientific community. A comparative assessment between the two systems is provided in (Foster, 2003) and with variations in final customers and the computing capacities needed, the two systems present different points of touch in their unsolved problems. In the context of P2P, research has concentrated on the development of fully decentralized networks. In specific, different Hash Distributed Table (DHT) frameworks for efficient path of messages have been created (Ratnasami, 2001). However, many other issues still need to be resolved efficiently, including full anonymity, trust between nodes, effective content search, etc. The Grid is described as "flexible, safe and coordinated sharing of resources between vibrant collections of people, institutions and resources, what we refer to as virtual organizations" (Foster, 2001). Carefully reading this definition, there are several challenges to the implementation of the facts, many of which can be shared with P2P technology, the discovery and use of remote resources, the formation and information maintenance of large distributed virtual communities, the preservation of personal and remote security, etc. There is no need to mention that the wireless situation, in specific mobility, further improves the complexity of the issues mentioned. Mobile telecommunications are the use of cell phones or other user equipment or terminals to make calls, exchange through sms, communicate information, use of multimedia services such as video call, MMS, etc. over a range (Pashtan, 2006).

**2.7 Defining Broadband Wireless Access Networks (BWA) and QoS**

BWA networks provide high-speed Internet access to users in a wide area of wireless technology. Internal Mobile Telecommunications-Advanced (IMT-Advanced) met the requirements for 4G BWA networks mentioned below (ITU-R, 2008).

- High Spectral Efficiency to provide maximum information rates of 100 Mbps for high mobility access and 1Gbps for low mobility access.

- Optimized switched packet.

- High level of mobility and security.

- Optimized terminal energy efficiency.

- Supports scalable bandwidths.

- LTE and IEEE 802.16 WiMAX (Worldwide Interoperability for Microwave Access) are both considered to be the candidate technologies for the fourth generation (4G) of mobile networks. The two technologies are available.

- Completely embedded IP solutions.

- "Anytime "access to" Anywhere".

- The system is particularly effective.

- High QoS for different apps.

Long Term Evolution (LTE) is the recent standard for the 3rd Generation Partnership Project. LTE Radio Access, the Evolve UMTS Terrestrial Radio Access Network (E–UTRAN), promotes high system ability, low latency and user mobility. LTE deploys two distinct uplink and downlink access methods. It uses the Orthogonal Frequency Division Multiple Access (OFDMA) on its downlink.

Uses Single Carrier-Frequency Division Multiple Access (SC-FDMA) on its uplink in order to reduce the Peak-to-Average Power Ratio (PAPR) to save the battery power to the User Equipment (UE). LTE physical supports transmission in both Time Division Duplex (TDD) and Frequency Division Duplex (FDD) modes. LTE physical supports scalable bandwidths from 1.25 to 20 MHz. LTE supports maximum information rates of 150 Mbps and 50 Mbps for Downlink (DL) and Uplink (UL) respectively. The objective of the IEEE 802.16 series of norms is to provide BWA over a lengthy range. Mobile WiMAX uses the OFDMA access method for both uplink and downlink transmissions. In both the TDD and FDD modes, WiMAX physical supports transmission. Mobile WiMAX physical promotes scalable bandwidth channels from 1.25 to 20 MHz. Supports maximum information rates of 128 Mbps and 56 Mbps in DL and UL, respectively.

WiMAX is the 4G technology applicant, apparent from the latest Holborn fire incident of 1st April 2015. The fire caused significant disruptions to broadband facilities in the impacted region. The companies in the impacted region switched to WiMAX to acquire broadband services (Scroxton, 2015). WiMAX continues to develop across Africa and the Middle East. In addition, Afghanistan's Ministry of Communications and Information Technology provided WiMAX permits to carriers in 2012 and projected to expand to 80 percent of Afghanistan's population in just two years (Cyprien, 2012). Pakistan has the greatest penetration of WiMAX worldwide. According to WiMAX Forum President Declan Byrne, "WiMAX technology has accomplished a penetration rate of 50% of all broadband links in urban centres in Pakistan" (Rehman, 2012).

WiMAX operators with TDD spectrum will continue to expand in Japan, Korea, Malaysia and the USA. WiMAX technology provides an ideal solution for private networks serving specialized sectors such as energy utilities, intelligent grid industrial telemetry apps, measurement and management of critical devices that require real-time and high safety, such as the aerospace, transport and petroleum sectors. WiMAX is anticipated to harmonize and integrate with LTE in such a way that WiMAX networks serve specific segments while LTE offers government networking (Aldmour, 2013). QoS relates to the general quality of apps encountered by users of the network. The network connection QoS can be evaluated in terms of several parameters. This thesis considers throughput, queuing delay, packet loss and reasonable distribution of resources.

    (a) Throughput: is the data rate (bits per second) of the traffic effectively obtained on the network.

    (b) Queuing Delay: shows the delay of the packets in the queue of the buffer of the base station. In situations where the departure rate for the packets from the buffer is lower than the arrival rate for the buffer, the queuing delay increases. Queuing delay has important effect on the results of real-time apps such as voice, live streaming and online gaming.

    (c) Packet Loss: This thesis relates to the loss of the packet to the output buffer due to overflow. It only occurs when the speed at which the packets arrive in the buffer is more than the speed at which they leave the buffer. Similar to queuing delay, packet loss has important effect on the QoS of real-time apps.

(d) Fair Resource Allocation: this attribute shows the capacity of QoS systems to distinguish between distinct types of services and to allocate funds to satisfy the QoS demands of each type of service. It also allows the network to allocate the same resources to links with the same QoS demands and thus guarantee the fairness of the network.

# CHAPTER THREE

## RESEARCH METHODOLOGY

### 3.1 Introduction

A review of the literature on the topic Evaluating of the Quality of 4G mobile network in the Greater Accra Region was captured in the previous chapter. The research design and methodology used in the study were described in more detail in this section. The rationale for choosing a qualitative research methodology was given and the function of a qualitative investigator was briefly explored. Population and sampling strategies used in this research were discussed. Details were given on the techniques of information collection used in the research, namely in-depth interviews and focus group interviews. Next, the method of assessment was described and, lastly, the section demonstrated how the reliability of the studies has been ensured and what quality criteria have been implemented.

### 3.2 Research Design

Research design was one of the testing strategies and methods selected by the researcher. The design helped the researcher to concentrate on the study methods that were suitable for the topic and to set up the experiments to be effective. A qualitative research study was used by the researcher and the research design chosen for the study was a narrative research. The investigator used a focus group and an In-depth interview technique for the study. The focus group was used because it is a way of collecting intentionally chosen individuals who are taking part in a scheduled debate aimed at generating customer perceptions about a specific issue or region of concern in a non-threatening and receptive setting. Focus groups have a unique benefit over some other kinds of market research. They are flexible in design, capitalize on the capacity of

decision-makers to communicate with their clients and their understanding of their brands, goods or services. An in-depth interview is described as a qualitative research method in which extensive individual interviews are performed. This technique was selected because the researcher was interested in dealing with a small number of participants in which their views were investigated on a specific program, concept or topic. The focused group in the study consist of people who use phones that can access 4G network. An In-depth Interview was used in such a way that the research work could be carried out within the specified timeframe.

## 3.3 The Scope of the Study

The study picked Accra Metropolis as a research region owing to the reality that it has better telecommunications equipment and rivalry between telecommunications providers is by all accounts solid in the region compared to other areas of the nation. In addition, the Accra metropolis has a heterogeneous population of mobile phone users with a varied socio-economic background and is therefore regarded a delegate sample of the population of mobile phone users in Ghana.

## 3.4 Population

The purpose of this research is to explore the quality of service in the mobile telecommunications sector in Ghana. As such, all mobile phone users in the Greater Accra region are part of the population of this research. The region has a population of over three million. Since the population is so big, collecting information on all the components is prohibitively costly.

**3.5 Sample and Sampling Technique**

When conducting research, it is difficult to study everyone doing everything everywhere (Miles & Heberman, 1994). Denscombe (2003), stated that, in spite of the fact that it is not possible for researchers to gather information from the entirety of the categories under investigation, the researcher acquired proof from an area of the category through sampling methods. The study population consists of customers from the telecommunications industry in the Greater Accra region. Thus, sixty (60) mobile phone users in the Accra metropolis were sampled for the study given the time constraints and limited resources available. The study used the purposive sampling techniques. The purposive sampling is explained by Kothari (1994) as another sort of non-probability sampling technique which is portrayed by the use of judgment and intentional effort to get representative samples by taking into account areas or groups for the sample. Frankel (2012) also indicated that purposive sampling, as a non-random sample is used when those to be selected have the requisite information. In view of this, the researcher purposively selected 4G network users at Accra metropolis for the study because they had the required information needed by the researcher in the study.

**3.6 Data Collection**

Data might be arranged either as primary or secondary in nature. Secondary data basically incorporates information found in books, diary articles, sites and catalogues, which gives information that may have been gathered for different purposes (Ghauri & Grønhaug, 2005). Primary data, on the other hand, is collected in the event that secondary data is not available to respond to a specific research problem that the researcher seeks to solve. This form of data can be collected in many ways, such as through observations, experiments, surveys and interviews, depending on the research

design / approach adopted for the study (Grønhaug, 2005). The researcher used interview for the study.

**3.7 Data Gathering Instruments**

The interview guide enables participants to skip some of the issues and come back to them later. In addition, the respondent had sufficient time to consider the questions before filling out his/her responses. The interview guide focused on the following fields:

A. **Background information**

The issues concentrated on the background data of the individuals in Accra, such as sex, age and ethnicity.

B. **Mobile telecommunication network operator**

The issues concentrated on the suppliers of mobile telecommunications networks that both individuals have used, just as the period they have gone through with the network operator.

C. **Mobile telecommunication services**

Issues concentrated on mobile telecommunications services that people use on their networks, for example conference calls, data services, GPS services, international roaming, multimedia messaging services, short message services and voice calls. It likewise concentrated on how mobile telecommunications services are rated on their mobile telecommunications network. Further issues concentrated on the importance of variables in determining the quality of mobile telecommunications services, such as cost/billing services, customer service, network accessibility and stability, user satisfaction and speech clarity. It also concentrated on the difficulties they have experienced in the use of the mobile

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telecommunications facilities listed above, as well as on the social impact of mobile telecommunications services. Justification for the methodology of studies is crucial. Theorists have argued that empiric surveys should have well-defined questions in addition to obtaining an efficient, reliable and valid assessment (Feldman, 1988) quoted in (Davis, 1996). The questionnaires intended for this research have been published in English.

## 3.8 Data Collection Procedure

The researcher asked permission from the respondents for the study to be conducted. The respondents were briefed on the purpose of the study and the procedures of how the data collection was undertaken. The purpose was to ensure that the minds of the respondents were well prepared towards the study. The researcher relied on primary data by considering the nature and the objectives of the study. Hence, the appropriate instrument was an interview. The respondents were asked to respond to interview questions based on their respective personal experiences. A period of two days was allotted for the interview.

## 3.9 Data Analysis

Data analysis is an iterative process which is made up of data reduction and drawing of conclusions (Alenezi, 2020). An interview was conducted as the research instrument for the study. The responses from the interview were transcribed into text to support the discussion of the results.

**3.10 Ethical Consideration**

The following ethics were adhered before and during the study. Confidentiality was an issue within the study. However, for its maintenance, the participants involved were guaranteed that any identifying data included would not be made available to other individuals who were not part of the study and their personal information will be kept confidential. Lastly, anonymity was maintained concerning the identities of participants for guaranteeing privacy.

# CHAPTER FOUR

# RESULTS OF THE STUDY

## 4.1 Introduction

The purpose of the study was to evaluate the quality of 4G Mobile Network in the Greater Accra Region. This chapter deals with presentation and analysis of data and the discussion of the research findings.

## 4.2 Demographic Characteristics of Respondents

Generally, a focused group representing people who access 4G network were surveyed for this study. Concerning the subject matter under study, the researcher considered the views of these respondents relevant to the study. The demographic characteristics of the respondents were collected and analyzed in a table and a chart below.
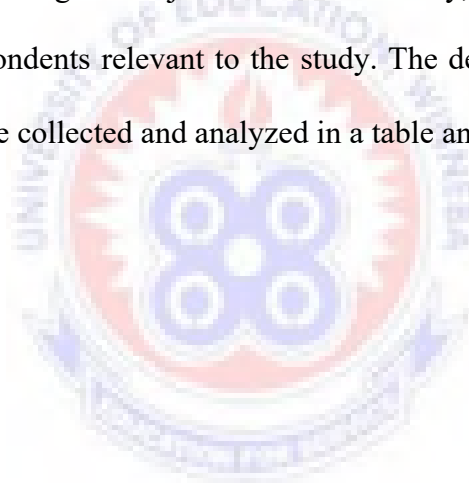
### 4.2.1 Demographic Background of Respondents

**Table 1: Demographic Characteristics of Respondents**

**Age**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 21-34 years | 36 | 60 | 60 | 60.0 |
| | 35-49 years | 22 | 36.7 | 36.7 | 96.7 |
| | 50 years and above | 2 | 3.3 | 3.3 | 100.0 |
| | Total | 60 | 100.0 | 100.0 | |

**Marital Status**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Single | 28 | 46.7 | 46.7 | 46.7 |
| | Married | 32 | 53.3 | 53.3 | 100.0 |
| | Total | 60 | 100.0 | 100.0 | |

**Network Operators used by Respondents**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 1 Network Operator | 11 | 18.3 | 18.3 | 18.3 |
| | 2 Network Operator | 40 | 66.7 | 66.7 | 85 |
| | 3 or more | 9 | 15 | 15 | 100.0 |
| | Total | 60 | 100.0 | 100.0 | |

**Gender**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Male | 35 | 58.3 | 58.3 | 58.3 |
| | Female | 25 | 41.7 | 41.7 | 100.0 |
| | Total | 60 | 100.0 | 100.0 | |

**Employment Status of Respondents**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Entrepreneur | 20 | 33.3 | 33.3 | 33.3 |
| | Unemployed | 6 | 10 | 10 | 43.3 |
| | Employed | 34 | 56.7 | 56.7 | 100.0 |
| | Total | 60 | 100.0 | 100.0 | |

**Source: Researchers' field survey, 2020**

Information from Table 1 shows that the total number of male respondents were thirty-five (35) and twenty-five (25) of the remaining were females. In terms of their age, thirty-six (36) respondents were found to have ages from twenty-one to thirty-four, twenty-two (22) respondents were found to have ages from thirty-five to forty-nine whiles the other two (2) respondents were from fifty years and above. This implies that majority of the respondents were relatively young people with much knowledge and understanding of the study. In terms of employment status, twenty (20) respondents were entrepreneurs, six (6) respondents were unemployed whiles the other thirty-four (34) were employed. This implies that majority of the respondents were workers. In terms of marital status, twenty-eight (28) respondents were single and thirty-two (32) respondents were married. This implies that majority of the respondents were married. In terms of network operators used by respondents, eleven (11) respondents use only one (1) network operator (sim), seventeen (17) of the respondents use two (2) network operators (sims), twenty-three (23) respondents use three (3) network operators (sims), and nine (9) respondents use three (3) or more network operators (sims). This implies that majority of the respondents use more than one network operators. In terms of respondents who use 4G network, all the respondents access 4G network. This implies that all the respondents' access 4G network.

## 4.3 Results

Interviews centered on the quality of 4G Mobile Network in the Greater Accra Region. Two primary categories were identified as affecting the participants' use of 4G Mobile Network:

a) 4G Mobile Network attributes (personal and professional).

b) 4G Mobile Network actions within the telecommunication system, with mobile network users.

*4.3.1 4G Mobile Network attributes*

4G Mobile Network attributes can be viewed as those individual characteristics that participants identified as affecting their use. Attributes were categorized as either personal or professional.

**Respondents were again asked about** what they do when they are faced with poor network. Selected comments have been given below;

> Daniel, Clement and Benson said that "*they switch off their phones*".
>
> "*When am faced with network challenges I move to another area basically or wait for some time and then it will be resolved by itself*", [Respondents 1 & 10]
>
> "*When I'm faced with a network problem I try to relocate to get to a place where I would get better network*", [Respondents 11 & 60]
>
> "*With poor network I wait for the network to go through then after it begins working, I can call the service provider and complain to them about what happened*", [Respondents 2]
>
> "*I mostly do calls when it is necessary*" [Respondents 7]
>
> "*I reboot my phone*", [Respondents 17, 8, 31, 55 & 20]

The study found that when they face poor network they only put their phones down for a while or move to areas where the network is good or sometimes switch their phones off and switch it on again to see if the network will be stable, others switch to another network so that they can do what they have to do with the network. The study found that if the problem persist (network problem), they have to change the network and they have no option than to change the network. The study also found that network users have to change their location to check whether they can get good network at those areas and better still they get into the school where most often they get good network.

However, the study found that sometimes it was not all that often but when it gets to the peak time, that was when they experience most of the poor network. Others reboot to check whether there is an internal cause because sometimes things do occur which might be the fault of the user. Lastly, the study found that 4G network users do their personal checks to find out whether it is from the network providers.

The researcher asked the respondents that when they have poor network, what would be their alternative options. Alaska, Alex, Isaac, Ebenezer, Emmanuel and the other participants spoke about what they do as an alternative option when they experience poor network: Selected comments have been given below;

Alaska said "*the alternative option for him is to switch to a different network called MTN*", Alex said "*when they have a poor network they just wait for some time when the network gets better they do their calls*".

Isaac, Ebenezer, Emmanuel said "*when they have poor network most of the time they wait for the network to be resolved*".

"*She uses different network if having a network problem with MTN then she considers AirtelTigo or Vodafone*". [Respondents 21, 24, 31, 23 & 22]

"*When he has poor network, the alternative option is to switch off his phone and then put it on again to see if the network would work*", [Respondents 19, 38, 13, 15 & 25]

"*When he has problem with their network he tries to change the sim, if for instance he is using MTN in an area where the network is bad he tries to use Vodafone*". [Respondents 12, 42, 33, 50 & 45]

"*He moves to a different location to have a better network*". [Respondents 43, 8, 1, 5 & 7]

The study found that when they have poor network they wait for the network to come or switch to another network. The study also found that users change the network immediately. Lastly, they switch on to a different network like from MTN to Vodafone or from Vodafone to MTN.

The researcher then asked the participants how they attempt to resolve the poor network services. Selected comments have been given below;

Sarpong, Maxwell and Enoch said that "*I don't have the intention of attempting to resolve poor network services*".

"*I only resolve network service in my area by lodging a compliant to the network service provider*". [Respondents 14, 37, 6, 45 & 25]

"*I expect the service provider to solve it so I used to wait*". [Respondents 29, 31, 33, 23 & 59]

"*I mostly call the network service providers to complain*". [Respondents 1, 4 & 50]

"*I try to resolve it and if still it does not work he tries to call the network customer service example if it is MTN he calls 111 and complain to them for them to help him solve the problem*". [Respondents 19, 21, 15 & 56]

"*Sometimes it may be the server which is off or the weather condition or area*". [Respondents 53, 60, 7, 46 & 52]

"*I call the service provider and tell them that the network is not clear or is not ok by using another network to call them*". [Respondents 3 & 48]

"*I just have to contact the main office of the telecommunication networks and not necessary diverting or changing the service but rather consulting them from*

*time to time to check for the problem to be resolved*". [Respondents 43, 38, 47 & 49]

"*I call the service providers to check whether they have a problem in the area, sometimes they do explain that they have sent their technical men to see, because they inform me that I'm not the only person who have called because of that they just want to come and resolve it or check whether there is a problem*". [Respondents 32, 34, 13, 35 & 9]

"*Currently, my phone has a double sim so I am using AirtelTigo and MTN at the same time. Usually, when there is a problem I switch between the networks*". [Respondents 29, 58, 13, 56 & 55]

The study found that mostly and sometimes, network users lodge complain by calling the service providers about the poor network that they are experiencing with their phones. The study found that users reboot their phone. Also, users call the call center of the network providers for them to see whether they can assist them. Lastly, when network users have poor network, they reposition themselves and if it persists then they call the network customer line whiles others still change the network.

The researcher then asked another question on how they know if their network challenge was resolved when they contacted the service providers. Selected comments have been given below;

Reuben and Engelbert said that "*I always send text messages*". [Respondents 1, 8, 7 & 9]

"*I normally don't contact network providers so I don't have any idea on that one*". [Respondents 20, 28, 23, 27 & 29]

"*I only know that the network challenge is resolved based on the feedback or the quality of network that I will later on get*". [Respondents 33, 38, 30, 31, 37 & 39]

"*The service will show on my phone, like the calls and everything will go through then I realize that it has been resolved*". [Respondents 43, 40, 47 & 49]

"*Okay, when I contact the service provider and the challenge is solved my network comes on so I am able to use it sometimes they keep telling me that there is nothing wrong with the network but I think it may be network jam because a lot of people use the network I am using*". [Respondents 53, 52, 54 & 51]

"*When I switch my phone on, I then look at the network icon on the screen of my device if the network is there. If it is there then it means it has been resolved and I can use it*". [Respondents 55, 56, 59 & 3]

"*I have to retry, probably the period that I would be experiencing the challenge if it is still not working, then I wait during the morning and evening*". [Respondents 21, 4, 24 & 25]

"*Sometimes when the network is good or when network problem is resolved, I see that I get either 3g or 4g but immediately it gets to the edge then it means the problem still exists. Sometimes, when I find it difficult to get the bars, then it tells me that there a problem with the network again*". [Respondents 5 & 6]

"*I will know if my network has been resolved when I put on my data and I am able to access the internet or make calls as compared to the initial stage where I couldn't connect to the internet. That is what will indicate for me to know that the service provider has been able to resolve my network*". [Respondents 32, 35, 1 & 34]

"*I have to retry what I was doing or make a call or try the data again to see if it has been resolved*". [Respondents 36, 41 & 42]

"*One thing I have observed is that usually when it is down, there is a triangle signal under the network system if it is working the triangle switches on and off which indicate that the network is working but when there is a problem, you will not see this triangle meaning that the two systems are not communicating and usually when I see that then it tells me that the network problem has not been solved*". [Respondents 50, 57 & 58]

The researcher found that for network users to know whether the network have been resolved is quite difficult so they normally look at the network icon on their device. That is the network bars whether it has been reduced or increased, if it has increased, then they assume that it has been resolved. If reduced, then they know that the problem is still not solved. The researcher also found that network users definitely know if there is a network problem because they will see a dramatic change.

The researcher then asked the participants about how frequent they are faced with poor network. Selected comments have been given below;

Richard, Koranteng and Offei said that "*I frequently face network problems maybe once in a week*".

"*With the frequent poor network I will say every now and then there is prudent poor network*". [Respondents 2, 5, 3, 1 & 4]

"*Almost three times in a month use to face that*". [Respondents 6, 7, 9 & 8]

"*Ok sometimes some places are better within the same town, some places are better than other place in terms of network quality*". [Respondents 10, 11, 12, 13 & 14]

"*With frequency of facing poor network is not frequent only when there is a weather change because of where I live. In Aburi, only when there is a weather change my network becomes a bit poor aside that I'm okay*". [Respondents 16, 15, 17 & 18]

"*I frequently face network problem in the morning because as a teacher you have to do research*". [Respondents 19, 20, 21, 22, 23 & 24]

"*The area where I find myself, that is where I most at times face network problem*". [Respondents 26, 25, 28, 29 & 27]

"*I mostly face poor network service because I'm mobile and not stationery due to the nature of my work*". [Respondents 32, 35, 31, 30, 36, 37 & 34]

"*Poor network is almost like an everyday problem*". [Respondents 38, 39, 40, 41, 42 & 43] "*It does not happen rampantly, sometimes within the year maybe once, twice or thrice but will say it is ok*". [Respondents 44, 55, 60 & 56]

"*It is not rampant as it used to be in the olden days*". [Respondents 46, 45, 48, 49, 47, 50 & 54].

The researcher found that network users move to and fro so mostly there are some areas that experience poor network. The study also found that some network users do not often experience poor network. Sometimes they experience poor network due to the place they find themselves like in a valley. The study revealed that at Aburi, there are some places you cannot get all network. Also, the network is poor at the office and at the house. The network is poor when network users always get home, they cannot

download and watch videos. However, the study found that there is no service tower near some areas that is why the network is very poor every day and there are some trees around. Lastly, the study found that some users were not frequently faced with network problems.

The researcher then asked the participants about the time of the day that they make calls and why. Selected comments have been given below;

Alaska and Benedicta said "*All day or anytime*".

"*I make calls in the morning and evening but not at night*". [Respondents 51, 52, 53, 54 & 55]

"*I normally make calls during the morning and afternoon but in terms of browsing I do it in the evening because that is the time there will be no traffic in the network system and I will be able to download my files at that particular time in the night and morning*". [Respondents 58, 57, 59, 60 & 56]

"*I usually make calls in the morning because by then people will be preparing to go to work so there is no much load on the network*". [Respondents 40, 41, 42, 43 & 44]

"*When you ask me of the time of day I make calls, I make calls almost every time. In the morning I call my family members, in the afternoon and then at night I also make calls*". [Respondents 45, 46, 47, 48 & 49]

"*I do make most of my calls in the evening because I will close from work around 5pm so I do most of my calls in the evening*". [Respondents 30, 31, 32, 33, 35 & 34]

"*I make calls at all times unless I'm asleep, sometimes because of positions held at different places, calls do come in for me to attend to different issues unless*

*I'm asleep or I don't hear the call that I don't make a call*". [Respondents 35, 36, 39, 37 & 38]

"*I mostly make calls in the evening because of the nature of my work, I'm a teacher as you know and a teacher needs to be in the classroom and learn and teach from morning till 5 pm so I will say I mostly make my calls in the evening or during break that I do make my calls*". [Respondents 28, 27, 29, 20 & 26]

"*I normally make calls in the morning because sometimes in the morning is free for some network or cheaper sometimes is easy to get the person than the afternoon*". [Respondents 25, 24, 23, 22, 21 & 20]

"*To be frank lam not a guy who likes calling but lam somebody who likes browsing and downloading stuff every day so I don't do much of calling*". [Respondents 18, 19, 17, 16 & 15]

The study found that network users make calls in the evening and the afternoon. Sometimes the network is good and sometimes it is bad because the towers are not close to the area. Also, network users make calls throughout the day, and others normally make calls in the morning before 9 am and also in the evening probably after 7 pm. The study also revealed that network users normally call friends and family in the morning to check out how they are doing and in the evening they call few people to see how their day has gone. Network users make calls most of the time, in the morning and in the evening. Others don't make calls in town but sometimes in their rooms, they have a particular place where they put their phones in order to get one single bar on the network icon before they make calls".

The researcher asked the participants about the network service operator they are using currently. Selected comments have been given below;

Charles and Clement said "*MTN*".

"*Currently I'm using multiple services*". [Respondents 1, 2, 3, 4, 5, 6 & 7]

"*I use MTN, Tigo and Vodafone*". [Respondents 8, 10, 9, 11, 13 & 12]

"*I currently use MTN and Tigo as my network service operators*". [Respondents 15, 16, 17, 18, 19 & 20]

"*I use four networks*". [Respondents 21, 22, 23, 24 & 25]

"*Currently, for my data service, I use AirtelTigo for browsing and research. AirtelTigo is used for research work because to me the charges are more affordable but when I want to call, I use MTN because it is far better than the other network*". [Respondents 26, 27, 28, 29, & 30]

The study revealed that network users use MTN, AirtelTigo, Glo and Vodafone service.

The researcher then asked the participants the years they have being using a network operating services. Selected comments have been given below;

Emmanuel and Enoch said "*I have used MTN network for 15 years*".

"*I have used the network for about 15 years*". [Respondents 1, 2, 3, 4 & 5]

"*I have been using my network for about 14 good years*". [Respondents 6, 7, 8, 9 & 10]

"*I have been using network operating services for more than a decade*". [Respondents 11, 12, 13, 14 & 15]

"*I have used several of the network services for years now*". [Respondents 16, 17, 18, 19 & 20]

"*I have used MTN as my network service operator for the past 15 years and AirtelTigo for the past 5 years, four years".* [Respondents 21, 22, 23, 24 & 25]

"*I started using MTN Since 2000 when I was in training college*". [Respondents 26, 27, 28, 29 & 30]

"*I have been using MTN for about five years now and the Vodafone I think one year just recently in a year's time that I started using Vodafone*". [Respondents 31, 32, 33, 34 & 35]

"*I have been using MTN sim for about ten years and Vodafone sim for about twelve years*". [Respondents 36, 37, 38 & 39]

"*I'm on Vodafone and MTN at the same time.I have been using Vodafone for the past twenty years as compared to MTN. I have used MTN for about ten years now*". [Respondents 41, 42, 43, 44 & 45]

"*I have been using MTN for about 11 years now and Vodafone for 3 years now*". [Respondents 46, 47, 48, 49 & 50]

The study found that, network users have used MTN for almost 15 years, others have used it for ten years now. The study also revealed that some network users have used the network for twelve years, others have used Vodafone for 17 years and AitelTigo for almost ten years now.

The researcher then asked the participants the years they have being using phone. Selected comments have been given below;

Maxwell and Sarpong said "*15 years*".

"*17 years*". [Respondents 51, 52, 53, 54 & 55]

"*I have been using phone for the past 14 years*". [Respondents 56, 57, 58, 59 & 60]

"*I have been using phone for more than a decade*". [Respondents 41, 42, 43 & 44]

"*For phone, he has used it for almost twenty years and just switched to his new network that is MTN*". [Respondents 45, 46, 47, 48 & 49]

"*I remember the first time I used phone was the phone booth that is from the secondary school but I own my personal phone since 2000 at the training college*". [Respondents 50, 40, 39, 38 & 37]

"*I have been using my phone for about three years now", another participant said "I have been using phones for about twelve to 13 years*". [Respondents 36, 35, 34, 33 & 32]

"*I have been using phone for twelve years*". [Respondents 31, 30, 29, 28 & 27]

"*I have been using phone for about twelve to fourteen years now*". [Respondents 21, 22, 23, 24 & 25]

"*I have used my current phone for three years but in all I have used phone for ten years*". [Respondents 26, 18, 19, 20 & 17]

The study found that respondents have been using phones for more than three years.

The researcher asked the participants if they own a personal phone and if so how many phone(s) do they own. Selected comments have been given below;

Daniel and Adi said "*Yes three phones*".

"*I own a personal phone*". [Respondents 1, 36, 37, 38, 2, 3, 39, 40, 4, 41, 42, 43, 44, 45, 46, 47, 48, 49 & 5]

"*I own my personal phone, and I only have one phone*". [Respondents 6, 11, 12, 13, 14, 15, 7, 8, 9 & 10]

"*I have my personal phone and I have two phones that I'm using*". [Respondents 15, 16, 17, 18, 19, 20, 21, 22, 23, 24 & 25]

"*Yes I own a personal phone and have only one but others have more than one*". [Respondents 26, 27, 31, 32, 33, 34, 35, 28, 29 & 30]

"*I don't like handling more than two phones maybe I'm not comfortable when I have two phones on me. So most often you only see me with one phone*". [Respondents 50, 51, 52, 53 & 54]

The study revealed that network users use their own personal devices and others use more than one phone.

The researcher then asked the participants that, do they switch to other network service providers when their service providers are having challenges with the service. Selected comments have been given below;

Alex and Benson said "*I always call the emergency service lines for the service providers to attend to related problems concerning network, especially when I need the network for an emergency work and I'm not able to get it but when I complain and wait for 5 minutes and nothing have been done. I just switch to other network to see whether I will get data to do what I wanted to do*". [Respondents 51, 52, 53, 54 & 55]

"*Yes, I use to switch to other network but now lam sticking to my old number*". [Respondents 56, 57, 58, 59 & 60]

"*I don't really switch to other service providers when my service provider is having challenges with the service unless it is very urgent*". [Respondents 41, 42, 43, 44 & 45]

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"*When it is an emergency situation, I may decide to switch to a different network*". [Respondents 46, 47, 48, 49 & 50]

"*Since I'm using multiple network, sometimes, if one network is not working I switch to the other*". [Respondents 31, 32, 33, 34 & 35]

"*I use even almost all of the networks in Ghana*". [Respondents 36, 37, 38, 39 & 40]

"*Yes that is why I'm using two phones when one is not working then I use another network on the other one*". [Respondents 21, 22, 23, 24 & 25]

"*Yes I do switch to other network when I'm having challenges with my network that is my MTN and that is the main reason why I bought the Vodafone sim so that I can switch in times when one is disturbing or giving me headache*". [Respondents 26, 27, 28, 29 & 29]

"*Yes I normally switch between MTN and Vodafone if one is not working*". [Respondents 11, 12, 14 & 15]

"*I switch to other service providers when my Vodafone is failing me*". [Respondents 16, 17, & 20]

"*I change to other network when I have problems with my network*". [Respondents 1, 2, 3, 4 & 5]

"*Yes I do switch on to other network maybe when I have an urgent information to send or when you want to send a massage to a friend. Definitely if one network is not working I have to switch on to the other network*". [Respondents 6, 7, & 8]

"*Yes I always switch to other networks when I have problems with my network service provider because there is a task that needs to be accomplished and I will*

*not rely on a system that cannot provide solutions to my need so I definitely switch to other network*". [Respondents 18, 19 & 13]

The study revealed that when respondents have problems with one network, they switch to other network.

The researcher asked the participants if they have used any other network services before their current network. Selected comments have been given below;

Enoch and Ebenezer said "*yes they have used different network before*".

"*I have never use any other network service before my current one*". [Respondents 21, 22, 23, 24 & 25]

"*I use them together so it is not that I have used one network before the other*". [Respondents 26, 27, 28, 29 & 30]

"*No I didn't change it. I'm still using it*". [Respondents 11, 12, 13, 14 & 15]

"*Yes, previously I was using Vodafone before I switched to MTN*". [Respondents 16, 17, 19, 18 & 20]

"*Yes, so I'm using multiple network simultaneously because my phone takes two SIMS*", [Respondents 1, 2, 3, 4 & 5]

"*Yes as I said, I was using MTN but now I'm using Vodafone but I have not stopped using the MTN but I added Vodafone for some reasons*". [Respondents 6, 7, 8, 9 & 10]

"*I started using Vodafone and that has been my line*". [Respondents 31, 32, 33, 34 & 35]

"*I have not been using any other network apart from my network*". [Respondents 36, 37, 38, 39 & 40]

*"Yes my first network provider was Tigo which is now AirtelTigo so there has been a merger between Airtel and Tigo"*. [Respondents 41, 42, 46, 477, 48, 49, 50, 43, 44 & 45]

The study revealed that respondents have used other network apart from what they use currently in their area". The study found that others have not use any other network before their current network".

The researcher asked the participants the reason why they changed from other network to their current network? Selected comments have been given below;

Daniel and Benedicta said "*because of network problem*".

*"I changed to the current network because a lot of people, friends and colleagues know me by my current number so I don't feel comfortable changing my number"*. [Respondents 1, 2, 3, 4 & 5]

*"I'm using multiple network providers' SIM but currently I have inserted only one"*. [Respondents 6, 7, 8, 9 & 10]

*"Based on the network as I said so that you can switch from one network if it is not working to other network"*. [Respondents 11, 12, 13, 14 & 15]

*"It has been fantastic using multiple network because it helps resolve some of my issues especially when one network is giving problems then I just switch to the other"*. [Respondents 16, 17, 18, 19 & 20]

*"I didn't change as I said, I have no other network I'm still using the MTN and Vodafone so I use it because when I go to an area and the MTN is not helping me I use the Vodafone"*. [Respondents 21, 22, 23, 24 & 25]

"*I changed to my current network because lam looking for a cost effective network provider. I realized that these days, data and calls are really expensive*". [Respondents 26, 27, 28, 29 & 30]

"*I only change to the current network due to problems with the Vodafone and the other reason too is that if I realize that to bundle with MTN is cheaper than the Vodafone then I switch. If Vodafone is cheaper than that of MTN based on the promotion they are having then I switch*". [Respondents 31, 32, 33, 34 & 35]

"*Yes I'm not a fan of changing network but since I started using MTN I have stuck to it for several times but due to issues of poor network, I have bought different network sim cards so that I will be able to switch onto them*". [Respondents 36, 37, 38, 39 & 40]

"*Multiple sim resolve my issue because I switch to one if one of them is not working*". [Respondents 41, 42, 43, 44 & 45]

The study found that respondents switched to a different network whenever there is a network problem with their current network. The study also found that respondents change from MTN to Tigo because sometimes MTN is stronger so as Tigo. They just use it interchangeably".

The researcher asked the participants on how different is their current network service provider from the previous network service provider. Selected comments have been given below;

Asiedu and Gyamfi said "*The current network consumes data as compared to the previous network they have used*".

"*They are all the same*". [Respondents 21, 22, 23, 24 & 25]

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"*I changed from my previous network to my current network thinking that the data will be more efficient but I am facing the same challenge relating to network challenges*". [Respondents 26, 27, 28, 29 & 30]

"*Ok with the current network which is Vodafone, it helps me in browsing as compared to the MTN because with MTN when it comes to their data, the way it elapses even amazes me.That is why I bought the Vodafone network because it will help me. It will also reduce the amount of money that I use to buy data*". [Respondents 11, 12, 13, 14 & 15]

"*There is no much difference.I realized that in Ghana the network service providers are not different especially the two networks I use that is MTN and Vodafone. I use MTN if I want to call MTN lines and Vodafone if I want to call Vodafone lines*". [Respondents 31, 32, 33, 34 & 35]

"*I use MTN as my network service provider and it is not so much different from Tigo*". [Respondents 36, 37, 38, 39 & 40]

The study found that respondents still use their previous and current networks. Especially Vodafone is better for calls and it depends on your location and sometimes MTN is also better in terms of data. The study revealed that the network that respondents used is the same as all the other service providers. For poor network, maybe each service provider has its own problem and one problem will be peculiar to other but at least the problems are similar.

The researcher then asked the participants if they were using multiple network service providers' Sims simultaneously and if yes why? Selected comments have been given below;

Maxwell and Engelbert said "*Yes due to internet connectivity*".

"*Currently lam not using multiple network simultaneously*". [Respondents 21, 22, 23, 24 & 25]

"*Yes, as I said so that I can have access to the internet anytime because as a teacher you should get two phones and more than one Sim card*". [Respondents 31, 32, 33, 34 & 35] "*Yes, I sometimes switched to the other network if the data is not working efficiently*". [Respondents 41, 42, 43, 44 & 45]

"*Yes I'm using a phone that uses two Sims and I bought that phone so that I can switch between networks if one is not helping I can use the other''* [Respondents 51, 52, 53, 54 & 55]

"*Yes lam using multiple network provider's sim.  I'm using it because I want to save cost*". [Respondents 11, 12, 13, 14 & 15]

"*Yes I use MTN and Vodafone concurrently in a day just because when there is a problem here, then I will switch on to the other one and make calls with it*". [Respondents 1, 2, 3, 4 & 5]

"*Yes, I'm using multiple Sims simultaneously like Vodafone for data because it is cheaper. When you have Vodafone cash and you want to buy 500mb you can get it at a cheaper price but MTN is expensive sometimes so when I don't have money in my Vodafone cash I use MTN*". [Respondents 6, 7, 8, 9 & 10]

"*I have not changed permanently but I'm using them simultaneously especially depending on the kind of work I'm doing whether I have to make a call that will take a long time or if I need data to do one or two work or to download then I just look at which network will be appropriate*". [Respondents 26, 27, 28, 29 & 30]

The study found that, because of the double SIM phones that respondents had, it made them use two or more SIMS in one particular phone at the same time. Also, respondents used two or more networks simultaneously for a different task.

The researcher further asked the participants who have been using the multiple network service providers' Sim have been able to resolve their issue? If 'yes' how? If 'no' why? Selected comments have been given below;

Daniel and Aboagye said "*Yes, I use multiple network service providers SIM simultaneously because of the difference in network services*".

"*Yes the use of multiple network service sim have resolved my issue, because when I switch or when I change the network service, it becomes better for me and I use them simultaneously*". [Respondents 1, 2, 3, 4 & 5]

"*Yes of course, because I get what I want to use the network for and pray that the other network service will be resolved soon*". [Respondents 6, 7, 8, 9 & 10]

"*It has helped me, because of the nature of my work is more of researching, finding out answers to some questions so when I tap on my phone I can access certain information*". [Respondents 11, 12, 13, 14 & 15]

"*Yes, it has resolved the issue of spending so much on buying phone. Using multiple network providers' sim has resolved that issue of me spending so much on phones*". [Respondents 16, 17, 18, 19 & 20]

"*Yes, multiple network service providers have really solved my issues for me because sometimes where I find myself, Vodafone might not be working so I use MTN to call*". [Respondents 21, 22, 23, 24 & 25]

The study revealed that using multiple network service providers' SIM resolve network challenges that respondents face. The study also found that the use of multiple network service provider is very important because sometimes as you encounter a network problem with one network it will lead to switching to other network.

### 4.3.2 4G Mobile Network Action

Actions spoke loudly to the participants. These actions, or, at times, lack of action, had a significant effect on the quality of 4G Mobile Network in the Greater Accra Region. The researcher asked the participants about their experience with their mobile network in terms of quality of service. Selected comments have been given below;

Ebenezer and Maxwell said "*Not bad always fast surfing*".

"*Occasionally when I call, it drops but I attribute that to the person lam calling having bad network at his end*". [Respondents 21, 22, 23, 24 & 25]

"*In terms of quality mobile network, I will mark them above average because of the quality of service I receive in terms of the speed for browsing and other things*". [Respondents 1, 2, 3, 4 & 5]

"*In terms of quality I will give it normal*". [Respondents 6, 7, 8, 9 & 10]

"*In terms of quality, I will give about 65 percent*". [Respondents 12, 13, 14, 15 & 11]

"*I use MTN as a network. In terms of quality service, I think MTN is one of the best in terms of internet services*". [Respondents 16, 17, 18, 19 & 20]

"*In terms of quality service, it is based on where I live or where I stay that is where I get my quality service and also the phone that I use*". [Respondents 26, 27, 28, 29 & 30].

"*With experience wise pertaining to the network quality, I could rate my network as average because I find it difficult browsing daytime. Normally, it leads me to browse at midnight. So that is the experience I'm going through in terms of my mobile network*". [Respondents 31, 34 & 35]

"*Yes their services are good*". [Respondents 36, 37, & 40]

"because *the area in which lam living, the MTN is one of the best network as compared to the others but so far I'm using MTN network and it has a good quality service*". [Respondents 38, 39, & 42]

"*In terms of quality of service by telecommunication networks in Ghana, I will say it's Smooth*". [Respondents 43, 44, 45 & 46]

"*The quality of service at my area is something that I always complain, almost all the 4 networks I use, they have very poor quality of service, something that is really disturbing me especially for where I stay. I find it difficult browsing*". [Respondents 47, 48, 49 & 50]

"*I will give them 70%*". [Respondents 51, 52 & 53]

"*Telecommunication networking companies are not providing us with 4G network and due to the bad nature of network it retards the activities of businesses, individuals, students, labor force and institutions*". [Respondents 32, & 33]

"*I will say during 2019, there was a big problem with telecommunication network like AirtelTigo where the network was not working at all. There will be signal on the phone indicating that the chip has expired. It was a rampant issue. Later, I discovered that Airtel and Tigo collaborating and that was the reason why there was that situation so you needed to go to their office for the issue to be trashed out. What they did was, they had to migrate you to a new company*

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*which is now known as AirtelTigo and they had to give you a different chip*".

[Respondents 41, & 57]

The study revealed that mobile network in terms of quality service, is poor because some telecom companies presume they have 3g and 4g.Meanwhile in realty, it is not working as we are supposed to experience it. The study also revealed that, network sometimes dropped when making calls or the call did not go through at all during busy hours. The study found that, due to the bad nature of network in Ghana, sometimes, users miss certain important information incase their boss wants to give an important information about academic work.

The researcher then asked the participants about the most worrying aspect of the poor network service. Selected comments have been given below;

Charles, Offei and Asiedu said "*The most worrying aspect is sometimes the signal does not show on the phone at all*". [Respondents 43, 44, 45 & 46]

"*The most worrying aspect of the poor network service is when you are browsing and the network slows down*". [Respondents 51, 52, 53 & 54]

"*Sometimes you need to make a call urgently and the network will be poor, it is very worrying*". [Respondents 55, 56, 57 & 58]

"ln *the aspect of poor network, sometimes it is in a sense that maybe you have an important issue to discuss and it doesn't go through or an important information you need to get from the internet and it is disturbing*". [Respondents 1, 4, 5 & 6]

"*The most worrying aspect of poor network service is that at times when I need to do important call or send important massages through the network, it delays*

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*my work. Sometimes, the receiver who is the person I'm sending the information to, does not get the message on time incase or in terms of making calls, I'm not able to hear the voice of the receiver or the receiver also complains, he or she is not able to hear my voice*". [Respondents 2, 3, 7, 8, 9 & 10]

"*When I experience poor network, it is worrying because there are some emergency calls I need to make immediately but I have to postpone it or wait till the problem is resolved before I make those calls. It is so worrying*". [Respondents 11, 12, 13 & 14]

"*Some of the inconveniences is that you might be calling somebody due to problems in the network, the service providers will tell you that the network or the line you are calling cannot be reached or the number you are calling is switched off. Meanwhile, it is not so*". [Respondents 15, 16, 17 & 18]

"*Most of the time, the internet is on edge except I move to a different location*". [Respondents 19, 20, 21 & 22]

"*The most worrying aspect is when your data is off or is not working*". [Respondents 23, 24, 25 & 26]

"*The inconveniences are many, some of them are; you may miss important information and sometimes somebody wants to send you mobile money then the person will go to the vendor trying to reach you before sending the money. But as a result of the poor network, he or she will not reach you so the person may decide to go back home with the money. Meanwhile, you may need the money urgently*". [Respondents 27, 28, 29 & 30]

"*To me the most worrying aspect of poor network is when I am not able to access the internet and a guy like me who loves to research and the network is down in terms of data, it's disheartening*". [Respondents 31, 32 & 33]

> "*In fact, I really have a tough time and I get pissed off because I need the network to solve an impending problem. Another one is when you bundle with huge sums of money and later the network becomes unsustainable, it will be of no use and it becomes frustrating, not able to use the data as expected*".
> [Respondents 35, 36, 37 & 38]

The study found that poor network service is worrying especially when you want to make a call and want to browse or research on the internet. The study also found that the most worrying aspect is the data in terms of browsing is the most worrying aspect. The study revealed that the network is very good, just that in some areas, there is a poor network especially when people get to their room. However, some participants have not experienced such a poor network. The most worrying aspect of poor network service is the fact that you cannot connect to your family and friends at the very moment you want to connect to them. It is really an inconvenience to many.

The researcher then asked the participants the inconveniences they have being facing due to the poor network quality. Selected comments have been given below;

> Ebenezer and Aisha said "*The inconvenience is, sometimes it delays my calls and I have to postpone certain calls or move to another area or when I am home, I postpone it and when I get to school I make calls*".
> "*As a result of the poor network quality, some of the inconveniences are the inability to download certain files from the Internet and poor voice quality when it comes to making of calls over the internet*". [Respondents 5, 6, 7 & 8]
> "*If there is poor network and at the same time you need some information urgently and the call is not going through, it makes me feel bad to the extent that I feel like throwing my sim away*". [Respondents 9, 10, 11 & 12]

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"*Due to the poor network, some inconveniences occur and these inconveniences include delay in service or delay in information and sometimes too,work that is supposed to be done on time is delayed*". [Respondents 1, 2, 3 & 4]

"*Yes, inability to access some information online, since I'm a teacher,I find it difficult accessing information online which is a challenge to me*". [Respondents 13, 14, 15 & 16]

"*Some of the inconveniences of poor network quality is that I can't make calls that I need to make*". [Respondents 17, 18, 19 & 20]

"*Some of the inconveniencies I have been facing is that, I am always somebody who is using data so it becomes difficult when the network is down and I cannot browse on the nets. Sometimes, basic things like WhatsApp and Facebook does not open and is really worrying*". [Respondents 21, 22, 23 & 24]

"*I'm worried about the poor internet connectivity especially when it is on edge and I cannot download anything from the internet*". [Respondents 25, 26, 27 & 28]

"*Yes, as a businessman, sometimes it is very worrisome when your distributors want to get you through the network and there is poor network .T.hey will not be able to get you which becomes a different issue*". [Respondents 29, 30, 31 & 32]

"*I don't have any specific place but sometimes, I just have to change the location if it is my room, I just have to move to a corner or if it is the area I just move to another place where there is good network*". [Respondents 33, 34, 35, 36, 37, 38 & 40]

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The study revealed that the inconveniences users have been facing due to the poor network quality are that, it has restricted their freedom of making calls and access to information on the internet. There are areas where there are no networks. Sometimes users have to get to one corner or on top of the hill to search for a signal. The study also found that sometimes, some of the inconveniences that comes with poor network is when assignments that require the use of internet are not completed and the assignment needs to be done before the following day, it makes users feel bad throughout the day.

The researcher then asked the participants that in their estimation, what accounts for the poor services provided by the telecommunication networks. Selected comments have been given below;

Alaska and Benedicta attributed it to the weather.

"*In my estimation, I live in a mountainous area maybe because of the hills it disturbs the waves*". [Respondents 35, 36, 37, 38 & 40]

"*In my estimation what account for the poor services provided by the network service is as a result of the absence of mast .Without telephone masts to provide the network for the people in that areas where there is poor network*". [Respondents 39, 34, 31, 32, 33 & 30]

"*As of poor service, I think most areas are not closer to the network tower*". [Respondents 1, 2, 3, 4 & 5]

"*Okay in my estimation as I have early on said, it may be due to poor weather condition or a number of people on the network that makes the network jam up especially on occasions like last year Christmas there was a network jam because a number of people on the network were many*". [Respondents 6, 7, 8, 9, 10 & 11]

"*To me I think they don't have a lot of network towers*". [Respondents 12, 13, 14, 15 & 16]

"*I wouldn't tell but sometimes in a day especially in the morning where maybe the dew or the weather is not favorable or when it becomes cloudy that is where I'm faced with this challenge*". [Respondents 17, 18, 19, 20 & 21]

"*Sometimes when there is light out and the tower light goes off*". [Respondents 22, 23, 24, 25, 26 & 27]

"*In my estimation I think what really accounts for poor network is, probably the distance between where I am and the mast. Sometimes too, I realize when lam in a basement it is difficult to get a network*". [Respondents 28, 29, 41, 42, 43, 44 & 45]

"*Sometimes it is the weather and sometimes maybe peak period in the days' time*". [Respondents 46, 47, 48, 49, 50]

The study revealed that users will account to network towers that are not available in some areas. Probably when the weather changes, it affects the network, so it will be attributed to the weather. What account for poor network is based on the quality of phone or device that is used to access the network and the area that you will find yourself. The study found that one of the things that users have seen is the masts that are erected, the system needs to be updated all the time. Mostly in Ghana, users were using 3G network and now have upgraded to 4G network and 4G is a high specs network that means it really runs very fast and therefore when you update the system to a 4G and the other communication system such as the mast should be upgraded to 4G so that it can communicate perfectly with the new engineering system and I see that that is usually the cause of the problem.

The researcher asked the participants how far away is their area from a network tower of their service provider. Selected comments have been given below;

Isaac, Ebenezer and Ruth said "*100m away*".

"*The services providers' tower is about one kilometer from where I stay*". [Respondents 33, 34, 35 & 40]

"*I will say about 2 kilometers that is how far the area for the network tower of the service provider from my end*". [Respondents 36, 37 & 38]

"*My house and where we have the service providers' tower is about 400m away from my house*". [Respondents 13, 14, 15, 16 & 17]

"*My area is about five kilometers away from the tower*". [Respondents 11, 12, 18 & 19]

"*In terms of the network tower I'm about 40 kilometers from my network tower*". [Respondents 20, 21, 22, 23 & 24]

"*I'm not so much close so I can't really tell whether it is because of the distance from the network tower*". [Respondents 25, 26, 27, 28, 29, 41 & 42]

"Just about a kilometer". [Respondents 1, 2, 3, 4 & 5]

"*In my case I will say where the building is situated is just down the hill and is about 5 kilometers from the mask but the mask is on the hill at Ahwerase while I stay at the out skirt of Aburi but it is down a hill which makes it difficult for us to get network*". [Respondents 6 & 7]

"*It is very close*". [Respondents 8, 9, 10, 43 & 44]

"*My home is probably about a kilometer and half from the nearest network tower*". [Respondents 45, 46, 47 & 48]

"*My house is far from a network tower*". [Respondents 49, 50 & 51]

"*About one kilometer away*". [Respondents 52 & 53]

*"Lucky for us, those who reside at Ahwrease, where we are is close to the place where there are a lot of network providers towers erected over there even television towers around"*. [Respondents 54 & 55]

The study found that the network tower is far from the area where users are located. The study also found that it is not far from user's residence, let say about one kilometers from the tower. The study revealed that some users live in an area where there are a lot of towers around.

The researcher asked the participants to tell him whether other people use different mobile devices and other network from what they are using experience poor network in their area. Selected comments have been given below;

Stephen, Timothy and Anass said "*Yes*".

*"Occasionally when we meet, they complain about their network"*. [Respondents 33, 34, 35 & 40]

*"People using different network and different mobile devices from mine also complain about the poor network service since we are living in the same vicinity"*. [Respondents 36, 37, 38 & 41]

*"Yes those using different network they face the same problem"*. [Respondents 42, 43, 44, 45 & 46]

*"In terms of other network, yes I have a lot of people around me in my home who use different networks,?I use about two networks because I have two phones. Sometimes, if my MTN is not working, the Tigo network will be in good condition so I switch to that one as well so it depends on the type of network some are poor and others are good"*. [Respondents 47, 48, 49, 50, 51, 53 & 52]

"*Yes, other people using similar network or same network also complain and not only about that network but other networks too so more or less people have two or three networks and when the problems come, they just switch to network*". [Respondents 53, 54, 55, 56 & 57]

"*Yes a lot of friends and family members that I'm staying around do complain of their network which I'm not using*" [Respondents 58, 59, 60 & 21]

"*I have not heard such complaints before*". [Respondents 23, 24, 25, 26, 27, 28 & 29]

"*Yes, a lot of people experience poor network in my area*". [Respondents 1, 2, 3, 4, 5 & 6]

"*They experience better other network in my area*". [Respondents 7, 8, 9, 10 & 11]

"*Yes, other people experience the same network problem*". [Respondents 12, 13, 14, 15 & 16]

"*When there is a problem and the problem is coming from the network provider, definitely it is a general problem so you will hear people complaining about the same thing that, the network is, we all bear this situation*". [Respondents 17, 18, 19, 20, 21, 22 & 23]

The study revealed that people using different networks and different mobile devices from what respondents are using, face the same problem. People using different network and different mobile devices from what respondents are using complain a lot.

The researcher asked the participants how the network quality is when they move to the nearby towns. Selected comments have been given below;

Asiedu and Dominic said "*very poor*".

"*When I move to the nearby towns, the network quality is better than where I stay*". [Respondents 17, 18, 19, 20 & 23]

"*When I move to the nearby towns the network quality in terms of voice and data is quite better than my present location*". [Respondents 21, 22 & 16]

"*It depends on the area as network quality varies. Some areas have very good network others have poor network*". [Respondents 15, 14, 13, 12, 11 & 10]

"*Actually, I don't normally move to different towns to get reception but based on the work*". [Respondents 1, 2, 3, 4 & 5]

"*I'm in Aburi but when I go to Ahwrease the network is very strong because of the mask and even in Aburi certain part of the town the network is very good, When I move to the nearby towns it depends on the town that I move to there are some of the towns when I go there the quality of network is good but the others are very poor*". [Respondents 6 & 7]

"*The network quality situation at nearby towns are almost the same like my area. There is no much difference*". [Respondents 8, 9 & 40]

"*Sometimes, it is better when I move to other nearby towns*". [Respondents 41, 42, 43, 44 & 45]

"*Network quality in nearby towns are just the same, sometime except data that you may have data quality to be in variations*". [Respondents 46, 47, 48 & 49]

"*Because I leave closer to where we have the tower.Sometimes, I decide to move closer to where the tower is so that I will get a quality network. Usually, when you move away from the areas where towers are, you start encountering*

*network problems. Network failures makes the network turns from 'H' which means high speed to edge and when it is at the edge you see big 'E' on your device. To me, edge means poor network when you move to areas like Nsawam and the other nearby communities you begin to have problems with the network*". [Respondents 50, 51, 52, 53, 54, 55 & 56]

The study revealed that network quality in some towns are not different from others but they also complain of poor network service due to the conditions around. With the surrounding towns, the network is quiet okay, even with the exception of the data that has been creating this challenge in the vicinity. The study found that when respondents move to a nearby town, the network quality is always good.

The researcher asked the participants the particular area where they move to within their town to get reception when they have poor network, and was asked to describe the nature of the area. Selected comments have been given below;

Engelbert, Maxwell and Reuben said "*Mountainous area*".

"*I move to the middle of the town and the other suburbs.Some places have good network, others too have bad networks*". [Respondents 1, 2, 3, 4 & 5]

"*The particular area I move to within my town is just closer to my house just some few meters from my house and the nature of the area is valley*". [Respondents 6, 7, 8, 9, & 10]

"*Sometimes if I have poor network I move to the roadside, the roadside is much closer to the tower*". [Respondents 11, 12, 13, 14 & 15]

"*I do switch from one network to the other when the network service is very bad*". [Respondents 16, 17, 18, 19 & 20]

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"*When I have poor network in my area or town, to get reception is within my home I do not move outside my home. In fact, either I move to my porch, corridor or my other rooms so I do not move within the town*". [Respondents 21, 22, 23, 24 & 25]

"*In Aburi town, the network is very good. When you move to Ahwrease where I attend church, the network is just perfect but at the outskirt when you are descending the hill that is where the problem is*". [Respondents 26, 27, 28, 29 & 30]

"*Ok in my area I don't experience bad or poor network due to the network that I'm using that is MTN so I don't mostly go to a specific area to receive a good network but if it happens I walk a little far to get access to good network*". [Respondents 31, 32, 33, 34 & 35]

"*Reception is available in this area, so when I experience network problem, I move to reception area*". [Respondents 36, 37, 38, 39 & 40]

"*I normally move to an open space where there are less trees and the place is open and a flat one without buildings or trees to see whether it can improve*". [Respondents 41, 42 & 43]

"*I move to a hilly area in my area when I have poor network or I want to receive a better signal*". [Respondents 44, 45, 46, 47 & 48]

"*I move to a better place to make downloads if I'm facing poor network quality in my area, the nature of the area gives poor data*". [Respondents 49, 50 & 51]

"*Because I am very close to the area where the network towers are positioned I need not to move to a specific area to make calls I will say lam blessed in that situation. Wherever I stand within the community lam able to make calls I don't have any problem with it*". [Respondents 52 & 53]

The study revealed that sometimes when users are in the house, they have to leave their rooms and hide themselves under or on top of a certain tree or on top of a hill whereby the data will work efficiently. Users normally move to an open space where there are less trees and the place is open without buildings or trees to see whether it can improve. The study found that some users are very close to the area where the network towers are positioned so they need not to move to a specific area to make calls. For others, wherever they stand within the community, they are able to make calls and don't have any problem with it.

The researcher asked the participants if they have been lodging complaints about network service related problems to their service provider. Selected comments have been given below;

Daniel, Charles and Benson said "*No*".

"*I have not been logging complaints to my network service provider*". [Respondents 1, 2, 3, 4 & 5]

"*I have been lodging complaints to my service provider*". [Respondents 6, 7, 8, 9, 10 & 11] "*I use to lodge complaints*". [Respondents 12, 13, 14, 15 & 16]

"*Yes I have been calling them when the network jams. I have been calling using other network*". [Respondents 17, 18, 19 & 23]

"Not really". [Respondents 20, 21, 22 & 25]

"*Sometimes, I do call them to complain to them and sometimes too they call asking me whether the network is helping me in the area that I'm living*". [Respondents 26, 27, 28, 29 & 30]

"*I do lodge complaints to my service providers especially with Vodafone because with MTN sometimes you call and nobody respond to you. Vodafone are so prompt with such problems*".

"*I do call the customer service line when I have challenges, sometimes it is resolved*". [Respondents 31, 32, 33, 34 & 35]

"*Yes we have been lodging complaints about those problems to the service providers*". [Respondents 36, 37, 38, 39 & 40]

"*Currently, I don't have any serious issue with my network provider so I have not been lodging any complaint to them*". [Respondents 41, 42, 43, 44, 45 & 46]

The study found that respondents have been complaining to service providers like MTN, Vodafone and others for several times. Some users don't mostly complain to the service provider when they encounter network problem.

The researcher then asked the participants about their friends if they make complaints of similar problem to them in the area. Selected comments have been given below;

Adi, Arhinful, Alaska, Sarpong, Maxwell, Enoch, Gideon, Ahorlu, Gyemfi, Emmanuel, Bani, Owiredu, and Koranteng said "*Yes*".

"*My friends complained to me about network quality*". [Respondents 20, 21, 22 & 23]

"*My friends also complained about similar problem in the area we are living*". [Respondents 18, 19, 24 & 25]

"*Yes ,not only me,but others complain about the problem*". [Respondents 26, 27, 28, 29, 30, 31, 32 & 33]

"*Yes, because we are all facing the same problem currently*". [Respondents 34, 35, 36, & 37]

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"*Yes, most of my friends have been complaining especially with the data roaming. Most of my friends who live in the same vicinity, have been experiencing this network problem or challenge especially with the data*". [Respondents 41, 42 & 43]

"*No please*". [Respondents 44, 45 & 46]

"*Yes, my friends complain but as I said, in my area, those that use the same network as mine they have not complained but as compared to others who have been using different network from mine have been complaining*". [Respondents 47, 48, 50 & 51]

"*Yes, a lot of people complain about similar problem*". [Respondents 54, 55 & 56]

"*Friends also complain the same thing in my area*". [Respondents 57, 58, 59 & 60]

"*Those in my work area and my school complain poor signal at their offices*". [Respondents 1, 2, 3, 4 & 5]

"*If I'm having problems similarly with my people in the same area, most of the time not related to my phone they complain a lot*". [Respondents 6, 7, 9 & 10]

"*Yes friends also complain about the same problem sometimes*". [Respondents 11, 12, 13 & 14]

"*Yes, they do complain*". [Respondents 52, 53, 8 & 49]

"*Yes friends who are using different network also complain about the same thing*". [Respondents 17, 38, 39, & 40]

The study revealed that users' friends do complain and sometimes share ideas as to which network is better, they do complain because they also have different network for which they sometimes switch.

The researcher then asked the participants if there is anything that you prefer to add to what you have said or change. Selected comments have been given below;

"*The main factors accounting for the bad facilities supplied by the networks are the broadband speed and the technology (several different devices) used for data transfer. The speed of connection among the telecommunication network also depends on the distance between your terminal device and the network centralizer. The more people live far away from the operator's broadband centralizer, the more the speed of the connection gets affected. Since majority of people around the world rely on network for their day to day activities, there will be a network overload which will result in network congestion*".*

[Respondents 57, 58, 1, 6, 8, 10, 34, 51, 59 & 60]

## CHAPTER FIVE

## CONCLUSION, SUMMARY AND RECOMMENDATIONS

### 5.1 Introduction

The purpose of the study was to evaluate the quality of 4G Mobile Network in the Greater Accra Region. This chapter presents the conclusions drawn from the discussion of the findings, summary, and the suggested recommendations to all the stakeholders about quality of 4G Mobile Network in the Greater Accra Region.

### 5.2 Summary and Findings

Growth in mobile information consumption is evident in areas such as music streaming, video streaming, communication, educational institutions and e-commerce, all of which are demonstrating a marked increase in the popularity of their mobile alternatives. As mobile solutions gain popularity, customers in every service require more advanced features (Olsson, 2015). These features are given within the supply chain by performers for the quickly changing digital content distribution. Following this fast evolution, the positions of the actors change, generating variable value chains for the distribution of digital material (Ibid....). People who face poor network system will be disadvantageous to this fast evolution.

People in Accra Metropolis in the Greater Accra Region of Ghana experience network problems which make them put their phones down for a while or move to areas where the network is good or sometimes switch their phones off and switch it on again to see if the network will be stable. Others switch to another network so that they can do their work or do what they have to do with the network. For others, if the problems persist, they have to change the network and they have no option than to change the network.

Sometimes others have to change their location to check whether they can get good network at those areas and better still they get into the school where most often they get good network. When people are experiencing poor network, they wait for the network to come or switch to another network. Sometimes others lodge complaints by calling the service providers on the poor network that they are experiencing.

For people to know whether network problems have been resolved is quite difficult. Normally, they just look at the network signal on their device to see whether it has been reduced or increased. If it has increased, then they assume that it has been resolved. If reduced, then they assume that the problem is still not solved. Telecommunication network users move to search for signal so mostly there are some areas that they experience poor network, others do not experience it as often.

People in the Accra Metropolis use network day in and day out for their life activities but because sometimes there is poor network, it makes people make calls and surf the internet in the morning before 9 am and also in the evening probably after 7 pm. Majority of people in Ghana use MTN, AirtelTigo, Glo and Vodafone as their network service operators. Most of the participants for this study have used either MTN or AirtelTigo, Glo or Vodafone service for a number of years.

The findings of the study indicates that people use more than one phone and as a result, they use more than one sim card with their reason being that if they are having problems with one network they switch to another network. For their intention to use a different network, some are still using their previous and current network. Others think that the problem they are facing with their current network is the same as all the other service providers. Maybe each service provider has its own problem and one problem will be

peculiar to other but at least the problems are similar. Those who use multiple sim cards enjoy a lot because sometimes as they are using one network, a network problem will make them to switch to another network. Participants for the study commented on the level of satisfaction on the service that telecommunication networks provide in terms of quality service. Some said it is poor because some telecom companies presume they have 3g and 4g meanwhile in realty it is not working as we are supposed to enjoy it.

Poor network service is worrying especially when people want to make calls, browse or research on the internet and the quality of service of the network drops, they will have to wait or switch to another network which requires additional cost. To some of the participants, the most worrying aspect is the data in terms of browsing and when you cannot connect to your family and friends at the very moment you want to connect to them. The inconveniences people have been facing due to the poor network quality is that it has restricted their freedom of making calls and getting access to information on the Internet. Some places in Ghana where there is no network, people have to get to one corner, climb to the top of the hill or tree to search for signal. People attribute poor network to network towers that are not available in some areas. When the weather changes, it affects the network. Quality of phone or device that is used to access the network, the area that you find yourself, the mast that are erected accounts for poor network. In Ghana, we were using 3G network but have upgraded to 4G network. 4G is a high specs network that means it really runs very fast and therefore when you update the system to a 4G and the other communication system such as the mast should be upgraded to 4G so that it can communicate perfectly with the new engineering system.

People live far from the network tower systems provided by the telecommunication networks. Others don't stay far from it and others live in an area where there are a lot of towers around. In an area where there is a network problem, it is likely that its' neighboring towns are not different from that area sometimes those in the neighboring towns also complain of poor network service due to the conditions around. In other places too, the network at the surrounding towns are quiet okay. Poor network at some places varies, in that when people move to a nearby town, the network quality is always good. Regardless of the poor network experienced by people, they normally move to an open space where there are less trees to see whether it can improve, different area to search for signals, climb to higher places, and get closer to the network towers. People complain to service providers like MTN, Vodafone and others anytime they experience poor network but others don't complain.

## 5.3 Conclusion

With the advancement in technological use by people around the world especially, people living in the Accra Metropolis rely mostly on the Internet for transaction, for education, for communication and so on. This issue has resulted in network reliability which has become a huge concern for people living in the Accra Metropolis and some places in Ghana. This is no longer just the concern of telecommunication network and their customers but also retard the development of businesses and the nation at large. As some rely on network daily, telecommunication networks need to grow and provide quality services (network speed) to its' customers. Since majority of the people around the world rely on network for their day to day activities, there will be a network overload (network congestion) that telecommunication networks should be prepared for. At some vicinities in the Accra metropolis, people move up a floor in order to get

a signal. Others go outside to find out where the closest cell tower is and some move closer to a window, etc.

## 5.4 Recommendations

Over reliance on network by people has brought network challenges and it is the duty of telecommunication networks to provide a reliable and sustainable network environment for its customers. There are some devices that can help boost the network signal and some of them are weBoost Drive Reach (470154) which is up to 5,000 sq. ft. of coverage under best conditions, up to +65 dB of gain, with 21 dBm uplink and 12 dBm downlink and allows multiple accessories for maximum coverage and customization. It also has a complete coverage for multiple rooms or midsize home for all carriers across multiple devices. With the use of weBoost Drive Reach (470154) assuming flawless outside signal, people can expect up to 5,000 square feet of coverage, but in most situations people can expect 2,000-3,000 square feet of indoor coverage. It is best for those in an area with next to no signal, this is the lowest grade signal booster. Another one is weBoost Drive 4G Sleek (470135) which boosts Voice, Text Messages, 3G & 4G LTE Data and it is for a single smartphone which is up to +23 dB Gain. WeBoost Drive 4G Sleek (470135) uses a magnetic vent mount and when paired with a bluetooth headset, it really shines for regular talk & text and hands-free navigation. There is also a device called Wilson Pro 70 Plus which boosts voice, text message, 3G & 4G LTE data, works for multiple cell devices, works with all carriers, networks, and phones and up to +70 dBm Gain which is great for urban areas. Researchers can work on how network services will be enjoyed by customers without a network problem in terms of quality of service.

## REFERENCES

Aggorowati, M. A., Suhartono, N. I & Gautama, H. (2012). Restructuring and Expanding Technology Acceptance Model Structural Equation Model and Bayesian Approach. *American Journal of Applied Sciences*, *9*(4).

Agyapong, G. K.Q. (2010). The Effect of Service Quality on Customer Satisfaction in the Utility Industry – A Case of Vodafone (Ghana). *International Journal of Business and Management.*

Ajiboye, J. O., Adu, E. O., & Wojuade, J. I. (2007). Stakeholders" Perceptions of the Impact of GSM on Nigeria Rural Economy: Implication for an Emerging Communication Industry. *Journal of Information Technology Impact, 7*(2), 131-144.

Aldmour (2013). LTE and WiMAX: Comparison and Future Perspective. Communications and Network.

Alenezi, A. (2020). The Role of e-Learning Materials in Enhancing Teaching and Learning Behaviors. *International Journal of Information and Education Technology*, *10*(1), 1–9. https://doi.org/10.18178/ijiet.2020.10.1.1338.

Anas, M., Rosa, C., Calabrese, F. D., Michaelsen, P. H., Pedersen, K. I. & Mogensen, P. E. ( 2008, May). QoS-Aware Single Cell Admission Control for UTRAN LTE Uplink. *IEEEVehicular Technology Conference* (VTC), 2487-2491.

Anderson, E.W., Fornel, C. & Lehmann, D. R. (1994). Customer satisfaction, market share and profitability. *Journal of Marketing*, 56, 53 -66.

Aronson, E., & Mills, J. (1959). The effect of severity of initiation on liking for a group. *Journal of Abnormal and Social Psychology*, 59, 177–181. doi:10.1037/h0047195.

Aypay, A, Çelik, H. C. Aypay, A (and) Sever, M. (2012) Technology Acceptance in Education: A Study Of Pre-Service Teachers In Turkey. TOJET: *The Turkish Online Journal of Educational Technology*, *11*(4).

Bagozzi, R. 2007. The legacy of the technology acceptance model and a proposal for a paradigm shift. *Journal of the Association for Information Systems*, *8*(4), 244-254.

Bahia, K., & Nantel, J. (2000). A reliable and valid measurement scale for the perceived service quality of banks. *International Journal of Bank Marketing*, *18*(2), 84-91.

Baileyt, J. E., & Pearson, S. W. (1983). Pearson development of a tool for measuring and analyzing computer user satisfaction. *Management Science*, 25, 5.

Beaubrun, R., & Pierre, S. (2001). Technological Development and Socio-economic Issues of Wireless Communications. Telematics and Informatics,

Beauvois, J. L., & Joule, R. V. (1996*). A radical dissonance theory*. London, England: Taylor & Francis.

Bertrand, M and Bouchard, S (2008). Applying the technology acceptance model to VR with people who are favourable to its use. *Journal of Cyber Therapy & Rehabilitation*, *1*(1).

Biaz, S. & Vaidya N. H.. (1999). Discriminating Congestion Losses from Wireless Losses using Inter-Arrival Times at the Receiver. Proc. *IEEE Symposium ASSET '99*.

Boshoff, C., & Gray, B. (2004). The Relationships between Service Quality, Customer Satisfaction and Buying Intentions in the Private Hospital Industry. *South African Journal of Business Management*, *35*(4), 27–37.

Brady, M. K., & Robertson, C., (2001). "Searching for a consensus on the Antecedent Role of Service Quality and satisfaction: Exploratory Cross-National Study", *Journal of Business Research*, *51*, 53-60.

Brehm, J. W. (1956). Postdecision changes in the desirability of alternatives. *Journal of Abnormal and Social Psychology*, 52, 384–389.

Buttle, F. (1996). SERVQUAL; review, critique, research agenda, *European Journal of Marketing*, *30*(1), 8-32.

Caruana, A. (2002). Service loyalty: The effects of service quality and the mediating role of customer satisfaction. *European Journal of Marketing*, 36(7/8), 811–828.

Chakravorty, & Pratt, I. (2002). WWW Performance over GPRS. IEEE MWCN '02.

Cook, S. (2008). Customer care excellence: How to create an effective customer focus. *Philadelphia: Kogan Page Limited*.

Creswell, J. W. (2003). Research design: qualitative, quantitative, and mixed methods approaches. *Sage Publications*.

Crews (2014). Retrieved October 10, 2018, from http://www.forbes.com: http://www.forbes. com/sites/waynecrews/2014/11/10/president-obamas-net-neutrality-planto-regulate-google-and-internet-content-providers

Criteo (2015). Retrieved October 10, 2018, from www.criteo.com: http://www.criteo.com /resources/mobile-commerce

Cronin, J. J. Jr & Taylor, S. A. (1992). Measuring service quality: A re-examination and extension. *Journal of Marketing*, 56, 405-20.

Cyprien, M. (2012). WiMAX Maintains Growth in Africa and Middle East [Online]. Available:

http://www.goingwimax.com/wimax-maintains-growth-in-africa-and-middle-east-13978/

Danneels, J. (1998). The future of communication. *Proceedings of the 24th European Solid-State Circuits Conference*, 35-43.

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly, 13*(3).

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User Acceptance of Computer Technology: A comparison of two theoretical models*. Management Science, 985.

Day, R. (1980). How satisfactory is research on consumer satisfaction? In J. Olson (Ed.), Advances in Consumer Research, 7 (pp. 593-597). Ann Arbor: Association for Consumer Research.

Day, R. L. (1984). Modeling Choices among Alternative Responses to Dissatisfaction, in TC Kinnear (ed), *Advances in Consumer Research, Association for Consumer Research11, ProvoUT*.

Delgado, O. & Jaumard, B. (2010). Joint admission control and resource allocation with GoS and QoS in LTE uplink. *IEEE GLOBECOM Workshops* (GC Wkshps), 829-833.

Denscombe, M. (2003). The Good Research Guide for Small-Scale social Research Projects (2nd ed.) Buckingham: *Open University Press*.

Deshpandey, P. (2006). S Day, R. L., (1984). Modeling Choices among Alternative Responses to Dissatisfaction, in TC Kinnear (ed), *Advances in Consumer Research, Association for Consumer Research11,Provo UT*. Deshpandey, P. (2006).

Deutsch, K. (1953). Nationalism and Social Communication: An Inquiry into the Foundations of Nationality, *Cambridge: MIT Press*.

Djiofack-Zebaze, C., & Keck, A. (2009). Telecommunications Services in Africa: The Impact of WTO Commitments and Unilateral Reform on Sector Performance and Economic Growth. *World Development, 37*(5), 919–940.

Douglas, L. & Connor, R. (2003). Attitudes to service quality- the expectation gap, *Nutrition & Food Science, 33*(4), 165-172.

Ducey, Adam J. (2013). "Predicting Tablet Computer Use: An Extended Technology Acceptance Model". Graduate Theses and Dissertations. Retrieved on 01/03/2015, from http://scholar commons.usf.edu/etd/4471.

Dunnewijk, T., & Hulte´n, S. (2007). A brief history of Mobile Communication in Europe. *Telematics and Informatics*, 164–179.

Dutta, A., &Roy, R. (2006). Managing Customer Service Levels and Sustainable Growth: A Model for Decision Support. *Proceedings of the 39th Hawaii Conference on System Services*.

Elnan, H., & Andersen, O. (1999). Measuring and Monitoring Service Quality in the Bus Industry. *Proceeding of the 3rd Asian Academy of Management Conference*.

Ericsson, & Telia. (1998). Att förstå telecommunication: 2 Lund, Student literature: Stockholm.

Ericsson. (2015). Retrieved October 10, 2018, from http://www.ericsson.com: http://www.ericsson.com/res/docs/2015/ericsson-mobilityreport-feb-2015-interim.pdf

Eshghi, A., Roy, S. K., & Ganguli, S. (2008). Service quality and customer satisfaction: An empirical investigation in Indian mobile Telecommunications services, *Marketing Management Journal*, 18(2), 119-144.

Fall, S. F. (1996). Simulation-based Comparisons of Tahoe, Reno, and Sack TCP. *ACM Computer Communication* Review.

Feeney & Nilsson, M. (2001). Investigating the energy consumption of a wireless network interface in an ad hoc networking environment. IEEE Infocom.

Feeney, L. M. (2002). A QoS Aware Power Save Protocol for Wireless Ad HocNetworks . Med-Hoc-Net 2002.

Feigin, K. Pavan, & Ylianttila, M. (2000). Hardware-fitted modeling and simulation of VoIP over a Wireless LAN. IEEE VTC '00.

Festinger, L. (1957). A theory of cognitive dissonance. *Stanford, CA: Stanford University Press*.

Festinger, L., & Carlsmith, J. M. (1959). Cognitive consequences of forced compliance. *Journal of Abnormal and Social Psychology*, 58, 203–210.

Fink, C., Mattoo, A., & Rathindran, R. (2003). An assessment of telecommunications reform in developing countries. *Information Economics and Policy*, 443–466.

Fornell, C. (1992). A National Customer Satisfaction Barometer. *The Swedish Experience J. Mark*. *56*(4), 6-12.

Fornell, C., Johnson, M .D.Anderson, E. W., Cha, J., & Bryant, B. E. (1996). The American Customer Satisfaction Index: Nature, Purpose and Findings. *Journal of Marketing, 58*, 7-18.

Foster, & Iamnitchi, A. (2003). On Death, Taxes, and the Convergence of Peer-to-Peer and Grid Computing. *2nd International Workshop on Peer-to-Peer Systems*.

Foster, C. Kesselman, & Tuecke, S. (2001). The Anatomy of the Grid: Enabling Scalable Virtual Organizations. *International Journal of Supercomputer Applications*, 15

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education* (8th ed.). New York, NY: McGraw-Hill.

Frankel, J. R., & Wallen, N. E. (2000). *How to design and evaluate research in education* (4th ed.). New York: McGraw-Hill Inc.

Fuentelsaz, L., Maicas, J. P., & Polo, Y. (2008). The evolution of mobile communications in Europe: The transition from second to third generation. *Telecommunication Policy*. 436-449.

Garg, A. K and Garg, D (2013). An Assessment of 3G Internet Service Acceptance in Botswana: Technology Acceptance Model with Social Influence and Price Perception. *Pakistan Journal of Social Sciences (PJSS) 33*(1).

Ghauri, P., & Gronhaug, K. (2005). *Research methods in business studies – A practical guide*. (3rd ed.). Prentice Hall.

Ghini, G. P. Roccetti, M. Salomoni, P. & Gerla, M. (2004). For Here or To Go? Downloading Music on the Move with an Ultra Reliable Wireless Internet Application. IEEE ICC'2004.

Giese, J. L., & Cote, J. A. (2002). Defining Consumer Satisfaction, Academy of *Marketing Science, 2000*(1), 1-24.

Giese, J.L. & Cote, J.A. (2000). Defining Consumer Satisfaction. *Academy of Marketing Science Review*, 1, 1-27.

Gitzenis & Bambos, N. (2002). Power-Controlled Data Prefetching/Caching in Wireless Packet Networks. INFOCOM '02.

Goff, T., Moronski, J. Phatak, D. & Gupta, V. (2000). Freeze-TCP: A true end-to-end Enhancement Mechanism for Mobile Environments. *IEEE INFOCOM* 2000.

Golmie, R. E. Van Dyck, & Soltanian, A. (2001). Interference of Bluetooth and IEEE 802.11: simulation modeling and performance evaluation. *ACM Int Workshop on Modeling, Analysis, and Simulation of Wireless and Mobile Systems*.

Gronroos, C. (1982). A service quality model and its marketing implications, *European Journal of Marketing*, *18*(4), 36-44.

Gronroos, C. (1983). Strategic management and marketing in the service sector. *Cambridge, MA: Marketing Science Institute.*

Grönroos, C. (2000). Service Management and Marketing: A Customer Relationship Management Approach (2nd ed.). John Wiley & Sons, Ltd.

Gruber, H., & Verboven, F. (2001). The diffusion of mobile telecommunication services in the European Union. *European Economic Review* 45, 577-588.

Huda, N., Rini, N., Mardoni, Y. & Putra, P. (2012). The Analysis of Attitudes, Subjective Norms, and Behavioral Control on Muzakki's Intention to Pay Zakah. *International Journal of Business and Social Science, 3*(22).

Huston, G. (2001). TCP in a Wireless World. IEEE Internet Computing, 82 – 84.

Iddrisua, I. K., Noonib, Fiankoc, & Mensahd, K.S. W. (2015). "Assessing the Impact of Service Quality on Customer Loyalty: A Case Study of the Cellular Industry of Ghana" *British Journal of Marketing Studies 3*(6), 15-30.

Ilhaamie (2010). "Service Quality in Malaysian Public Service: Some Findings" *International Journal of Trade, Economics and Finance*, 1(1),

ITU-R. (2008). 1645 : Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT -2000.

Jiang, Y., Chen, D. & Lai, F (2010). Technological-Personal-Environmental (TPE) Framework: A Conceptual Model for Technology Acceptance at the Individual Level. *International Information Management Association.*

Johns, N. (1999). What is this thing called service? *European Journal of Marketing*, *33*(10), 958-973.

Jones, T., & Sasser, W.E (1995). Why satisfied customers defect. Harvard Business Review, 73, 88-99. *Journal of Business & Economic Studies*, *15*(1), 82-97.

Jung & Vaidya, N. (2002). *A power control mac protocol for ad-hoc networks*. ACM, Mobicom.

Kamerman, A. (2000). Coexistence between Bluetooth and IEEE 802.11 CCK: Solutions to Avoid Mutual Interference . *IEEE 802.15 Working Group Contribution* .

Kheng, L.L., Mahamad, O., Ramayah, T., M. & Rahim, Mosahab, R. (2010). The impact of service quality on customer loyalty: a study of banks in Penang. Malaysia. *International Journal of Marketing Studies*, *2*(2): 57-66.

Kim, Z. J., Chang, L. & Leung, K. (2000). Incorporating Proxy Services into Wide Area Cellular IP Networks. *IEEE WCNC '00*.

Kothari, G. R. (1994). *Research methodology, methods and techniques.* New Delhi: Wiley Eastern Limited.

Kothari. (2007). *Research Methodology: Methods and Techniques, Revised Second Edition*. New Delhi: New Age International.

Kotler, P., & Keller, K. (2006). Marketing Management (12th ed.). *Pearson Education Inc, New Jersey.*

Krashinsky, & Balakrishnan, H. (2002). Minimizing energy for wireless web access using bounded slowdown. *ACM, Mobicom.*

Kwan, R., Arnott, R., & Kubota, M. ( 2010). On Radio Admission Control for LTE Systems. *IEEE72nd Vehicular Technology Conference Fall* (VTC 2010-Fall), 1-9.

Ladhari, R. (2009). A review of twenty years of SERVQUAL research, *International Journal of Quality and Service Sciences*, *1*(2) 172-198.

Lewis, B. R. & Mitchell, V.W. (1990). Defining and measuring the quality of customer service. *Marketing Intelligence & Planning*, *8*(6), 11-17.

Malisuwan, S., Kaewphanuekrungsi, W., Madan, N., & Sivaraks, J. (2015). Analysis of 2.1 GHz spectrum auction in Thailand. *Journal of Economics, Business and Management*, *3*(6), 591-598.

Marangunic, N. & Granic, A. (2015). Technology acceptance model: a literature review from 1986 to 2013. *University Access Information Society,* 14:81–95.

Mascolo, C., Casetti, M., Gerla, M. Y., Sanadidi, & Wang, R. (2001). TCP Westwood: Bandwidth Estimation for Enhanced Transport over Wireless Links. MOBICOM 2001.

McLuhan, M. (1964). Understanding Media: The Extensions of Man, New York: Mentor in Levinson, Paul (2000). *McLuhan and Media Ecology, Proceedings of Media Ecology Association*, Vol. 1.

Mehdi., K., Osama., K. & Hossam, H. (2012). Call admission control with resource reservation for multi-service OFDM networks. *International Conference on Computing, Networking and Communications* (ICNC), 781-785.

Meier, R., Ben, E. R., & Schuppan, T. (2013). ICT-enabled public sector organizational transformation: Factors constituting resistance to change. Information Polity: *The International Journal of Government & Democracy in the Information Age*, 18(4), 315-329. doi:10.3233/IP-130315.

Miles, M., B., Huberman, A. M. (1994). Qualitative data analysis: an expanded sourcebook. (2nd ed.). *Thousand Oak, CA: Sage Publications*.

Mittal, B., & Lassar, W. M. (1998). Why do customers switch? The dynamics of satisfaction versus loyalty. *Journal of Services Marketing*, *12*(3), 177-94.

Mohan, J. R. Smith, C. S. Li. (1999). Adapting multimedia internet content for universal access. *IEEE Transactions on Multimedia*, 1.

Mudit, R. B. & Anand, V. B. (2010). A Survey Generations of Mobile Wireless Technology.

Negi, R. (2009). Determining customer satisfaction through perceived service quality: A study of Ethiopian mobile users. *International Journal of Mobile Marketing*. *4*(1), 31-38.

Ojo (2010). The relationship between service quality and customer satisfaction in the telecommunication industry: Evidence from Nigeria. *Broad Research in Accounting, Negotiation, and Distribution, 1*(1), 88.

Oliver, R. L. (1997). *Satisfaction: A Behavioral Perspective on the Consumer*, New York: McGraw Hill.

Olsson, M. & Mulligan, C. (2013). EPC and 4G Packet Networks: Driving the Mobile Broadband Revolution, Second Edition. Retrieved October 10, 2018, from http://common.books24x7.com.

proxy.lib.chalmers.se/toc.aspx?bookid=51031:

Olsson, M. & Mulligan, C. (2015). Retrieved October 10, 2018, from http://common.books24x7.com.proxy.lib.chalmers.se/toc.aspx?bookid=51031

Oyeniyi, O., & Abiodun, A. J. (2008). Customer service in the retention of mobile phone users in Nigeria. *African Journal of Business Management 2*(2), 026-031. [Online] Available: http://www.academicjournals.org/AJBM.

Pantano, E. & Di Pietro, L. (2012). Understanding Consumer's Acceptance of Technology Based Innovations in Retailing. *Journal of Technology Management and Innovation*, *7*(4).

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1988). SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality. *Journal of Retailing*, *64*(1), 12-40.

Parasuraman, A., Zeithaml, V.A. & Berry, L. L. (1985). A conceptual model of service quality and its implication. *Journal of Marketing*, 49, 41-50.

Pashtan A (2006) Wireless terrestrial communications: cellular telephony. *Telecommun Syst* 1:1–12.

Patil1, R.R.Karhe2, M. A. Aher. (2012). Development of Mobile Technology: A Survey.

Pattara-Atikom, P. Krishnamurthy, & Banerjee, S. (2003). Distributed Mechanisms for Quality of Service in Wireless LANs. *IEEE Wireless Communication magazine*.

Phan, G. Zorpas and R. Bagrodia. (2002). The Convergence of HeterogeneousInternet-Connected Clients Within iMASH . *IEEE Personal Communications magazine*.

Portera, Constance Elise & Donthub, Naveen. (2006). Using the technology acceptance model to explain how attitudes determine Internet usage: The role of perceived access barriers and demographics". *Journal of business research*, 59(9), 999-

Priyanka, S. & Kumar, A. (2013). Understanding the evolution of Technology acceptance model. *International Journal of Advance Research in Computer Science and Management Studies*, 1(6).

Qiu., Q., Zhao., L., Ping., L., Wu., C. & Yang. (2011). Avoiding the evolved node B buffer overflow by using advertisement window control. *11th International*

*Symposium on Communications and Information Technologies* (ISCIT), 268-273,12-14.

Ramli, R., Jamaluddin, F., Bakar, E. M. N. E. A., Alias, M. Y., & Mahat, N. (2013). Assignment of spectrum demands by merits via analytic hierarchy process and integer programing. *Journal of Information and Communication Technology*, 39-53.

Ratnasami, P. Francis, M. Handley, R. Karp and S. Shanker. (2001). A Scalable Content Addressable Network. Proc. of SIGCOMM'01.

Rehman, S. (2012). Overview of WiMAX in Pakistan [Online]. Available: http://propakistani .pk/2012/09/17/overview-of-wimax-in-pakistan

Reid, A. A. (1978). New Telecommunications Services and their Social Implications. Philosophical transactions of the royal society of London. *Series A, Mathematical and Physical Science*, 175-184.

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York, NY: Free Press

Rogers, E.M. (1983). *Diffusion of Innovations* (3rd ed.). New York: Free Press.

Rust, R.T. & Oliver, R. L. (1994). Service quality: insights and managerial implications from the fron- tier", in Rust, R. and Oliver, R. (Eds), Service Quality: New Directions in Theory and Practice, *Sage Publi- cations, Thousand Oaks,* CA, pp. 1-20.

Saravanan, R., & Rao, K. S. P. (2007). Measurement of service quality from the customer's perspective – An empirical study, *Total Quality Management, 18*(4), 435-449.

Scroxton, A. (2015). London businesses turn to Wimax after Holborn fire [Online]. Available:

http://www.computerweekly.com/news/4500244428/London-businesses-turn-to-Wimax-after-Holbornfire

Shahin, A. (2010). "SERVQUAL and Model of Service Quality Gaps: A Framework for Determining and Prioritizing Critical Factors in Delivering Quality Services", Online article.

Shroff, R.H., Deneen, C. D., & N.G., E.M.W. (2011). Analysis of the technology acceptance model in examining students' behavioral intention to use an e-portfolio system. *Australasian Journal of Educational Technology*, *27*(4), 600 – 618.

Sinha, N. V., Sivakumar, R. & Bharghavan, V. (1999). WTCP: A Reliable Transport Protocol for Wireless Wide-Area Networks. ACM Mobicom '99.

Skow, J. Kong, T. Phan, F. Cheng, R. Guy, R. Bagrodia, M. Gerla & S. Lu. (2002). A Security Architecture for Application Session Handoff. *International Conference on Communications*.

Söderlund, M. (1998). Customer satisfaction and its consequences on customer behaviour revisited. *International Journal of Service Industries Management*, *9(*2), 169-88.

Spreng, R. A., & Mackoy, R. D. (1996). An empirical examination of a model of perceived service quality and satisfaction. *Journal of Retailing*, *72*(2), 201-14.

Stemm and R. H. Katz. (1998). Vertical handoffs in wireless overlay networks. *Mobile Networks and Applications*, 4.

Suki, N. M. & Suki, N. M. (2011). Exploring The Relationship Between Perceived usefulness, Perceived Ease Of Use, Perceived Enjoyment, Attitude And Subscribers' Intention Towards Using 3g Mobile Services. *Journal of Information Technology Management*, *12*(1).

Teas, D. K. & Wilton, P.C. (1988). Models of consumer satisfaction formation: An Extension. *Journal of Marketing Research*, *25*, 204-212.

Teo, T. (2013). A comparison of non-nested models in explaining teachers' intention to use technology. *British Journal of Educational Technology*, *44*(3), E81-E84. doi:10.1111/j.1467-8535.2012.01350.x

Thakur, R. (2013). Customer Adoption of Mobile Payment Services by Professionals across two Cities in India: An Empirical Study Using Modified Technology Acceptance Model. *Business Perspectives and Research.*

Wang, H., Li, W. & Agrawal, ( 2005). D. P. Dynamic admission control and QoS for 802.16 wireless MAN. *Wireless Telecommunications Symposium*.

Wen, Y. & Kwon, O. (2010). An empirical study of the factors affecting social network service use. *Computers in Human Behavior*.

Wicks, A. M., & Roethlein, C. J. (2009). A Satisfaction-Based Definition of Quality.

Wisniewski, M. (2001). Using SERVQUAL to assess customer satisfaction with public sector services. *Managing Service Quality, 11*(6), 380-388.

Woodside, A. G., Frey, L. L., & Daly, R.T. (1989). Linking service quality, customer satisfaction and behavioral intention. *Journal of Health Care Marketing*, *19*, 5-17.

WTO (1985). Identification and Evaluation of those Components of Tourism Services which have a Bearing on Tourist Satisfaction and which can be Regulated, and State Measures to Ensure Adequate Quality of Tourism Services, World Tourism Organization, Madrid.

Yang, S. C., & Olfman, L. (2006). The effects of international telecommunication investment: Wireline and Wireless Technologies, 1993 - 1998. *Telecommunications Policy* 30, 278–296.

Yi, Y. (1990). Critical Review of Consumer Satisfaction. *Review of Marketing*, 68-123.

Zhao, C. Castelluccia, and Mary Baker,. (2001). Flexible network support for mobile hosts. *MONET Special Issue on Management of Mobility in Distributed*, 6, 2.

## APPENDIX A

## INTERVIEW PROTOCOL (GUIDE)

The researcher want to express his profound gratitude for dedicating your precious time to meet me today. My name is Alex Bampo a student of University of Education Winneba, Kumasi campus. The researcher would like to talk to you about the topic "Evaluation of the Quality of

Service of 4G Mobile Network in the Greater Accra Region"

The interview will be conducted under 60 minutes. Please take note that the researcher will record the interview, simply because some of the important issue or comments can be missed and the researcher cannot be able to write very fast even though notes will be taking but not all information can be captured.

In addition, all your responses will be kept extremely confidential. This means that all that you will say will only be know and discussed with the supervisor of this project work and that your official personal details will not be disclosed in any of our official report as a respondent. Please take note that you should not talk about anything that you do not know and you have a reserved right to ignore unfavorable questions and end the interview at any time.

Are there any questions about what the researcher has explained to you about the interview?

Please are you ready and willing to participate in this interview?

…………………............... …………………………   …………………..

Interviewee                                 Witness                            Date

**Demographic Information**

1) What is your name?

2) How old are you?

3) What is your hometown?

4) What is your mother tongue (language)?

5) Are you employed, unemployed or a student?

6) If employed, for how long have you being in the service?

7) If a student which level of education are you now?

8) Marital status: Married or Single

9) What is your gender? Male or Female

10) What is the total number of network operators you use? 1, 2, 3, more than 3

**General Questions**

1) When you have poor network, what would be your alternative options?

2) How do you attempt to resolve the poor network services, by your service provider?

3) Tell me about your experience with your mobile network in terms of quality of service.

4) What are the most worrying aspect of the poor network service?

5) What inconveniences have you being facing due to the poor network quality?

6) How would you know if your network challenge was resolved when you contacted the service provider?

7) Tell me what you do when you are faced with poor network.

8) Tell me about how frequent you are faced with poor network.

9) In your estimation, what accounts for the poor services provided by the network?

10) How far away is your area from a network tower of your service provider?

11) Tell me whether other people using different mobile devices and other network experience poor network in your area

12) What time of the day do you make calls and why?

13) When you move to the nearby towns, how is the network quality?

14) Which particular area do you move to within your town to get reception when you have poor network, describe the nature of the area?

15) Which network service operator are you currently using?

16) How long have you being using the network operator services?

17) How long have you being using phone?

18) Do you own a personal phone? (how many phone(s) do you own)

19) Have you being logging compliance about service related problems to your service provider?

20) Do you switch to other network service providers when your service provider is having challenges with the service?

21) Have your friends complained of similar problem to you in the area?

22) Have you used any other network services before your current network?

23) Why did you change to your current network?

24) How different is your current network service provider from the previous network service provider?

25) 25. Are you using multiple network service providers' sim simultaneously? If yes why?

26) Has the use of multiple network service providers' sim resolve your issue? If

yes how? If no why?

27) Please is there anything that you prefer to add to what you have said or change?

The researcher will analyze the information you and other interviewees have provided

to me and submit a draft report to my supervisor. The researcher will be happy to send

a copy to review at that time, if you will be interested.


Thank you for your precious time.