AN EFFICIENT PREDICTIVE MODEL FOR CHOOSING MOBILE CELLULAR SERVICE PROVIDER IN NIGERIA

BY

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CERTIFICATION

I certify that this work "An Efficient Predictive Model for Choosing Mobile Cellular Service Provider in Nigeria" was carried out by Ohuabunwa Augustine Ebere. Reg. Number: 20104771288 in partially fulfillment for the award of the degree of M.Sc in Information Management Technology in the Department of Information Management Technology of Federal University of Technology Owerri.

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DEDICATION

I dedicate this work to all my colleagues in Electronics Development Institute (ELDI), Awka and to my parents Mr/Mrs Ignatius Ohuabunwa, my beloved wife Ngozi .P.Ohuabunwa and project supervisor Dr. B.C.Asiegbu for their love, support and care.

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ABSTRACT

Free competition and new network technology have increased competition and widened the range of network service available throughout the world. However, for cellular network service providers, loyalty is a rare trait among customers when it comes to choosing a particular mobile cellular system provider. Despite the huge financial commitment by companies into their respective communication technologies, users ultimately make decisions based on their perceived quality of service (QoS). This thesis attempts to identify the factors affecting the Quality of Service of cellular mobile network providers in Nigeria and put their effect in quantifiable terms using four leading telecommunication firms viz. MTN-Nigeria, Globacom, Etisalat and Airtel. With a clear choice of information sources, regressional analysis and SPSS was utilized. It was discovered that six factors affect the quality of service of cellular mobile network: Network coverage/ Availability of service($X_{5)}$, Call quality($X_{3)}$, Price of service ($X_{4)}$, Customer care($X_{2)}$, Diversity of bundle option of service ($X_{1)}$ and Promotion/Offering of Incentive($X_{6)}$. A predictive model was derived as : $Y = 3.731+0.565X_5 + 0.440X_3 + 0.221X_2+ 0.189X_4 + 0.165X_1 + 0.097X_6$.

The significance of the factors X_4, X_1 , X_2 and X_6 depend on X_5 and X_3, hence-

$Y = 3.731(1+0.1514\ X_5+0.1179\ X_3)$.

Keywords: Model, Call-drop, Cell, Call-quality and Quality-Of-Service (QOS)

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Wireless communication technology has gained widespread acceptance in recent years. A lot of services which are provided by the wired network have been supported by the wireless equipment. With different network services, the demand for supporting multi-type traffic applications in wireless network has increased dramatically **Yadav et al (2013).** This fast and constant increase in the cellular market is expected to leave a huge imprint in all facets of human (day to day) life, such as social networking, transportation, healthcare, education, and national security.

Unfortunately for network providers, loyalty is a rare trait among customers when it comes to choosing a particular mobile cellular system provider. Despite the huge financial commitment by companies into their respective communication technologies, users ultimately make decisions based on their perceived quality of service (QoS). As cellular technology continues to ingrain itself in all aspects of society, network providers must emphasize on delivering high quality of service to its end users. This is critical for any service provider to gain a sustainable competitive edge in the market. To remain competitive, network providers must understand and characterize customer's perception of the quality of service

provided by their respective technologies. Thus, the assessment of the quality of services based on user experiences becomes essential**.**

1.2 Statement of the Problem

In a competitive market, network service providers compete base on the quality of services Melody (2001). From the perspective of the service organization, there is a desire to survive in the business environment. It is a fact that consumer's perception of product quality is an important aspect of a purchasing decision and market behavior. This positive relationship of service quality with customer's satisfaction is proven in Danaher and Mattsson (1994) and Kim et al (2004), with customer's preference is proven in Ranaweera and Neely (2003), and competitiveness is proven in Rapert and Wren (1998).

Also, the concept of customer satisfaction has received much attention in recent time. A company's most important success factor is the ability to deliver better customer value than competitors do, and the objective of quality of service assessment is to assist service providers to deliver value to their customers. This will guarantee high return to the organization's shareholders and employees Riggs (1983).

Several studies as can be seen in the literature review have been isolating individual factors and the influence on quality of service of cellular network. However, this is not objective enough as there is need to investigate collective

effects of the combined factors on the quality of service. In view of these challenges, this current work is geared towards assessing closely the factors influencing quality of services of the cellular mobile providers based on customer's perception.

1.3 Objectives of Study

The broad objective of the study is to assess the quality of service of cellular mobile network operators in Nigeria.

The specific objectives include:

i. Identification of factors affecting quality of service of cellular mobile network

ii. Assessing collective effect of these factors on quality of service of cellular network

iii. Assessing the individual effect of each of these factors on quality of service

iv. Making recommendation based on findings of this study.

1.4 Research Questions

Based on the statement of problem and objectives of the study, the researcher posed the following questions to himself:

i. What are the factors affecting quality of service?

ii. To what extent do all the factors collectively affect quality of service?

iii. To what extent does each factor influence quality of service?

These questions will be answered based on facts and figures collected in the course of this study.

1.5 Statement of Hypothesis

On the basis of the statement of problem, objective and research questions of the study, the researcher also formulated the following hypothesis to be tested:

Ho1 There is no significant effect of the collective factors on quality of service

Ho2 There is no significant effect of Network coverage/Availability of service on quality of service

Ho3 There is no significant effect of Call quality on quality of service

Ho4 There is no significant effect of Price of Service on quality of service

Ho5 There is no significant effect of Customer care on quality of service

Ho6 There is no significant effect of Diversity of bundle option of service on quality of service

Ho7 There is no significant effect of Promotion and Offering of incentive on quality of service

1.6 Scope and Limitations of the Study

This study build on the findings of the previous works on quality of service of cellular network by confirming; Price, network coverage, availability, market segmentation and call quality as the major factors that affect quality of services. It concentrated on the four leading players in the telecommunication industry in Nigeria; MTN, Globacom, Etisalat and Airtel, although there are others, such as Internet service providers (ISP), fixed and wireless providers such as zoom, visafone etc. Also, Imo State was use as a case study while conducting the research. The researcher is bound to experience certain challenges such as: the nonchalant attitude by some respondents in filling the questionnaire, difficulty in respondents returning their questionnaires especially those living outside Imo state. This was partially solved by providing them with e-mail and some had to be contacted on phone for follow-up.

1.7 Significance of the Research

An enhanced quality of services in the telecommunication (telecom) sector is vital for sustainable economic growth of any country. Nigeria is a developing economy in the dynamic global environment. It is striving to bridge the digital divide and become competitive. In 2003, the privatization and deregulation policies adopted by the government have resulted in rapid growth of information

and communication technology in the country and hence a significant growth in the nation's economy.

Cell phone service was formally introduced in Nigeria in 2004. As a result of prudent policies of the government, the sector has witnessed phenomenal growth during the last 9 years. Nigeria communication commission(NCC), a regulating body, indicated that Nigeria has experienced more than 150% continuous growth rate in the telecommunication sector from years 2004-05 to 2006 -07. Such development in the application of cellular/digital technology is playing an increasing important role in today's business markets.

The study is immensely significant in diverse ways to various sectors of the economy, business organization, policy makers and stakeholders. Over 60 million subscribers in Nigeria are going to benefit from this work because it is going to aid stakeholders in appreciating the effects of several factors on the quality of service of cellular mobile network from customer's perspective. For example, understanding the effect of availability of service on the quality of service is critical to ensuring customer's loyalty since consumer's post-purchase evaluation of a service overall quality is positively related to the availability of the product's main functional features on one hand and the consumer's experience- in-use of other auxiliary features on the other hand.

To the Nigeria Communications Commission, the findings and results of this study will help in the fight to protect ICT consumer interests by providing a means of assessing the quality of service of the cellular network operators to ensure they satisfy the minimum performance standards in Quality of Service Regulations of 2006, 2009 and 2012.

The findings of this work will also be of benefit to Network operators as it will help them to deliver value to their customers by monitoring closely the various factors that affect the quality of service as identified in this research, this will guarantee an increase in their customer base and consequently a high return to the organization's shareholders and employees.

Furthermore, this research will be of great help in the Agricultural sector of the economy. Presently, the Federal Ministry of Agriculture adopted the use of handset in the collection of farmer's data for the distribution of farm inputs (like fertilizer). What happens to the farmer's dwelling in those region of the country without network coverage? Certainly, they will be left out and this will hamper the success of such exercise.

Again, The finding of this research will benefit the oil and gas sector. It is a fact that most engineers in this sector spend significant time away from their office (off-shore). In such a situation, poor quality of call or lack of network coverage in

the migrated region will negatively affect the productivity of these workers since communication will be completely distorted.

Another major contribution to knowledge is that while several researches have been done is this area, the researcher found out that most if not all limited their research to individual factors and their effects on Quality of Service. This study therefore, is significant in that it attempts to establish the collective effects of these factors on Quality of service.

CHAPTER TWO

LITERATURE REVIEW

2.1 Historical Overview of Cellular Communication

The Principle of wireless communication is base on the transmission of information signal using electromagnetic wave over a distance Jeffry Wheat et al (2001). Early writings show that people were aware of magnetism for several centuries before1600s. However, they did not become aware of the correlation between magnetism and electricity until the 1800s. In 1820, Hans Christian Oersted, a Danish physicist and philosopher working at that time as a professor at the University of Copenhagen, attached a wire to a battery during a lecture. Coincidentally, he happened to do this near a compass and he noticed that the compass needle swung around. This is how he discovered that there was a relationship between electricity and magnetism. Oersted continued to explore this relationship, influencing the works of Michael Faraday and Joseph Henry. In 1831, Michael Faraday theorized that a changing magnetic field is necessary to induce a current in a nearby circuit. This theory is actually the definition of induction. Faraday's initial findings still serve as the basis of modern electromagnetic technology.

Around the same time that Faraday worked with electromagnetism, an American professor named Joseph Henry carried out an experiment in which he successfully

transmitted an electrical signal over a distance. Although Henry never developed his work on electrical signaling on his own, he did help a man by name Samuel Morse **Yadav et al (2013)**. In 1832, Morse read about Faraday's findings regarding inductance and was inspired to develop his ideas about an emerging technology called the telegraph. Henry helped Morse construct a repeater that allowed telegraphy to span long distances, eventually making his Morse Code a worldwide language use in communication. Morse introduced the repeater technology with his 1838 patent for a Morse Code telegraph. Like so many great inventions, the telegraph revolutionized the communications world by replacing nearly every other means of communication—including services such as the Pony Express.

After the significant discoveries of induction and conduction, scientists began to test conduction with different mediums. The scholars and scientists of the day worked to apply these discoveries and explore the parameters of the properties. In 1887, a German named Heinrich Hertz became the first person to prove that electricity travels in waves through the atmosphere. Hertz went on to show that electrical conductors reflect waves, whereas non-conductors simply let the waves pass through the medium. In addition, Hertz also proved that the velocity of light and radio waves are equal, as well as the fact that it is possible to detach electrical and magnetic waves from wires. Hertz served as inspiration to other researchers

who scrambled to duplicate his results and further develop his findings. Inventors from all across the world easily validated Hertz's experiments, and the world prepared for a new era, the wireless transmission of electromagnetic waves.

Further development in radio transmission was led by an Italian inventor called Guglielmo Marconi who was particularly intrigued by Hertz's published results. Marconi was able to send wireless messages over a distance of ten miles with his patented radio equipment, and eventually across the English Channel. In late 1901, Marconi and his assistants built a wireless receiver in Newfoundland and intercepted the faint Morse code signaling of the letter "S" that had been sent across the Atlantic Ocean from a colleague in England. It was an astounding proof that the wireless signal literally curved around the earth, past the horizon line. Even Marconi could not explain how it happened, but he had successfully completed the world's first truly long-distance communication and the communication world would never be the same. Another researcher by name Reginald Fessenden, proceeded to further develop Marconi's achievements. He became the first person to create a radio band wave of human speech **Yadav et al (2013)**. The importance of his results was felt worldwide, as radio was no longer limited to telegraph codes.

In 1921, mobile radios began operating in the 2 MHz range, which is just above the Amplitude Modulation (AM) frequency range of current radios. These mobile radios were generally used for law enforcement activities only. They were

not integrated with the existing wire-line phone systems that were mostly common at that time. Since the technology was still so new, the equipment was considered experimental and not practical for mass distribution. In fact, people originally did not consider mobile radio as a technology for the public sector. Instead, the technology was developed for police and emergency services personnel, who really served as the pioneers in mobile radio.

It was not until 1924 that the voice-based wireless telephone had the ability to be bi-directional, or two-way. Bell Laboratories invented this breakthrough telephone. Not only could people now receive messages wirelessly, they could also respond to the message immediately, greatly increasing convenience and efficiency. This improved system was still not connected to landline telephone systems, but the evolution of wireless communication had taken one more major step. One issue that still plagued this early mobile radio system was the size of the radio; it took up an entire trunk, adding to the size restriction is the cost of the radio system that was almost as expensive as the vehicle.

In 1935, Edwin Howard Armstrong introduced Frequency Modulation (FM).This technology not only increased the overall transmission quality of wireless radio but also drastically reduced the size of the equipment. The timing could not have been any better. World War II had begun, and the military quickly embraced FM technology to provide two-way mobile radio communication. Due to

the war, companies immediately sensed the urgency to develop the FM technology rapidly, and companies such as Motorola and AT&T immediately began designing considerably smaller equipment. Many of these new inventions became possible due to the invention of the circuit board, which changed the world of electronic equipment **Yadav et al (2013)** .

During this period, Wireless technology is based on the car-mounted police radios of the 1920s. Mobile telephone service became available to private customers in the 1940s. In 1947, Southwestern Bell and AT&T launched the first commercial mobile phone service in St. Louis, Missouri, but the United State Federal Communications Commission (FCC) limited the amount of frequencies available, which made possible only 23 simultaneous phone conversations available within a service area (the mobile phones offered only six channels with a 60 kHz spacing between them). Unfortunately, that spacing schema led to very poor sound quality due to cross-channel interference, much like the cross talk on wire-line phones. The original public wireless systems generally used single high-powered transmitters to cover the entire coverage area Gomez and Sanchez (2005). In order to utilize the precious frequencies allotted to them, AT&T developed an idea to replace the single high-powered transmitter approach with several smaller and lower-powered transmitters strategically placed throughout the metropolitan area; calls would switch between transmitters as they needed a stronger signal.

Although this method of handling calls certainly eased some of the problems, it did not eliminate the problem altogether. In fact, the problem of too few voice channels plagued the wireless phone industry for several years **Yadav et al (2013)**. Demand always exceeds supply. Since the United State Federal Communication Commission (FCC) refused to allocate more frequencies for mobile wireless use, waiting lists became AT&T's temporary solution as the company strove for the technological advances necessary to accommodate everyone. For example, in 1976, there were less than 600 mobile phone customers in New York City, but there were over 3500 people on waiting lists. Compare this situation to today's, in which providers give away free phones and thousands of minutes just to gain a subscriber.

Cellular technology has come a long way. The term cellular describes how each geographic region of coverage is broken up into cells. Within each of these cells is a radio transmitter and control equipment. Early cellular transmission operated at 800 MHz on analog signals, which are sent on a continuous wave. When a customer makes a call, the first signal sent identifies the caller as a customer, verifies that he or she is a customer of the service, and finds a free channel for the call. The mobile phone user has a wireless phone that in connection with the cellular tower and base station handles the calls, their connection, handoff, and the control functions of the wireless phone.

Personal communications services (PCS), which operates at 1850 MHz, followed years later. PCS refers to the services that a given carrier has available to be bundled together for the user. Services like messaging, paging, and voicemail are all part of the PCS environment. Within the same period, Some cellular providers began looking into digital technology (digital signals are basically encoded voice delivered by bit streams). They started using digital signals to send not only voice, but also data.

2.1.1 Cellular Mobile Technology Evolution

The introduction of semiconductor technology and the smaller microprocessors made more sophisticated mobile cellular technology a reality in the late 1970s and early 1980s. The First Generation (1G) technologies started the rapid growth of the mobile cellular industry. The most predominant systems are the Advanced Mobile Phone System (AMPS), Total Access Communication System (TACS) and the Nordic Mobile Telephone (NMT) system. However, analog systems did not provide the signal quality desired for a voice system. These systems provided the foundation for the growth of the industry into the digital systems characterized by 2G.

The need for better transmission quality and capacity drove the development of the Second Generation (2G) systems and brought about the deployment of

digital systems in the mobile industry. The U.S. companies like Sprint PCS predominantly gravitated towards the Code Division Multiple Access (CDMA) systems; most of the rest of the world embraced the (Global System for Mobile communication (GSM) systems. Dual band mobile phones were created to allow roaming between digital 2G coverage areas through analog 1G areas. The Code Division Multiple Access (CDMA) and Global System for Mobile Communication (GSM) 2G technologies are currently incompatible. The globalization of the world economy and the market for mobile data capabilities fueled the development of the 2.5G and 3G technologies. Both provide a migration path towards convergence of the two standards (GSM and CDMA) toward a globally interoperable mobile system. Both 2.5G and 3G also provide a migration path for a fully converged mobile voice, data and video system.

With the beginning of convergence came the development of new protocols created to optimize the limited bandwidth of mobile systems (Halonen et al, 2003). The Wireless Access Protocol (WAP) was one of the first specifications for protocols created to meet these challenges by creating more efficient applications for the mobile wireless environment. The General Packet Radio Service (GPRS) was created to provide a packet-switched element (classical data) to the existing Global System for Mobile Communication (GSM) voice circuit-switched architecture. In addition, General Packet Radio Service (GPRS) seeks to increase

the relative throughput of the Global System for Mobile Communication (GSM) system fourfold, using a permanent Internet Protocol (IP) connection from the handset to the Internet.

Enhanced Data Rates for GSM Evolution (EDGE) was created as a further extension to the Global System for Mobile Communication (GSM) data rates but is not limited to the time division multiple access (TDMA)-based GSM systems. Enhanced Data Rates for GSM Evolution (EDGE) uses the same time division multiple access (TDMA) frame structure, logic channel and 200 kHz carrier bandwidth as today's Global System for Mobile Communication (GSM) networks. Enhanced Data Rates for GSM Evolution's (EDGE) acceptance in the market to date is limited, and as with any technology, may be affected by the low acceptance rate. Many mobile service provider migrated directly from existing General Packet Radio Service (GPRS) and Global System for Mobile Communication (GSM) systems directly to Third Generation (3G) systems.

The promise of the Third Generation (3G) mobile wireless technologies is the ability to support applications such as full motion video that require much larger amounts of bandwidth. This capability is known as Broadband and generally refers to bandwidths in excess of 1 Mbps. Wideband Code Division Multiple Access (WCDMA) and Code Division Multiple Access (CDMA2000) are two versions of systems designed to meet this demand; however, they still are not

globally compatible Jeffry Wheat, et al (2001). A global group of standards board called the Third-Generation Partnership Project (3GPP) has been created to develop a globally compatible 3G standard so that the global interoperability of mobile systems can be a reality. The standard this group has developed is named the Universal Mobile Telecommunications System (UMTS).

Since 2003, several developments have led to a renewed interest in wireless communications. The first one is a continued growth of 2G and 2.5G cellular communications, stimulated by new markets as well as new applications. To give just one example, in 2008, China had more than 500 million cell-phone users; even before the first 3G networks became operative. Worldwide, about 3.5 billion cell-phones were in use in 2008, most of them based on 2G and 2.5G standards. Furthermore, 3G networks have become widely available and popular – especially in Japan, Europe, and the U.S.A. Data transmission speeds comparable to cable (5 Mbit/s) are available. This development has, in turn, spurred the proliferation of devices that not only allow voice calls but also Internet browsing and reception of streaming audio and video. One such device, called iPhone, received enormous attention among the general public when first introduced, but there exist actually dozens of cell-phones with similar capabilities. These so-called "smart-phones" account for 20% of the cell-phone market in the U.S.A. As a consequence of all these developments, transmission of data to and from cell-phones has become a

large market. Even while 3G networks are still being deployed, the next generation (sometimes called 4G or 3.9G) has been developed.

In 2004, just as the first widespread rollout of Wideband Code Division Multiple Access (WCDMA) systems was happening, the Third Generation Partnership Project (3GPP) industry consortium started to work on fourth-generation (4G) systems. It was predicted at that time (and borne out by later developments) that the data rates and spectral efficiencies of Wideband Code Division Multiple Access (WCDMA) would not meet the demand of future applications; therefore, a new system had to be developed. In a somewhat bold move, it was decided to completely change both the air interface and the core network. The air interface was to move to Orthogonal Frequency Division Multiplexing (OFDM) as modulation, and Orthogonal Frequency Division Multiple Access (OFDMA), with (limited) support for Multiple Input Multiple Output system (MIMO) antenna technology. The core network was to evolve into a pure packet-switched network. The new standard became known as 3GPP Long-Term Evolution, or simply LTE.

The development of Long-Term Evolution (LTE) originally took place in parallel to the further evolution of Wideband Code Division Multiple Access (WCDMA). Around 2007/2008, Long-Term Evolution (LTE) started to take the center stage of the Third-Generation Partnership Project (3GPP) meetings. The

basic parameters of the air interface were soon agreed on, but the implementation details required an enormous effort to achieve compromises yet stay reasonably simple and self-consistent. At the time of this writing, Release 8 of the Long-Term Evolution (LTE) specifications has been finalized. It provides for data rates up to 300 Mbit/s in the downlink (DL). Further improvements, in particular extending the use of Multiple Input Multiple Output (MIMO) for increasing the spectral efficiency, are foreseen for future releases. Release 10, also known as LTE-Advanced is intended to provide data rates up to 1 Gbit/s. LTE-Advanced will also be submitted to the International Telecommunications Union (ITU) as one of the candidates for International Mobile Telecommunications (IMT)-Advanced cellular systems.

LTE has received strong support from the vast majority of cell-phone and infrastructure manufacturers. Most notably, the Third-Generation Partnership Project Two (3GPP2) alliance (which had promoted the CDMA2000 systems, a rival to 3GPP's WCDMA system) decided to terminate the development of its own incipient 4G standard; rather, its members are now participating in the development of Long-Term Evolution (LTE). Therefore, both the existing Wideband Code Division Multiple Access (WCDMA) and Code Division Multiple Access (CDMA2000) network operators will eventually migrate to Long-Term Evolution (LTE). While there are still two different flavors of LTE (a Frequency

Domain Duplexing (FDD) and a Time Domain Duplexing (TDD) mode), great effort has been made to make those two modes as similar as possible; and indeed the duplexing method is the only essential difference between them. Figure 2.1 illustrates the cellular mobile technology evolution path.

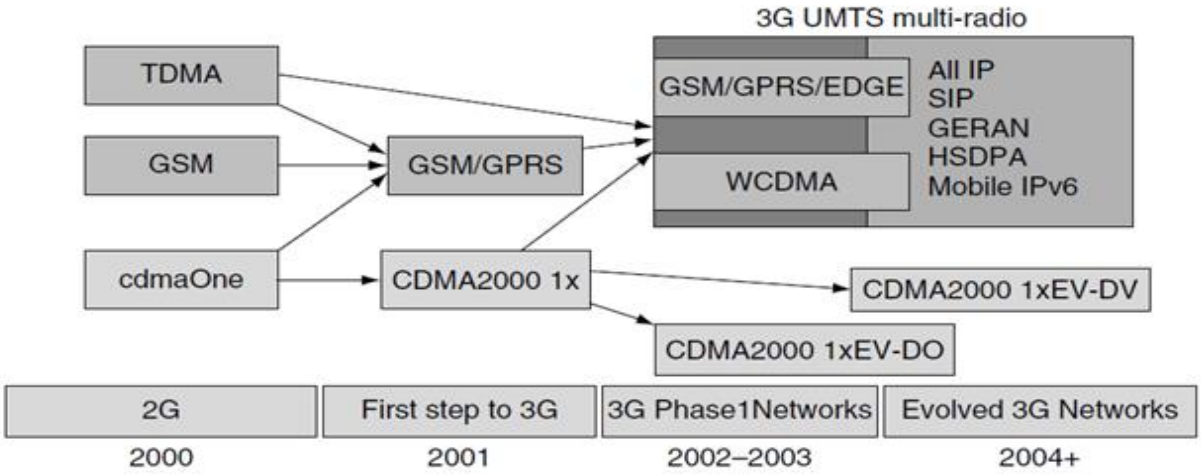

Figure 2.1 Cellular Mobile Technology Evolution path.

Source: Gómez and Sánchez (2005).

2.1.2 Evolution Challenges

With the design and commercialization of a new system, there are a large amount of requirements that need to be considered not only from a technical perspective, but also from an economical and commercial point of view Gómez and Sánchez (2005). The major challenges that are important to consider are:

1. Backwards compatibility: In order to get maximum reuse of older investments, a natural evolution requires the new system to be backwards compatible towards older, already commercially deployed systems. For example, with the introduction of Universal Mobile Telecommunications System (UMTS) in Europe, it is of high importance that the new system will from day 1 be able to perform inter-system handovers to and from the commercial deployed Global System for Mobile Communication (GSM) network. The reason for this is obvious, as the operator wants to be able to offer continuous service coverage. Note, however, that general requirements on backwards compatibility can mean many very different technical requirements on the new system. An operator might want to make maximum use of his already deployed network by integrating the new and the old system; this will lead to such requirements as inter-system handovers and the ability to co-site the two systems. On the other hand, a mobile phone vendor might want to ease the implementation of a multi-system handset, and might want to set requirements on clock frequencies to be used, as well as limiting the complexity between how the two systems interact.

2. Service transparency: New systems typically offer new services. For that reason it can be difficult, especially in the beginning, for the operator to offer a continuous service support over the whole coverage area. For example, high-speed data service is impossible to maintain in Universal Mobile Telecommunications System

(UMTS) when the user leaves the UMTS coverage area and are handed over to General Packet Radio Service (GPRS). From this aspect, it is considered important to be able to maintain some type of service, even if the service level is lower.

3. Interoperability/roaming: As users move between systems, it is difficult for the operator to maintain a constant service level. In the same case as in the service transparency example above, a user that is roaming into another network might not get all the services he/she can normally access in his/her home network, as they might simply not be implemented. Another consequence is the implications this might have on the billing models to be use

2.1.3 Service Delivery

In the early data services market, many consumers are impressed to just use a service when mobile. However, once this euphoria has passed, the vast majority of consumers start to judge a service based on how it meets their needs and expectations. As an example, Short Message Service (SMS) was designed as a store and forward service, and was offered as such by most operators in the mid-1990s with messages sometimes delayed hours before delivery. Consumers have conclusively taken to the service as a way of communicating quickly and efficiently with friends and colleagues without the need for a conversation. However, in meeting these needs; we expect that a message is delivered almost instantly. When important business and social meetings are arranged by Short

Message Service (SMS), a couple of hours delivery delay is unacceptable. As we can see from this example, a consumer's expectations of a service dictate whether it is perceived as working well or badly Halonen, et al (2003). These expectations in turn determine the critical success factors that the network must deliver if the service is to be perceived as good. For instance, a customer browsing the Internet from a handset with a 3G data card will expect that the Web page loads accurately to a point where they can start reading in less than 10 seconds, otherwise their concentration will lapse making the service uncomfortable to use. This implies that the network must deliver accurate information with a very little delay. In this example, the way the Web page is built can also make a difference. For example, a Website that displays text within 10 seconds but then downloads images in the next 10 seconds will often appear to be quicker than a page that completely downloads in only 15 seconds.

In the example above, if the network achieves the critical success factors, the consumer is likely to perceive a service as working well. If the network fails to deliver, the consumer is likely to perceive a service as working poorly. When considering the quality of a network it is worth remembering that services run either between two terminals or a terminal and a server, and that the critical success factors apply across the whole connection. There is no point, for example, in engineering the General Packet Radio Service (GPRS) network to meet the

consumer's expectations when the connection to the content provider is not to the same standard and hence degrades the overall experience. The main causes of a network failing to deliver against the critical success factors are:

1. Radio network performance – Are there a lot of errors on the radio interface?

2. Network capacity – Is there sufficient capacity to deliver a good service?

3. Network design – Is there too much delay in the system; is sufficient capacity available end to end?

4. Application design – Are the right protocols being used for a mobile environment?

5. Service support – Is service enhancement technology correctly configured?

2.2 Radio Network Performance

A well-planned radio network where data errors on the air interface are minimized in most cases will improve application performance. If there are a large amount of errors, retransmissions are required which can slow down the amount of information that can be transferred by protocols such as Transmission Control Protocol (Gómez and Sánchez, 2005). Radio errors also introduce extra delay into any conversation between application clients/servers, slowing down application response times. In a similar way, voice conversations can be slowed down by satellite delays.

2.2.1 Network Capacity

Well-designed mobile networks are dimensioned so that they have just enough capacity during busy periods. Any more capacity than necessary adds network cost for operators reducing the profit margins. Too little capacity with numerous applications will deliver a poor customer experience. It is, however, extremely difficult to predict loading accurately as demand may fluctuate by time, day, month and season as well as demand growing with time. As a result, any operator wishing to offer customers a good experience (so as to encourage the uptake of services) would have to expensively over dimension their network to avoid congestion. To overcome this problem, quality of Service (QoS) is to be implemented into the network equipment. The quality of service concept encapsulates the idea that different data streams could be treated differently by the network depending upon the service being carried Gallagher (2008). Ideally, a service that requires fast response time is assigned a quality of service that in periods of congestion it would receive priority over other traffic. Conversely, a service that can tolerate a reasonable delay would have lower priority than other traffic.

By assigning different quality of service to different services, when congestion occurs traffic can effectively be smoothed over time with high priority traffic still being transmitted with little delay but lower priority traffic being

delayed until capacity is available. As a result, in periods of temporary congestion, a network providing quality of service can meet customer-service expectations with existing capacity. In this way, with quality of service, operators can more effectively load their networks as they can tolerate temporary congestion while at the same time ensuring that they deliver to the customers the good service experience they expect. It is worth noting, however, that quality of service mechanisms are designed to work in periods of temporary congestion, where lower priority traffic can be delayed without impacting the service experience of those services. If heavy congestion occurs or the network is congested for extended periods of time, quality of service cannot be relied on to maintain the customer service experience. In these cases, further capacity is required and the network should be re-dimensioned to a level where only temporary congestion occurs.

2.2.2 Service-Enhancing Technology

The aim of service-enhancing technologies is to improve the performance of data services by overcoming limitations in wireless systems caused by the radio environment Gómez and Sánchez (2005). Examples of service-enhancing technology are:

1. Payload compression – Information transferred across the radio interface is compressed first so that it takes less time to transfer over a radio connection.

2. Controlled quality degradation – Higher quality and resolution especially of pictures implies larger file sizes and thus longer transmission times. When the final end of the transmission is a mobile terminal with limited screen resolution, in addition to normal compression, images can be downgraded or reduced in size so that they are still recognizable and fit better to terminal screens. This process is a compression with losses and can perform in network elements such as proxies.

3. Proxies – Proxies store copies of Web page components locally so that when a Web page is requested, the proxy can instantly provide the Web page components without incurring further delay as it avoids having to get the Web page from the Internet. As Web pages can be made up of many components which need serial requesting, cutting the end-to-end delay associated with collecting components can have a significant impact on Web page download times

4. Protocol optimization – Protocols are adapted to make them more suitable for use in the radio environment. The most common optimization is related to the Transmission Control Protocol (TCP) which is used to carry the majority of Web traffic. The optimization aims to counteract the reduction in flow rate associated with delays to Transmission Control Protocol (TCP) acknowledgements, which Transmission Control Protocol (TCP) interprets as congestion, by injecting fake acknowledgements into data streams. At the application level, optimization can take the form of consolidating all the Web components into one transaction, which

is downloaded so that long delays caused by requesting and receiving Web page components serially is avoided.

2.3 Basic Component of GSM Cellular System

A Global System for Mobile Communication (GSM) system consists essentially of three parts – namely, the Base Station Subsystem (BSS), the Network and Switching Subsystem (NSS), and the Operation Support System (OSS).

2.3.1 Base Station System (BSS)

The BSS consists of Base Transceiver Stations (BTSs) and the Base Station Controllers (BSCs). The BTS establishes and maintains the connection to the Mobile Station (MSs) within its cell. The interface between the Mobile Station (MS) and the Base Transceiver Stations (BTS) is the air interface, called the Um-interface in the GSM context. The Base Transceiver Stations (BTS) hosts, at a minimum, the antennas and the Radio Frequency (RF) hardware of a Base Station (BS), as well as the software for multiple access (G. Gómez and R. Sánchez, 2005). Several Base Transceiver Stations (BTSs) are connected to one Base Station Controller (BSC); they are either co-located, or connected via landline, directional microwave radio links, or similar connections. The Base Station Controller (BSC) has a control functionality. It is, among other things, responsible for Hand-Over

(HO) between two Base Transceiver Stations (BTSs) that are connected to the same Base Station Controllers (BSC). The interface between Base Transceiver Station (BTS) and Base Station Controller (BSC) is called the Abis-interface. In contrast to the other interfaces, this interface is not completely specified in the standard. Distribution of the functionalities between Base Transceiver Station (BTS) and Base Station Controller (BSC) may differ depending on the manufacturer. In most cases, one BSC is connected to several Base Transceiver Stations (BTSs). Therefore, it is possible to increase the efficiency of implementation by shifting as much functionality as possible to the Base Station Controller (BSC). However, this implies increased signaling traffic on the link between the Base Transceiver Station (BTS) and the Base Station Controller (BSC), which might be undesirable (since these links are often rented landline connections). In general, the Base Station Subsystem (BSS) covers a large set of functionalities. It is responsible for channel assignment, maintenance of link quality and handover, power control, coding and encryption.

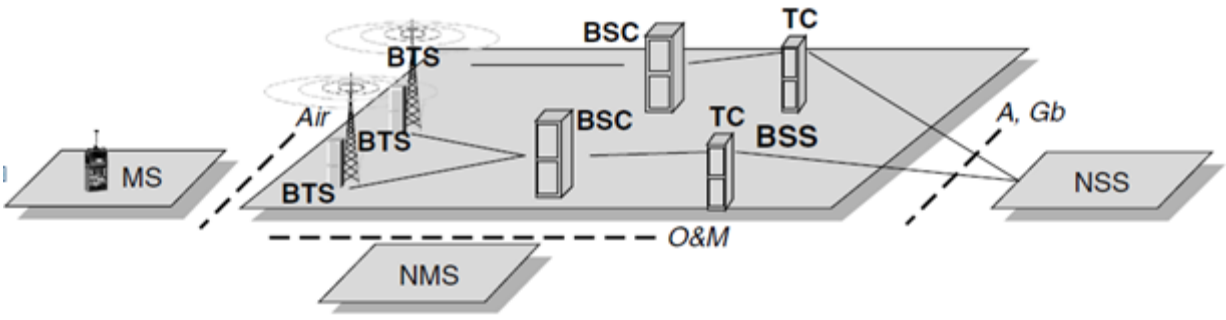

Figure 2.2 Basic GSM System architecture.

Source: Gómez and Sánchez (2005).

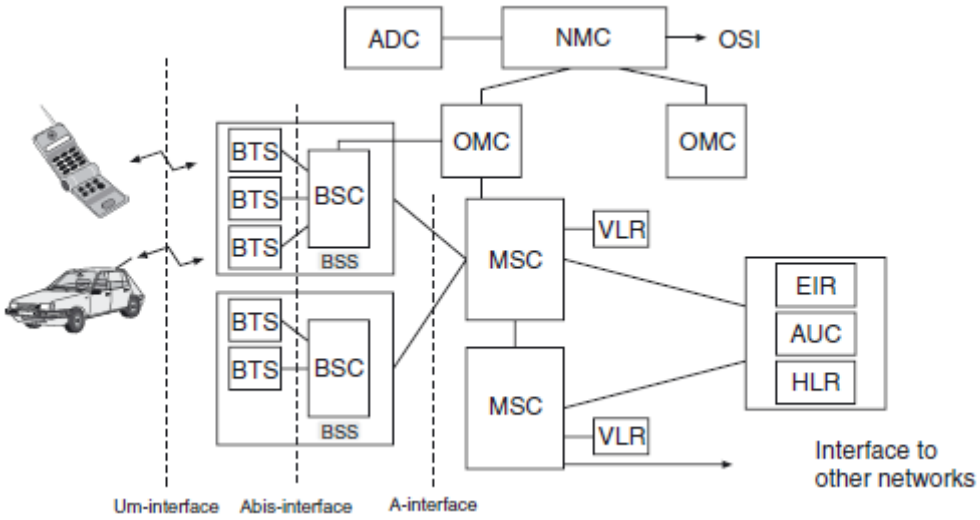

Figure 2.3 Block diagram of a Global System for Mobile Communication system.

Spource: Gómez and Sánchez (2005).

In fig 2.3- ADC stands for Administration Center; NMC, Network Management Center and OSI, Operator System Interface.

2.3.2 Network and Switching Subsystem (NSS)

The main component of the NSS is the Mobile-services Switching Center (MSC), which controls the traffic between different BSCs (see Figure 2.3). One function of the MSC is mobility management, which comprises all the functions that are necessary to enable true mobility for subscribers (Gómez and Sánchez, 2005). To give but one example, one function of the Mobile-services Switching Center (MSC) is the management of hand over that occur when a mobile station is leaving the area of one base Station Controller (BSC) and moving into the area covered by another Base Station Controller (BSC). Other functions are the so-called paging and location update. All interactions with other networks – especially the landline Public Switched Telephone Network (PSTN) – are also performed by the Mobile-services Switching Center (MSC). The Network and Switching Subsystem **(**NSS**)** includes some databases, too. The Home Location Register (HLR) contains all the numbers of the mobile subscribers associated with one Mobile-services Switching Center (MSC) and information about the location of each of these subscribers. In the event of an incoming call, the location of the desired subscriber is looked up in the HLR and the call is forwarded to this location. Therefore, we can conclude that from time to time a traveling mobile station has to send updates of its location to its Home Location Register. The Visitor Location Register (VLR) of one MSC contains all the information about

mobile subscribers from other HLRs that are in the area of this Mobile-services Switching Center (MSC) and are allowed to roam in the network of this MSC.

Furthermore, a temporary number will be assigned to the Mobile Station (MS) to enable the “host” Mobile-services Switching Center (MSC) to establish a connection to the visiting Mobile Station (MS). The Authentication Center (AUC) verifies the identity of each Mobile Station (MS) requesting a connection. The Equipment Identity Register (EIR) contains centralized information about stolen or misused devices.

2.3.3 Operation Support System (OSS).

The OSS is responsible for organization of the network and operational maintenance Gómez and Sánchez (2005). More specifically, the OSS mainly covers the following functions:

1. Accounting: how much does a specific call cost for a certain subscriber? There are also plenty of different services and features, from which each subscriber may choose an individual selection included in a specific plan. While this rich choice of services and prices is vital in the marketplace, the administrative support of this individualism is rather complicated.

2. Maintenance: the full functionality of each component of the Global System for Mobile Communication (GSM) network has to be maintained all the time.

Malfunctions may either occur in the hardware or in the software components of the system. Hardware malfunctions are more costly, as they require a technician to drive to the location of the malfunction. In contrast, software is nowadays administrated from a central location. For example, new versions of switching software can be installed in the complete the Base Station Subsystem (BSS) from a central location, and activated all over the network at a specific time. Revision and maintenance software often constitutes a considerable part of the overall complexity of Global System for Mobile Communication (GSM) control software.

3. Mobile Station (MS) management: even though all MSs have to pass a type approval, it may happen that "bad apple" devices, which cause system-wide interference, are operating in the network. These devices have to be identified and their further activities have to be blocked.

4. Data collection: the Operation Support System **(**OSS) collects data about the amount of traffic, as well as the quality of the links.

2.4 Network Elements for an enhanced GSM Cellular System

When new network elements (as shown in fig. 2.4) are added to the existing Global System for Mobile Communication (GSM) architecture, a system that is based on packet-switched technology is created. The new elements are practically a parallel transport network for the packet information, which reuses the air

interface layer Base Transceiver Stations (BTSs) and some of the units in the core network.

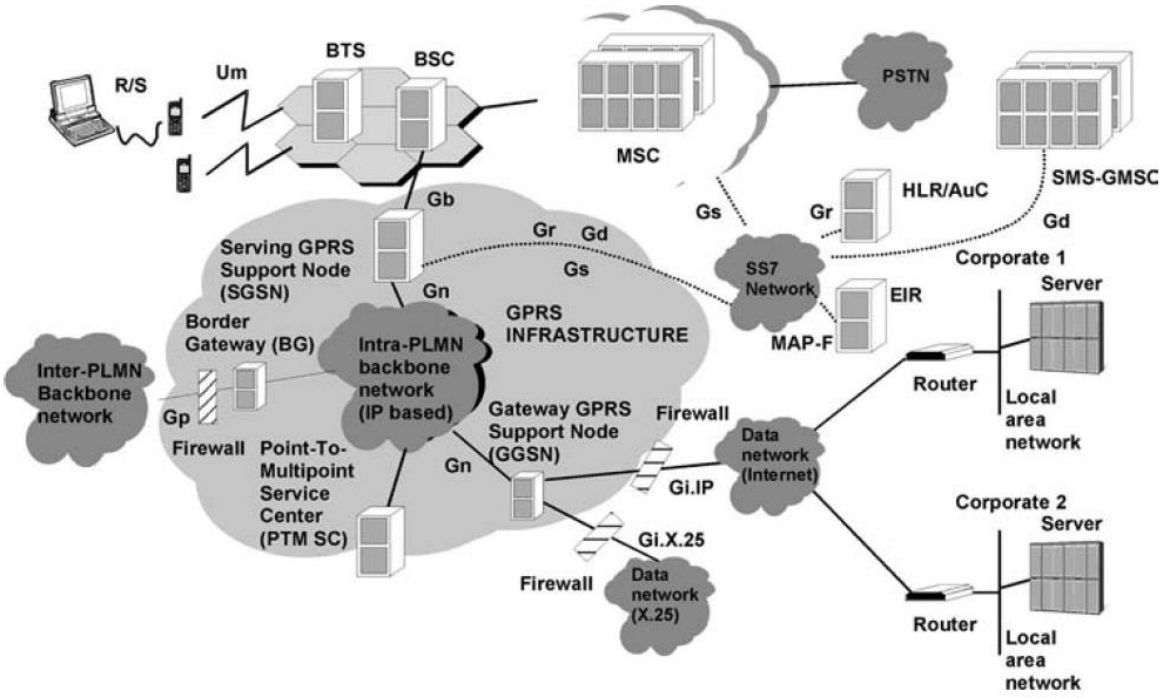

Figure 2.4 Functional view of General Packet Radio Service (GPRS) architecture. Source: Gómez and Sánchez (2005).

The Packet Control Unit (PCU) is an extension to the Base Station Controller (BSC) that implements the Radio Link Control (RLC) and Medium Access Control (MAC) procedures in the network side. It, in fact, contains the implementation of the different Radio Resource Management (RRM) algorithms. The Packet Control Unit (PCU) processes the data packets between the Base Transceiver Stations (BTS) and the Serving GPRS Support Node (SGSN), which are coming through the Abis and the Gb interfaces, respectively.

The Serving GPRS Support Node (SGSN) is a switching element that can handle communications with several Packet Control Unit (PCUs) associated to different Base Station Controllers (BSC) Gómez and Sánchez (2005). It takes care of the mobility management and authentication for the General Packet Radio Service (GPRS) users, and has register functionalities. The Serving GPRS Support Node (SGSN) performs the adaptation between the Internet Protocol (IP) world and the General Packet Radio Service (GPRS) protocol stack. Internet Protocol (IP) packets are received from the Gateway GPRS Support Node (GGSN) and converted into Logic Link Control (LLC) data units in order to be transmitted to the Base Station System **(**BSS) subsystem. Protocol conversion is done through the Sub Network Dependent Convergence Protocol (SNDCP) layer. The communication with the Packet Control Unit (PCU) is performed through the Gb interface (Iu in later GERAN releases) and with the GGSN via the Gn interface. The Gateway GPRS Support Node (GGSN) provides connectivity to external packet networks for the General Packet Radio Service (GPRS) connections. It is linked to the different Serving GPRS Support Node (SGSNs) through the Gn interface, and to the external packet networks through the Gi interface.

2.5 Historical Development of Telecom Industry in Nigeria

In Nigeria, the Telecommunications Industry has experienced exponential growth in the last four years with close about 12 million telephone lines connected to date **Ndukwe (2005)**. For this, Nigeria has been described as one of the world's fastest growing telecommunications markets. These achievements can be attributed largely to the goodwill exhibited by the Nigerian government and the enabling and conducive environment with respect to government policy and regulatory regimes. The telecom market reform in Nigeria evolved from several administrative, structural and operational changes since 1960, through 3 successive National Development Plans Nwakanma (2012), viz.

- Separation of the Post & Telecom Department in 1985, and the establishment of a public monopoly telecom company, NITEL – an amalgamation of the Telecom arm of the P&T and the then NET
- Seminar on telecom sector restructuring in 1987 led to the first National Telecommunications Policy, whose recommendations included:
- Privatisation of the public monopoly, NITEL
- Deregulation/liberalisation of the industry
- Establishment of the National Regulatory Authority
- Introduction of mobile telephony in 1992, through a joint venture between NITEL and DSL of Canada to form MTS.

- Establishment of the National Regulatory Agency(NRA) in 1993
- Introduction of competition in fixed telephony in 1997 through licensing of Private (Fixed) Telephone Operators
- Review and amendment of Telecom Law in 1998
- Review of the 1987 Telecom Policy, and the release of a new National Telecom Policy in 2000, with the following thrusts:
- To modernise & expand the telecom network and services
- To licence 4 national digital mobile telephone operators, with initial 5-year exclusivity;
- To privatise the incumbent operator/carrier by 2002;
- To licence a second national carrier by 2002;
- To achieve 2 million fixed lines and 1.2 million mobile telephone lines by 2002 and 5 million fixed lines and 4 million mobile lines by 2005;
- To strengthen and empower the Regulator through full independence;
- To establish a National Frequency Management Council to coordinate and allocate block spectrum to different user groups
- To develop and enforce Universal Access obligations for fixed and mobile telephone operators

2.5.1 Drivers

`The reform was motivated by:

- The inability of governments to continue funding public enterprises, due to dwindling resources
- The need to ensure affordable access to services while creating the conditions for the development of the information and infrastructure needed to improve operational efficiencies in all aspects/sectors of the economy.
- The need to attract foreign investment and reduce the role of the government where the private sector has the capabilities to operate more efficiently.
- The success of market reform in the developed world.
- The prescription of market reform by the multilateral financial institutions to the developing countries as the panacea for economic growth and development.

2.5.2 The Telecommunications Industry Structure in Nigeria

- The Ministry of Communications
- The Nigerian Communications commission
- Nigerian Telecommunication Limited (NITEL)
- The Second National Operator – Globacom
- Other licensed private telecommunication

- Operators and service providers

2.6 Contribution of Related Works and Research Gap

There are a whole lot of literature on cellular communication system with regards to the Quality of Service (QoS) of the network. These include conference proceedings, workshop reports, news reports, agency reports and scholarly articles. Kostanic et al (2009) presented a QoS assessment methodology for cellular communication networks based on the data collected through drive-testing. The work focuses on the end user perception of service quality by providing independent QoS measurement for voice and data services. In their work, the authors discuss QoS assessment for both the circuit switched and packet switched side of the network; however, they fail to provide QoS measurements as function of both voice and data services simultaneously.

Weissberger et al (2009), stressed the importance of network operators evaluating user-perceived QoS of data services in cellular networks. In their work, the authors specify user experience as a key factor in determining the network operator's success; and present a methodology for evaluating quality of the FTP data service in cellular UMTS networks. Their methodology is based on data collected through drive testing and can be easily extended to other cellular data services. However, the proposed methodology concentrates on evaluating end-user experience based only on data services on a single network.

Similarly, Weissberger et al (2010) present results of evaluation of (user-centric) QoS of background services in an individual UMTS network. In their work, the authors present results for user perceived QoS for email and SMS. However, their approach is bounded to a single UMTS network.

Otero et al (2010) presented a multi-network methodology for evaluating QoS for both voice and data services. The authors use drive-testing to measure individual QoS criteria for both voice and data services. The criteria used for evaluating QoS in voice services are Accessibility, Retainability, Call Quality, and Voice Quality. For data services, the identified QoS criteria include Connection, FTP Downlink, and FTP Uplink. Once drive testing is performed and the data collected, their approach uses desirability functions to fuse all measurements into one unified value that is representative of QoS for a particular application class. In their work, the authors define the following application classes: Emergency, Business, and Personal. For each class, the desirability function parameters are adjusted to reflect the priorities of the (voice and data) services expected. This results in a holistic QoS measurement that considers prioritized voice and data services. The approach provides an improvement to previous work by fusing both voice and data services, and providing a way to customize the evaluation process to specific classes of applications. However, their approach fails to provide evaluation of QoS relative to other networks in the same geographical area.

J.D. Power (2009) studied the Quality of service of mobile cellular user in the United Kingdom. The study used a sample of 3,325 mobile phone customers throughout United Kingdom. The study showed that the Quality of service in the Telecommunication Industry will be a function of how the service meets customer's expectation such as, coverage, call quality, promotions, offerings of incentives and rewards, prices of service, billing, customers bundled services etc. This goes to show that price of service is not the only determinant of Quality of service. Indeed, several other factors (both direct and indirect) must be investigated and acknowledged. In Canada, the consumers' satisfaction survey in 2007 based on the responses of 6000 mobile phone users indicated the essential elements of service quality of mobile operators as quality of calls, prices, billing, customers' services, and diversity of bundled options of services (Customer Satisfaction, 2007).

The quality of service is also related to the availability of the products main functional features on one hand and a consumer's experience-in –use of the auxiliary features on the other, Otero et al (2010). A product main functional features are the source of the primary benefits that the consumer expect to obtain when purchasing it. In general, consumer's evaluation of products overall quality are related to the availability of these features in comparison with the competition.

Shoewu O. and Edeko F.O [2011] opined that the focus in Nigeria cellular mobile network has gradually shifted from providing coverage to providing diverse bundled options of services to customers since very limited service option could lead to dissatisfaction among subscribers and thus, reduce the perceived quality of service.

Accenture (2008) carried out survey of 4,189 consumers in Australia, Brazil, Canada, China, France, Germany, India, United States, and United Kingdom. More than 67% respondents confirmed customer services as the core major factor that affect the quality of service of mobile network operators. Also, Omotayo and Joachim (2009) attempted to find the relationship between customer's services on customer retention base on service quality in cellular mobile network and found a strong relationship. They demonstrated the support for the application of customer's service to enhance customer's perceived quality of service and further showed that respondents had a positive impression towards their telecom company's ability to meet their changing needs showing that respondents would likely stay with their telecom companies as long as their changing needs are satisfied. They concluded that if quality of service is not managed effective through the provision of an excellent customer's service, customer's loyalty may be lost.

According to Rajesh et al (2013), Price plays a vital role in the telecommunication market especially for the mobile service provider. This include not only the buying price but also the call an rental charges. Generally, a price- dominated mass market leads to customers having more choice and opportunity to compare the pricing structure of the diverse service providers. When a customer sees the value offered by the service provider as equivalent to the price of the service, the quality of such service is likely rated high. A study was undertaken in 2007 on Consumer Satisfaction in Telecommunication markets in the Organization of Economic Cooperation and Development (OECD) countries by the Directorate for Science, Technology, and Industry (DSTI) Committee on Consumer Policy. The study focused on mobile phone users and found that price of service is the major factor for switching over to new operators. The study further highlighted that major factors affecting mobile phone users' dissatisfaction included lack of differentiation in United Kingdom, prices, early termination fees, unsolicited calls and inaccurate billing in United States, (DSTI, 2007).

Yadav et al (2013) examine Quality of service and Customers Preference of Cellular Mobile Service Providers. The study shows that communication and price were most influential and most preferential factors in selecting telecommunication service provider. However, product quality and availability has

a significant impact on consumer perception (quality of service) choice in selecting cellular mobile service provider.

From the reviewed literature, it is evident that there is room for the development of a holistic and user-centric evaluation methodology that provides objective measurements of Quality of service. This will allow network providers to better assess how well their services are being perceived relative to their competitors. Also, there is a need to investigate the collective effects of the combined factors that affect the quality of service. This current work is geared towards providing a solution to these challenges.

2.7 Conceptual Framework for the Study of Quality of Service

The literature is filled with proliferation of different definitions for quality of service from different perspectives. It is defined as the extent to which a service meets customer's needs or expectations (Asubonteng et al, 1996). Parasuraman et al (1988), defined Quality of service as a form of attitude, which could be related to satisfaction but not equivalent to it that results from a comparison of expectations with perceptions of performance. The concept of quality of service from the customer perspective, therefore, includes not only what (outcome) the consumer expects, but also how the consumer is served (Grönroos, 2001).

Quality of service is not just a corporate offering, but a competitive weapon which is necessary for corporate profitability and survival Anderson et al (1994); Grönroos (1990); Newman and Cowling (1996); Rosen et al (2003). Thus, quality of service is a critical business requirement that is driven by customer satisfaction, which in turn drives customer loyalty, retention (that eventually leads to profitability) and growth, as proposed in the Service-Profit Chain Heskett et al (1994).

2.7.1 Motivation for Quality of Service (QoS)

The motivation to look at Quality of Service is two-fold Gómez and Sánchez (2005):

- To provide a service experience to consumers that meets their expectations so as to retain the customers.
- To achieve optimum loading of an operator's network so that the desired service experience is delivered for each customer while maximizing network utilization.

2.7.2 Theories Relevant To The Research And Model

Theories relevant to this research work are: the Four-Layered Quality of Service (QoS) Model and Customer's Satisfaction Model**.** Figure 2.5 illustrates the four-layered Quality of Service (QoS) model. It is base on the architecture proposed by

ITU-T Hardy (2002) and relate to other theories such as the theory of Quality of Experience (QoE) and the OSI reference model. Quality of Service paradigm in network starts with identifying client's expectations from the service providers, or more precisely from the underlying network they are using. These expectations in turn help service providers in defining the network performance parameters, including information loss, end-to-end delay, delay variation or jitter, throughput and the like. To achieve the values identified for these parameters, a range of mechanisms is available for application to different network layers. The last part of the model deals with the client's experience in terms of network performance, relating the model to Quality of Experience (QoE).

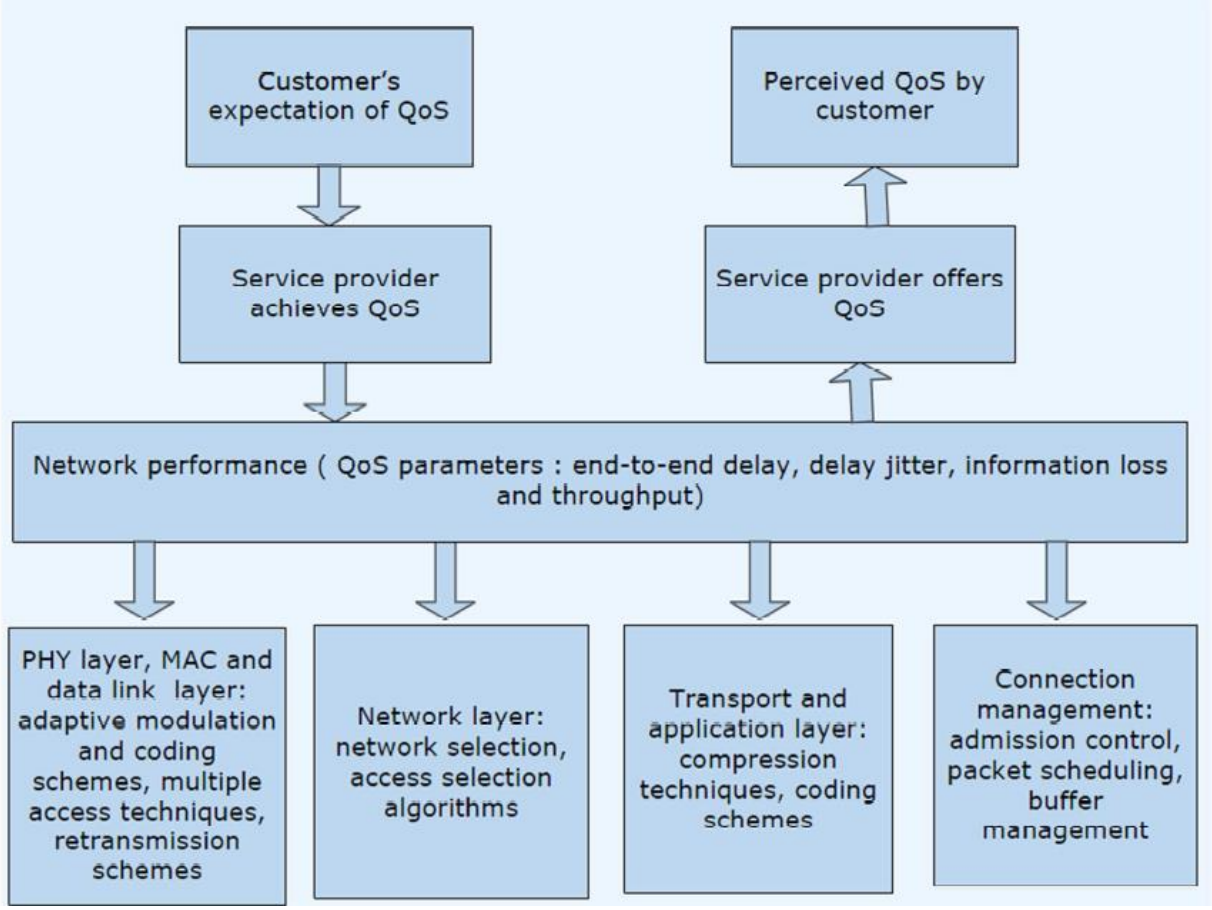

Fig 2.5 . Four-layer QoS Model.

Source: Farnaz Farid et al (2013)

Each network layer employs its own mechanisms to achieve certain Quality of Service levels in terms of the key performance parameters. Physical layer uses adaptive modulation and coding scheme to improve the bandwidth allocation and interference management depending on the network conditions. Network layer uses path and access selection, and queuing algorithms to improve the Quality of service parameters. Quality of Service mechanisms in transport and application

layer involve various compression techniques and coding schemes. For example, robust header compression technique is used to compress the 40 byte overhead of RTP/UDP/IP to a smaller number Fitzek et al (2005). Connection management mechanisms are engaged to secure the application-level Quality of Service up to a certain level. Admission control algorithm controls the maximum number of users in the network to maintain the minimal levels of Quality of Service required to support the ongoing transmissions Tragos et al (2008). For instance, if entry of a new user in the network causes the interference level to be raised to a value greater than the threshold value, the new user is not admitted. All these mechanisms aim to achieve timeliness, precision, and accuracy of transmission.

Another model relevant to this research work is the customer's satisfaction model. Base on customer's satisfaction, there are many variables and factors determinants of the Quality of Service of Cellular Mobile Service Providers as shown in the diagram. Haque et al (2010) and Haque and Rahman (2010) benchmark mobile services with these attributes and dimensions.

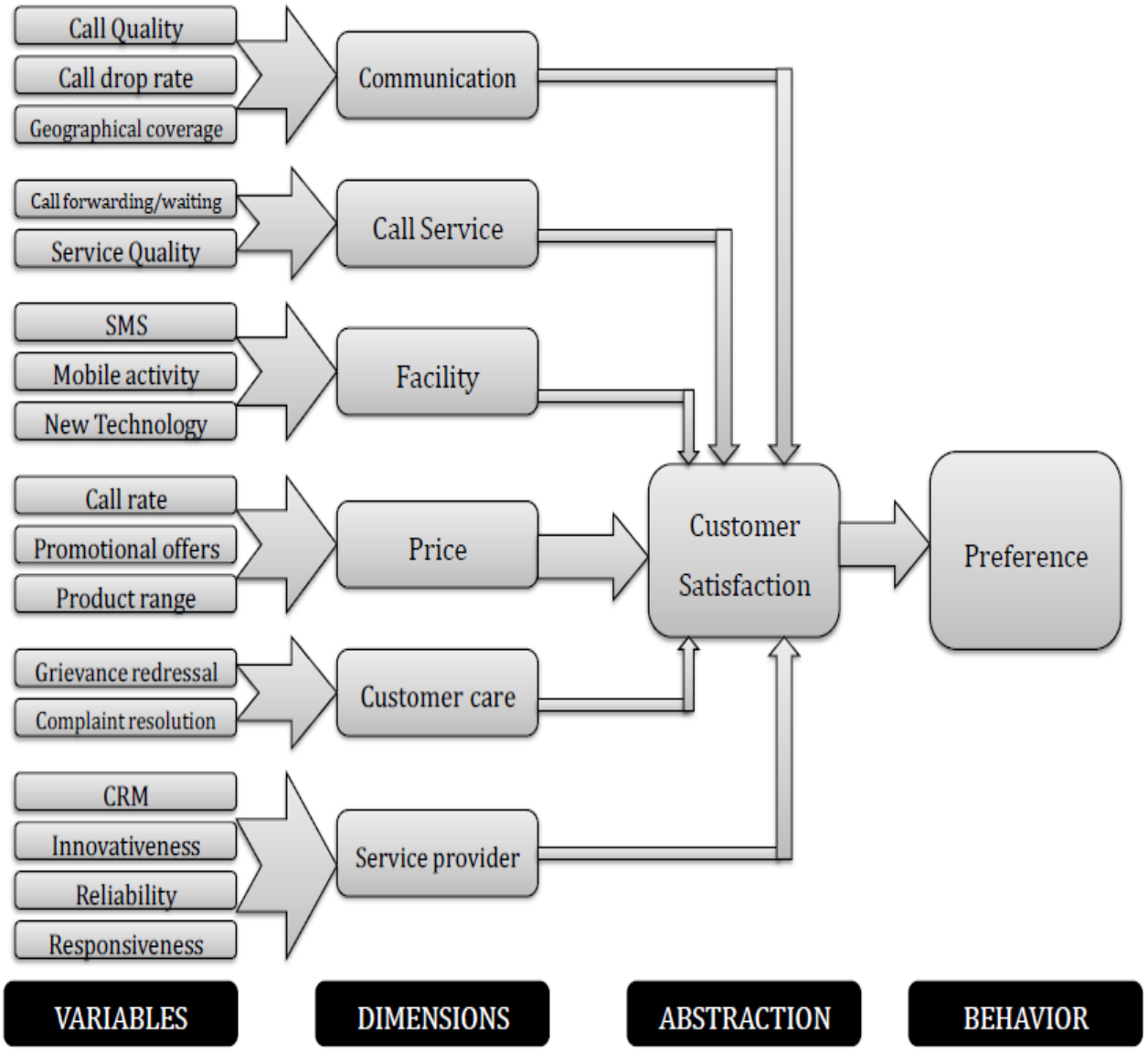

Figure 2.6 Customer's Satisfaction Model. Source: International Journal of Innovative Research and Studies (2013).

Call Quality is a function of call clarity, call Blocking and Dropping rate. Within each cell of the mobile network, there are mainly two classes of call traffic: new call and handover call. A new call is the one which is generated in the current cell, while a handover call is the one that is generated in another cell but transferred

(handed over) into the current cell Panoutsopoulos and Kotsopoulos (2002). In order to establish a communication with a base station, a mobile terminal must first obtain a channel from the base station. A channel consists of a pair of frequencies: one frequency (the forward link/downlink) for transmission from the base station to the mobile terminal, and another frequency (the reverse link/uplink) for the transmission in the reverse direction. When a call enters into the radio coverage of current cell, the channel allocation scheme decides whether the attempt of this call can obtain an available channel or not. If not, the call is dropped immediately. The handover process is often initiated either by crossing a cell boundary or by a deteriorated quality of received signal on the currently employed channel. Calls are drop when attempt for call handover fail. If two cells using the same channel or same set of channels are not effectively spaced apart, co-channel interference could result and this affect the clarity of call.

Price of Service in this case deals mostly with the call rate and the cost of other associated services charge by the network service providers. The special significance of price for the decision to purchase is as indisputable in the telecommunication sector as it is elsewhere. This is particularly true in the mobile telecommunication sectors as available studies suggest Rahman et al (2010). Also a study carried out by Hanif et al (2010), in Pakistan, revealed that there is a high correlation between price fairness, Quality of service and customer satisfaction

Onah (1978) defined market segmentation as the process of dividing a market into units and locating individuals who belong to each market. He further stated that the assumption is to have people who are apparently homogeneous or have common characteristics grouped together. According to Nigeria Institute of Management (NIM), market segmentation principles are as follows: By Industry, production process, location, consumption type, financial muscle (SMPE 201: page 40) When market segmentation is based on the principle of consumption type, subscribers are given the option to select from the available range of service/Product, the service plan which best meet their expectation at any particular time.

Another variable identified in the model is network coverage/Availability of service. Cellular network subscribers are increasingly becoming mobile and as such would prefer mobility in terms of product and services. According to Quelch et al (2008), the customer's evaluation of quality is related to the availability of the salient futures of product/service in comparison with the competitor.

Customer services are among the core attribute of mobile service. It deals with the ability of the cellular mobile network operators to handle satisfactorily and timely customer's complaint; Keeping customers informed as to when services

will be performed and readiness to respond to customer's requests. Good customer's care enhance loyalty Haque and Rahman (2010).

Promotion/Offering of incentive as a variable of the mobile service has to do with advertising campaign aimed at making products/services of the cellular mobile network operator widely known and acceptable by the subscribers. Also, the offering of material inducement in order to encourage subscribers to purchase the particular product/service of interest.

2.7.3 Quality of Service Factors

The factors worthy of special attention to Quality of service and their definitions are as follows:

- Call Quality: This is associated with the clarity of call, call blocking and dropping rate.
- Network coverage/ Availability of product and Service: This describe the area where the radio signal of a given cellular network service provider can be received and the accessibility of the services/products subscribed by users.
- Price of service: This refers to the call rate and the cost of other associated services charge by the cellular mobile network providers.
- Promotion/Offering of incentive: This is the advertising process and material inducement aimed at making products/services of the cellular

mobile network operator widely popular and acceptable by the subscribers in a given locality.

- Diversity of bundle option of service (Market Segmentation): This is the process of dividing a market into units and locating individuals who belong to each market. When market segmentation is based on the principle of consumption type, subscribers are given the option to select from the available range of service/Product, the service plan which best meet their expectation at any particular time.
- Customer care: This deals with the ability of the cellular mobile network operators to handle satisfactorily and timely customer's complaint.

The first four constructs (Price, Network coverage/Availability of Service, Call Quality, Promotion and Offering of incentive) where confirmed in similar study carried out by Rahman et al (2010) whereas the last two; Diversity of bundle option of service and customer care were from Rajkumar Paulrajan and Harish Rajkumar (2011). It is expected that this research will put the correlation between Quality of service and the factors above.

CHAPTER THREE

METHODOLOGY

This chapter highlights the procedure adopted in carrying out this research work. It begins with a restatement of the research questions and hypotheses, discuses the features of the population and data collection instrument and concludes with the limitations encountered in the project.

3.1 Restatement of Research Questions and Hypothesis

3.1.1 Research Questions

Based on the statement of problem and objectives of the study, the researcher posed the following questions to himself:

i. What are the factors affecting quality of service?

ii. To what extent do all the factors collectively affect quality of service?

iii. To what extent does each factor influence quality of service?

These questions will be answered based on facts and figures collected in the course of this study.

3.1.2 Statement of Hypothesis

On the basis of the statement of problem, objective and research questions of the study, the researcher also formulated the following hypothesis to be tested:

Ho1 There is no significant effect of the collective factors on quality of service

Ho2 There is no significant effect of Network coverage/Availability of service on quality of service

Ho3 There is no significant effect of Call quality on quality of service

Ho4 There is no significant effect of Price of Service on quality of service

Ho5 There is no significant effect of Customer care on quality of service

Ho6 There is no significant effect of Diversity of bundle option of service on quality of service

Ho7 There is no significant effect of Promotion and Offering of incentive on quality of service

3.1 Research Design

This research work took the form of a survey research of the explanatory type. The researcher is interested in observing what is happening to sample subjects or variables without any attempt to manipulate or control them **Asika (1991).** It involves a one- time observation of independent and none manipulate variables. Primary and secondary data were employed to accomplish this work. The primary data was generated from administered questionnaires while the secondary data was got from the regulatory body (Nigeria communication commission) company records, journals, texts, and other materials relevant to the

topic. Three approaches exist for conducting explanatory research namely: literature search, experience survey and analysis of insight stimulating examples **Selltis (1965)**.

In the immediate preceding chapter, past literatures on the subject were reviewed. The requirements of exploratory and explanatory survey will be fulfilled through the use of questionnaire instrument and secondary sources of data.

3.2 Population of Study and Data Collection Instrument

The population studied in this work is of two groups. The first group consists of telecommunication subscribers. The second group is made up of staff of major service provider in Nigeria namely: MTN, Globacom, Airtel, Etisalat etc. Both groups are finite population. Subscribers were estimated in March, 2011, to be about 60 million. The data collection instrument used was questionnaire. Based on the administered questionnaires, relevant information about the subscribers which include age distribution, educational status, etc. were extracted. For the second group (staff), such data as gender, department, time of joining the company etc were retrieved. For this study, subscribers from various locations and zones in the country were randomly selected and their opinions were taken to be a reflection of other subscribers. Due to proximity however, most subscribers contacted were based in Owerri in Imo state. Other states were also contacted as explained in next chapter.

3.3 Sampling Design and Procedure

A sample is a representative part of a population. One characteristic of a good sample is that it must be quit representative. According to **Nworuh G.E. (2004),** a good sample must be quite representative of the population and this is directly related to:

a. Precision by which we ensure that random fluctuations or error variance or sampling error is minimal.
b. Absence of systematic variance or sampling bias which is caused by some known or unknown influences that cause the scores to tend more to one side than the other.

As stated earlier, the first group is estimated at 60 million. For a 95% confidence level (5% significance interval), a sample size of 400 was arrived at. For the second group of staff of service providers, 25 questionnaires were allocated to each cellular network network service provider making a total of 100 copies of questionnaires for this category of respondents.

In order to calculate the number of questionnaires, the Yamane (1964:280) formula for finite population was applied stated as thus-

$$n = N/1+Ne^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{equ (3.1)}$$

Where

I = constant value

N = population size

e = co-efficient of confidence or margin of error or allowable error or level of significance

n = sample size

So,

$n = N/1+Ne^2$ **Yamane (1964)**

$$n = \frac{60,000,000}{1+60,000,000(0.05)^2}$$

n = 399.997

Therefore, a total of 400 respondent subscribers under category 1 will be targeted.

3.3.1 Selection Technique

Random Selection Technique was used. The sampling design employed in both cases in stratified sampling which is a variant of random sampling. **Asika (1991)** described it as a probabilistic sampling method where the population is grouped into some definite characteristics. These groups are called strata. From these strata, the samples are chosen by applying random selection technique on each stratum. The entire research was carried out mostly in the three Local Government Area of Owerri North, Owerri West and Municipal and states like Lagos, and Rivers state.

This was however done in a way that most people from various geopolitical zone of the country were involved by randomly distributing the questionnaire in places like markets, 'Ama Hausa'(Hausa concentrated area in Owerri), banks, state secretariats, secondary schools, polytechnics and universities etc to ensure that opinion is a true reflection of the people's view. Also, the category II questionnaire was strictly for experts in the telecommunication industry i.e. staff and key players in the industry.

Questionnaires were appropriated to staff of telecommunication firms whose offices are in Owerri, Rivers state and via mail to staff whose offices are located in Lagos. The researcher appropriated the 100 questionnaire for staff of cellular mobile operators thus;

- 15 questionnaires to GLO, Owerri
- 10 questionnaires to GLO, Port-Hercourt
- 17 questionnaires to MTN, Owerri.
- 8 questionnaires to MTN, Lagos .
- 5 questionnaires to Etisalat, Lagos.
- 20 questionnaires to Etisalat, Owerri.
- 25 questionnaires to Airtel, Owerri.

The questionnaires were administered to these entities such that their opinions, is a representation of other respondents opinions.

3.4 Validation of the Instrument

To ensure the validity of the instruments, the researcher subjected the instruments to face-to-face validity by giving it to professional statisticians and scholars. They examined the items contained in the questionnaire and ensure that they were in line with the objectives of the study. The structure and language of the questionnaire were also modified as necessary to reflect their corrections. The design instruments were structured in such a way as to minimize the effect of errors of inconsistency and ambiguity.

3.5 Method of Data Analysis

Method of data analysis using the statistical techniques of multiple regression analysis, the relationship model is specified as follows:

$$Y= b_o + b_1X_1 + b_2X_2...b_nX_n + e \text{ .....eqn (3.2)}$$

Where e=0; and b_1.....b_n are parameters referred to as regression coefficients. This study, having six independent variables and a dependent variable, the multiple regression is designed as

$$Y= b_o + b_1X_1 + b_2X_2+ b_3X_3+ b_4X_4+ b_5X_5+ b_5X_5+ b_6X_6\text{.....eqn (3.3)}$$

The dependent variable is the technological growth and denoted by Y. The independent variables are those factors that affect the quality of service. They are Network coverage/ Availability of service, Call quality, Price of service, Customer care, Diversity of bundle option of service and Promotion/Offering of

Incentive. Regression analysis is a forecasting or predictive technique that establishes relationship between dependent and independent variables. Regression is the primary method of analysis used in associative technique. The essence of associative technique is the development of an equation that summarizes the effect of predictor variables on independent variables. Predictor variables are variables that can be used to predict values of the dependent variables of interest. Regression analysis is therefore a statistical tool which helps to predict one variable (dependent variables) from another variable or variables (independent variable).

While correlation analysis will be used to determine the degree of relationship between the dependent and independent variables stated above. In the analysis there exists a correlation coefficient which measures the strength and direction between the variables. Correlation coefficient can range from -1.00 to +1.00. A correlation of 1.00 indicates that changes in one variable are always matched by changes in the other or a correlation of -1.00 shows that increase in one variable is matched by decrease in the other variables. For a simple regression analysis, the correlation coefficient between two variables can be computed using the equation:

Coefficient OF Correlation $R = \sqrt{\frac{n(\sum xy) - (\sum x)(\sum y)}{N(\sum x^2) - (\sum x)^2 \, n(\sum y^2) - (\sum y)^2}}$ .....eqn (3.4)

Where y is the dependent variable, x is the independent variable and n is the number of paired observations **Nworuh G.E. (2004)**.

The square of the correlation coefficient r^2 provides a measure of percentage of variability in the value of *y* that is explained by the independent variables, it is called the coefficient of determination. The possible value of r^2 ranges from 0 to 1.00. The closer r^2 is to 1.00 the closer the percentage of explained variation. A high value of r^2, say 0.8 or more would indicate that the independent variables are good predictors of the dependent variable. A value of say 0.25 or less would indicate a poor indicator, and a value of 0.25 to 0.8 would indicate a moderate predictor.

3.5.1 Testing of Hypothesis

In order to correctly test a hypothesis, the researcher selects an appropriate test statistics e.g. t-test or f-test or test of correlation coefficient r. He will then specify the test statistics distribution when H_o is true based on the result of the test statistics.

Test of Significance (F-Ratio Test): The F-ratio will be used to test the significance of the contribution of all the identified and selected indices of satellite technology to technological growth. Analysis of variance (ANOVA) will be used to analyze the data. The analysis of variance answers the question 'is there at least one mean that is significantly different from the others?' If the power of estimate (p-value) for the ANOVA result is greater than the significant level of 0.05, the

analysis is over and we conclude that there is no difference between the pair of means. If however, the ANOVA's p-value is significant at ($p<0.05$), then we conclude that there is a difference between the pairs of means.

Table 3.1 ANOVA Table

Source of variation	Sum of squares (SS)	Degree of freedom	Mean square	F-Ratio
Regression	$SSR = R^2\sum y^2$	K	$MSR = \frac{SSR}{k}$	$F = \frac{MSR}{MSE}$
Error	$SSE=\sum y^2-R^2\sum y^2$	n-k-I	$MSE = \frac{SSE}{n-k-I}$	
Total	$SST = \sum y^2 - \frac{(\sum y)^2}{N}$	n-I		

Source: Nworuh (2004)

$SST = SSR + SSE$ ..... eqn (3.10)

$SST = \sum T^2 - (\sum Y)^2$ ……eqn (3.11)

$SSR = R^2\sum y^2$ …….. …eqn (3.12)

$SSE = \sum y^2 - R^2\sum y^2$ .....eqn (3.13)

Where;

SST = sum of square total

SSR = Sum of square due to regression

MSR = mean square due to regression

MSE = mean square error

SSE = sum of square due to error

K= the number of independent variables

N= the number of observations

We read off F with (K-1; N-k) from the table and compare this ratio with the F_{α} and take a decision.

T-Test: The T-Test shows that a significant relationship exists between the dependent and independent variables. One may then proceed to examine the regression coefficients further and to test more hypotheses about them. Thus, the null hypothesis, H_o is rejected. We may examine the individual coefficient further to find out which one contributes to the significance by testing the null hypothesis.

3.5.2 Decision Rule

The rule states as follows: the researcher should reject Ho if the probability of obtaining a value of the test statistics of a given or more extreme magnitude when H_o is true, is equal or less than a small number. This value is given as $\alpha = 0.05$ or 0.01.

If the F-Ratio calculated is greater than F-ratio tabulated, at α level of significance and (K-1), (N-K) degrees of freedom, then we reject H_o and accept H_A and then

conclude that there is some truth in the estimated model (i.e. the regression model is significant since the independent variables significantly accounts for the variation in the dependent variables.

To test for the specific strengths of the various independent variables with a T-test statistics

T-Ratio = $\beta_k/€(\beta_k)$

Where β_k = Estimation of population parameter

€= standard error of the estimate

K= number of variables

N= number of observations

Also, if $\beta_k/€(\beta_k) > t_{n-k}$: $\alpha/2$ level of significance, we reject H_o and accept H_A and therefore conclude that the variable belongs to the model.

3.5.3b Likert Scale

The type of scale used in this research is called summated rating scale of Likert type. The likert summated scale involves a list of statements related to the factors in question and which respondent are required to indicate the degree of agreement or disagreement with each of the statements **Osuala** (1995). a numerical score is assign to each agree/disagreement. The scores from all the statement are added up to get the total score of each respondent. In a five point scale, for each statement,

respondents are requested to select only one position from among a scale that have five categories as follows: strongly disagree, disagree, neutral, agree and strongly agree. Each category is assign a numerical value as follows-

Strongly Disagree (SD)	Disagree (D)	Neither Agree nor Disagree (N)	Agree (A)	Strongly Agree (SA)
1	2	3	4	5

Table 3.2 Likert 5 Point Table

Source: Osuala (1995)

The likert summated rating will be used to elicit responses to questions, capture information and measure data dealing with the extent of agreement or disagreement on the variables according to the consumer's satisfaction model described in chapter two:

- Market segmentation
- Price of Service
- Availability of Service and Network Coverage
- Call Quality
- Promotion and Offering of Incentive
- Customer care

Berbard Philip (in:Asika, 1991) defined scale as a 'procedure for the assignment of numbers (or other symbols) to a property of objects in order to impart some of the characteristics of numbers to the properties in question. The

assignment of the numbers depends on the individual's or object's possession of what the scale is expected to measure.

The advantages of Likert scale are as follows:

a. The scale easily transforms feelings into a seemingly interval scale which is amenable to statistical analysis.

b. It is flexible and consequently can be used to measure in minute detail, the degree of intensity of feeling or attitudes.

c. Likert scale, though an elegant attitudinal measuring scale, it is very easy to construct and also easy to interpret.

3.5.3c Definition of the variables

The variables used in the research work are as follows:

- Call Quality: This is associated with the clarity of call, call blocking and dropping rate.
- Network coverage/ Availability of product and Service: This describe the area where the radio signal of a given cellular network service provider can be received and the accessibility of the services/products subscribed by users.

- Price of service: This refers to the call rate and the cost of other associated services charge by the cellular mobile network providers.
- Promotion/Offering of incentive: This is the advertising process and material inducement aimed at making products/services of the cellular mobile network operator widely popular and acceptable by the subscribers in a given locality.
- Diversity of bundle option of service (Market Segmentation): This is the process of dividing a market into units and locating individuals who belong to each market.
- Customer care: This deals with the ability of the cellular mobile network operators to handle satisfactorily and timely customer's complaint.

3.5.3d Model Specification

The research model is stated below-

$$Y= b_o + b_1X_1 + b_2X_2+ b_3X_3+ b_4X_4+ b_5X_5+ b_5X_5+ b_6X_6 \text{.....eqn (3.4)}$$

Where:

X_5 is Network coverage/ Availability of service, X_3 is Call quality, X_4 is Price of service , X_2 is Customer care, X_1 is Diversity of bundle option of service and X_6 is Promotion/Offering of Incentive.

CHAPTER FOUR

ANALYSIS OF RESULTS AND DISCUSSION

4.1 Data Presentation and Description

This chapter focuses on the presentation, analysis and description of data Collected. This analysis of data is necessary to bring out the result of the research work done and also comment on data collected and draw conclusion on it. Frequencies of each demographic variable are computed.

As already justified in chapter three, 400 questionnaires were distributed. However, due to several factors, a total of 293 respondents returned their responses. This represents 73.3% returns. Also, 69 out of the 100 sent to experts were returned representing 69% returns for experts. It is worthy to note here that method of return of questionnaire was by hand delivery, via my e-mail address (ausfrane@yahoo.com) for experts whose offices were located in Port-Harcourt, Abuja and Lagos. Below is a step –by- step analysis of the response of the respondents.

4.1.1 Part A Category I For Subscribers

1. Gender

Table 4.1 Respondents' Distribution by gender

Variable(gender)	Frequency	Percentage
Male	134	46
Female	159	54

Source: FIELD WORK n=293

2. Nationality

Nigerian 293 Others nil

100%

3. Zone of origin

Table 4.2 Respondents' Distribution by zone of origin

Variable (zone)	Frequency	Percentage
South East	249	84.9
South South	13	4.5
South West	27	9.2
North East	2	0.7
North West	2	0.7

Source: FIELD WORK n=293

Table 4.2 shows that majority of the respondents are based in the south eastern part of the country. This is understandable considering the fact that the researcher is based in the south east.

4. Educational Background

Table 4.3 Respondents' Distribution by Education Background

Variable (education background)	Frequency	Percentage
Primary/Secondary	12	4.1
Undergraduate	131	44.6
OND/NCE	26	8.9
HND/BSC	79	27.0
MSC/PHD	45	15.4

Source: FIELD WORK n=293

TABLE 4.3 shows that the bulk of the respondents are undergraduates owing to the fact there are over seven higher institutions in Owerri and its environs.

5. Distribution by Telecom Providers

Table 4.4 Respondents' Distribution by Subscription

Variable(telecom provider)	Frequency	Percentage
MTN only	126	43.2
Airtel only	39	13.3
Globacom only	18	6.1
Etisalat only	23	7.8
Others	87	29.6

Source: FIELD WORK n=293

The 87 respondents that fall under the "OTHERS" category represent respondents that have more than one service providers. Few of them are subscribed to Visafone, while others subscribed to the combinations of two or more of the providers. Specifically, 43 of the 87 used MTN and Etisalat and most of such class gave cost (MTN) and value added service (Etisalat) as their reason for the acquisition of the two lines at the same time.

6. Choice of Subscriber

Table 4.5 Respondents' Distribution by Factor Influencing Choice of Subscriber

Variable(factors influencing choice of subscriber)	Frequency	Percentage
Price of service	43	15.7
Availability of service/Network coverage	78	26.6
Call Quality	96	31.8
Customer care	25	8.5
Diversity of bundle options of service	32	10.9
Promotion and Offering of incentive	19	6.5

Source: FIELD WORK n=293

4.1.2 Part B for Mobile Network Operator's Staff (Experts)

Out of the 100 sent to experts, only 69 returned their responses. The problem of reaching out to experts was a major challenge as most of the major telecom providers have their offices in Lagos State.

This made the researcher to employ the use of e-mail. The questionnaire was scanned and sent to experts via e-mail as well as personal calls were made to them to ensure prompt response.

1. Nationality

Nigerian 69 100% Others Nil

2. Zone of origin

Table 4.6: Expert Respondent's distribution by Zone of origin.

Variable (zone)	Frequency	Percentage
South East	36	52.2
South South	13	18.9
South West	19	27.5
North east	01	1.4
North central	Nil	Nil
North west	Nil	Nil

Source: FIELD WORK n=69

Most of the experts are based in the South East and South West. This is understandable since most of the firm have their head offices in Lagos.

3. Which of the Telecom Providers do you work for?

Table 4.7: Expert Respondent's distribution by place of work.

Variable(occupation)	Frequency	Percentage
MTN	19	23
Globacom	13	24
Etisalat	24	16
Airtel	8	19
Others	05	18

Others= Visafoam=05

Source: FIELD WORK n=62

4. What level of management are you?

Lower Level = 42

Middle = 25

Upper = 02

Source: FIELD WORK n=69

4.1.3 Part C for Expert

5. When did you join your employer?

2001 – 2004 = 21

2005 – 2008 = 13

2009 – 2012 = 27

2013—2014 = 08

Source: FIELD WORK n=69

6. Which region do you operate?

SE = 26

SS = 14

SW = 23

NE = 01

NC = 05

NW = -

Source: FIELD WORK n=69

7. In your own opinion, which of the following factors affect the Quality of service of cellular mobile network?

(a) Call Quality =14

(b) Tariff/Price of service =13

(c) Availability of service/Network coverage =18

(d) Customer care =09

(e) Diversity of bundle options of service =10

(f) Promotion and Offering of incentive =05

it could be said that the factors affecting the quality of service of cellular mobile network could be ranked in order below-

(a) Availability of service/Network coverage =18

(b) Call Quality =14

(c) Tariff/Price of service =13

(d) Diversity of bundle options of service =10

(e) Customer care =09

(f) Promotion and Offering of incentive =05

The opinion of experts above was further subjected to analysis by incorporating the response of the 293 respondents (experts inclusive).

4.2 Model Estimation and Hypotheses Testing

4.2.1 Relationship Model Estimation and Interpretation

In order to analyze the hypothesis and research questions outlined in chapter one of this study, the data collected were subjected to multiple regression analysis and the outputs is shown in Tables below:

Table 4.20 The Correlation Matrix

Predictors	Coefficients
X_1	0.078
X_2	0.082
X_3	0.026
X_4	0.102
X_5	0.263
X_6	**0.059**

a. *Predictors: Network Coverage/Availability of Service(X_5), Call Quality(X_3), Price of Service(X_4), Customer Care(X_2), Market Segmentation(X_1) and Promotion/Offering of incentive(X_6).*

b. *Dependent variable : Quality of Service of cellular mobile network operators in Nigeria.*

Source: FIELD WORK

The correlation between the variables is provided in the correlation Table 4.20

Nworuh (2001) defined correlation analysis as the technique used in measuring the closeness of the relationship between variables or among variables. It should be noted that a high degree of correlation does not indicate a cause and effect relationship between variables that is, correlation coefficients measure the strength of the relationship between variables and cannot give any information on causation.

Ranking the factors using Pearson's correlation, we have:

Table 4.21 Pearson's ranking of the variables

Predictors	Coefficients
X_5	0.360
X_3	0.299
X_4	0.217
X_1	0.187
X_2	0.127
X_6	0.080

a. *Predictors: Network Coverage/Availability of Service(X_5), Call Quality(X_3), Price of Service(X_4), Customer Care(X_2), Market Segmentation(X_1) and Promotion/Offering of incentive(X_6).*

b. *Dependent variable : Quality of Service of cellular mobile network operators in Nigeria.*

Source: FIELD WORK

4.2.2 Estimation of Relationship Model and Interpretation

The model describing the relationship between Quality of Service of cellular mobile network operators in Nigeria and the factors affecting the Quality of Service can be expressed using Table 4.22, un-standardized Beta coefficients.

Table 4.22: Model Coefficient Matrix

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	3.731	2.689		1.388	.166		
X_1	.165	.116	.078	1.419	.157	.910	1.098
X_2	.221	.150	.082	.1469	.143	.899	1.113
X_3	.440	.11	.206	3.753	.000	.920	1.088
X_4	.189	.106	.102	1.788	.075	.854	1.171
X_5	.565	.122	.263	4.636	.000	.861	1.161
X_6	.097	.086	.059	1.120	.264	.991	1.009

a. *Predictors: Network Coverage/Availability of Service(X_5), Call Quality(X_3), Price of Service(X_4), Customer Care(X_2), Market Segmentation(X_1) and Promotion/Offering of incentive(X_6).*

b. *Dependent variable : Quality of Service of cellular mobile network operators in Nigeria.*

Source: FIELD WORK

$Y = 3.731+0.565X_5 + 0.440X_3 + 0.221X_2+ 0.189X_4 + 0.165X_1 + 0.097X_6$….(4.1)

The equation can thus be readily used to predict the quality of service of cellular mobile network operators in Nigeria.

Where-

Y = Quality of service of cellular mobile network operators

X_5 = Network coverage/ Availability of service

X_3 = Call quality

X_4 = Price of service

X_2 = Customer care

X_1 = Diversity of bundle option of service

X_6 = Promotion and offering of incentive

A close look at the standardized Beta values in Table 4.22 shows that the largest coefficient is contributed by the Network coverage/availability of service **.565**, followed by Call Quality **.440**, then Customer care **.221**, then Price of Service **.189,** then Diversity of bundle option of service **.165** and Promotion / offering of incentive **.097.** Based on these results we can go ahead in answering our research questions.

The interpretation of the relationship model based on the output of our multiple regression analysis as shown in Tables 4.23 and 4.24 is as follows:

1. Equation (4.1) shows that the level of relationship existing between Quality of service and the Quality of service factors which is represented by (X_1, X_2, X_3, X_4, X_5 and X_6) is fairly strong. The coefficient of correlation 0.456 (Table 4.23) indicates that 45.6% correlation exists between the dependent variable Quality of Services of cellular mobile network providers and the factors affecting Quality of Service (independent variable).

2. Table 4.23 shows that 20.8% of the variation in the Quality of Service of cellular mobile network provider in Nigeria is explained by the cumulative variations in the six independent variables when all possible error in the estimation is taken into consideration.
3. Equation (4.1) is considered a significant predictor of the Quality of Service of cellular mobile network providers in Nigeria as the sig. F change reads 0.000 (Table 4.24) which is less than 5% level of confidence.

Table 4.23: Coefficients of Correlation and Determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.456[a]	.208	.192	3.64050

a. . Predictors: Network Coverage/Availability of Service(X_5), Call Quality(X_3), Price of Service(X_4), Customer Care(X_2), Market Segmentation(X_1) and Promotion/Offering of incentive(X_6).

b. Dependent variable : Quality of Service of cellular mobile network operators in Nigeria.

Source: FIELD WORK

4.2.3 Hypothesis Testing

In order to test our hypothesis, we refer to Tables 4.22, 4.23, 4.24 and 4.25, at 0.05 level of confidence the formulated hypotheses are tested below:

H_{01}: There is no significant effect of the collective factors on the Quality of Service.

H_{A1}: There is a significant effect of the collective factors on the Quality of Service.

Table 4.24 ANOVA of Sample Data

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	996.432	6	166.072	12.531	.000[a]
	Residual	3790.435	286	13.253		
	Total	4786.867	292			

a. *Predictors: Network Coverage/Availability of Service(X_5), Call Quality(X_3), Price of Service(X_4), Customer Care(X_2), Market Segmentation(X_1) and Promotion/Offering of incentive(X_6).*

b. *Dependent variable : Quality of Service of cellular mobile network operators in Nigeria.*

Source: FIELD WORK

In order to test the null hypothesis H_0 stated above we introduce the analysis of variance (ANOVA) which is based on the F-Test. The F-Test would be used to test the significance of all the Quality of Service factors on the Quality of Service of cellular mobile network providers in Nigeria. The analysis of variance was used to analyze the data as explained in table 4.24 above.

To access the statistical significance of the test we look at the ANOVA table. The model reaches statistical significance at (sig = .000) which is less than the significance level of 5% ($p<0.05$) therefore we reject the null hypothesis H_o and

accept the alternative hypothesis H_A which states that there is a significant effect of the collective factors on the Quality of Service.

H_{02}: There is no significant effect of Network coverage/Availability of service on Quality of Service.

H_{A2}: There is a significant effect of Network coverage/Availability of service on Quality of Service.

From Table 4.22, at a significant level of 0.000 for Network coverage/Availability of service, we reject the null hypothesis H_{03} because the probability value is less than the 0.05 level of confidence ($p>0.05$) and accept the alternative hypothesis which states that there is a significant effect of Network coverage/Availability of Service on the Quality of service of cellular mobile network operator in Nigeria.

H_{03}: There is no significant effect of Call quality on Quality of Service.

H_{A3}: There is a significant effect of Call quality on Quality of Service.

From Table 4.22, at a significant level of 0.000 for Call quality, we reject the null hypothesis H_{03} because the probability value is less than the 0.05 level of confidence ($p>0.05$) and accept the alternative hypothesis which states that there is a significant effect of Call quality on the Quality of service of cellular mobile network operator in Nigeria.

H_{04}: There is no significant effect of Price of Service on Quality of Service.

H_{A4}: There is a significant effect of Price of Service on Quality of Service.

From Table 4.22, at a significant level of 0.075 for Price of Service, we accept the null hypothesis H_{03} because the probability value is greater than the 0.05 level of confidence ($p>0.05$) and reject the alternative hypothesis which states that there is a significant effect of Price of Service on the Quality of service of cellular mobile network operator in Nigeria.

H_{05}: There is no significant effect of Customer care on Quality of Service.

H_{A5}: There is a significant effect of Customer care on Quality of Service.

From Table 4.22, at a significant level of 0.143 for Customer care, we accept the null hypothesis H_{03} because the probability value is greater than the 0.05 level of confidence ($p>0.05$) and reject the alternative hypothesis which states that there is a significant effect of Customer care on the Quality of service of cellular mobile network operator in Nigeria.

H_{06}: There is no significant effect of Diversity of bundle option of service on Quality of Service.

H_{A6}: There is a significant effect of Diversity of bundle option of service on Quality of Service.

From Table 4.22, at a significant level of 0.157 for Diversity of bundle option of service, we accept the null hypothesis H_{03} because the probability value is greater than the 0.05 level of confidence ($p>0.05$) and reject the alternative hypothesis which states that there is a significant effect of Diversity of bundle option of service on the Quality of service of cellular mobile network operator in Nigeria.

H_{07}: There is no significant effect of Promotion and Offering of incentive on Quality of Service.

H_{A7}: There is a significant effect of Promotion and Offering of incentive on Quality of Service.

From Table 4.22, at a significant level of 0.264 for Promotion and Offering of incentive, we accept the null hypothesis H_{03} because the probability value is greater than the 0.05 level of confidence ($p>0.05$) and reject the alternative hypothesis which states that there is a significant effect of Promotion and offering of incentive on the Quality of service of cellular mobile network operator in Nigeria.

4.3 Result Discussion

4.3.1 Result Discussion of Research Question

Results are discussed here in the context of the research questions.

- What are the factors affecting quality of service?

The Quality of Service factors identified in the research work are Network coverage/Availability of service; call Quality, Price of service, Customer care, Diversity of bundle option of service and Promotion/offering of incentive.

- To what extent do all the factors collectively affect quality of service?

The researcher based on the results derived from table 4.21, states that collectively, all the factors affect the Quality of Service of cellular mobile network operators in Nigeria. The drivers collectively accounted for over 20% impact on the Quality of Service.

- To what extent does each factor influence quality of service?

From the t-test analysis in table 4.22, it is obvious that Network coverage/Availability of service and Call Quality were the only significant factors that affect the Quality of Service while other factors (that is Price of service, Customer care, Diversity of bundle option of service and Promotion/offering of incentive) were observed to be insignificant when considering their individual effect on the Quality of Service.

The results of this research agree with Otero et al(2010) who revealed that the Quality of Service of cellular network providers is mostly related to the availability of products main functional features (source of the primary benefits that the consumer expect to obtain when purchasing the product) on one hand and a consumer's experience-in –use of the auxiliary features on the other. This implies that any effort made to expand the coverage area of network and bring product/service to the reach of customers will greatly enhance the of Quality of Service than when channeled to other areas.

It also confirm the result obtained by the consumers' satisfaction survey in Canada (2007) based on the responses of 6000 mobile phone users which shows that the essential elements of the Quality of Service of cellular mobile operators are: Quality of calls, Prices/billing, Customers' services and Diversity of bundled options of services. Again, Otero et al (2010) confirm that call quality which is a function of call clarity, call blocking and dropping rate is among the major determinant of Quality of service. This is also in line with the findings of Hanif et al(2010) who showed that there is a high correlation between price fairness and service quality.

The results further affirm the posits of Rajkumar Paulrajan and Harish Rajkumar(2010) who stated that prompt and satisfactory resolution of customers complaint have a positive impact on the customer's rating of service quality.

It established that though other factors affect the Quality of Service of mobile cellular network operators in Nigeria, Network coverage/Availability of service have the strongest impact.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings and Conclusions

This research explored the impact of several factors on the Quality of Service of cellular mobile network providers in Nigeria. In addition, it established the perception of both the subscribers and experts in the telecommunication sector on what factor, most significantly affect the Quality of Service of cellular mobile network operators in Nigeria. The results arrived at was that the following factors affect the Quality of Service:

Network coverage/ Availability of product and Service

Call quality

Customer care

Price of service

Diversity of bundle option of service

Promotion/Offering of incentive

Though the six factors above affected the Quality of Service collectively, it was also found out that two factors namely Network coverage/Availability of service or product and Call quality were more significant going by the results of the t-test. The following conclusions have been drawn from the results of this research:

- That Nigeria subscribers as well as experts agree that the most critical factor of Quality of Service is Network coverage/Availability of product and Service. This is understandable considering the fact that Users are increasingly becoming mobile and as such would prefer availability in terms of product and services as they move from one location to the other.
- In this research, it can be said that collectively, the factors of Quality of Service which are Network coverage/Availability of service, Call quality, Price of service, Customer care, Diversity of bundle option of service and Promotion/offering of incentive have significant effect on the Quality of Service but individually only Network coverage/Availability of service and Call quality have impact on the Quality of Service of cellular mobile network operators in Nigeria.
- That despite the huge amount of money spend on advertisement and promotional activities by the mobile communication companies, cell phone users in Nigeria are more price- sensitive than promotion-sensitive when judging the Quality of Service of cellular mobile network service provider.
- In this research, it can be justifiably concluded that Diversity of bundle option of service and Promotion/offering of incentive as Quality of Service factors have the least impact on the Quality of Service of cellular mobile network operators in Nigeria.

5.2 Recommendations for Further Research

Based on the summary of findings and conclusions established from the results of analysis, this research work identified Availability of product and service/ Network coverage and Call quality as the critical factors that affect the Quality of Service of cellular mobile network providers in Nigeria.

Telecommunication industries should invest more on radio infrastructural development to ensure wide coverage area and also reduce call dropping rate associated with overloading the existing network facility to its capacity.

Infrastructures should be properly maintained and alternatives should be put in place to sustain service in case of equipment failure.

Finally, more research should be carried out to ascertain other factors that affect the Quality of Service of cellular mobile network operators in Nigeria since from the analysis of result, the factors captured in this paper contributed about 20.8%, meaning that there are other factors not captured in this work that have significant impact on the Quality of Service. Also, similar research should be carried out in other zones of the country to confirm that the conclusions drawn from this work are true reflections of the Nigerian situation.

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APPENDIX A
QUESTIONNAIRE

Federal University of Technology, Owerri (FUTO)
Dear respondent,

This questionnaire is part of my research paper in partial fulfillment of my postgraduate study in Information Technology (MSc) in the department of Information Management Technology, Federal University of Technology Owerri. The purpose of this research is to investigate (analyze) the factors affecting quality of service of cellular mobile network. The information and response gathered will be used for academic purposes only, and will be kept strictly confidential. The survey will take about 10-15 minutes to completes, your participation in this survey is appreciated.

Thank you.
Yours faithfully
Ohuabunwa, A.E
For further clarification and inquires please contact:
ausfrane@yahoo.com

QUESTIONNAIRE

Federal University of Technology, Owerri (FUTO)

Note: Quality of Service is the extent to which a service meets customer's needs or expectations.

PART A (CATEGORY I-SUBSCRIBERS)
Please tick the item that best describes you

1. Gender: Male ☐ Female ☐
2. Nationality: Nigerian ☐ Others (Please specify……)
3. Zone of Origin: SE ☐ SS ☐ SW ☐ NE ☐ NC ☐ NW ☐
4. Education Background:
Primary/ Secondary ☐ Undergraduate ☐ OND/NCE ☐ HND/BSC ☐ MSc./Ph.d ☐
5. Occupation: Student ☐ Self Employed ☐ Unemployed ☐ Civil Servant ☐
Others (Please Specify……)
6. Are you a subscriber to any Telecommunication Provider?
Yes ☐ No ☐
7. If yes, which of the providers are you subscribed to
MTN ☐ Airte ☐ Globacom ☐ Etisalat ☐
Others (Please specify…….)

PART A: CATEGORY II (EXPERTS)

1. Nationality: Nigerian ☐ Others(Please specify……)
2. Zone of origin: SE ☐ SS ☐ SW ☐ NE ☐ NC ☐ NW ☐
3. Which of the Telecom providers do you work for?
   (a) MTN ☐
   (b) Globacom ☐
   (c) Etisalat ☐
   (d) Airtel ☐

(e) Others (Please Specify……)

4. What level of management are you?

Lower ☐ Middle ☐ Upper ☐

SECTION B: CATEGORY 11 (EXPERT)

1. When did you join your employer?

2001-2004 ☐ 2005-2008 ☐ 2009-2 ☐

2. Which region do you operate?

SE ☐ SS ☐ SW ☐ NE ☐ NC ☐ NW ☐

3. In your own opinion which of the following factor(s) affect the quality of service of cellular mobile network?

a. Price of Service ☐

b. Availability of service/Network Coverage ☐

c. Call quality ☐

d. Customer care ☐

e. Diversity of bundle options of service ☐

f. Promotions and offerings of incentive ☐

g. Brand Image ☐

h. Others (please specify……..)

N/B Quality of Service is a measure of the extent to which a service meets customer's needs or expectations.

SECTION C: BOTH CATEGORIES

This section is to measure your view (range) of the factors affecting quality of service of cellular mobile operators in Nigeria. There is no right or wrong answer. Please choose your answer by ticking the corresponding box using scale of 1 to 5 as shown below:

Strongly Disagree (SD)	Disagree (D)	Neither Agree nor Disagree (N)	Agree (A)	Strongly Agree (SA)
1	2	3	4	5

X_1	PRICE OF SERVICE	SD	D	N	A	SA
1.	Price of service is responsible for the customer's perceived quality of service					
2.	Customers are satisfied when the price of service is equivalent to the value obtained by using such service					
3.	The price of service need to be low to achieve high quality of service					
4.	The price charge by the cellular mobile operators in Nigeria is still high compare to other nation for the same service					

X_2	AVAILABILITY OF SERVICE/NETWORK COVERAGE	SD	D	N	A	SA
1.	Availability of service influences positively the quality of service of cellular mobile network					
2.	When there is no signal bar in the handset, the quality of service is negatively affected					
3.	The scarcity of recharge card leads to a poor quality of service					
4.	Network Coverage without Availability of Service will not lead to high Quality of Service					

X_3	CALL QUALITY	SD	D	N	A	SA
1.	Loudness and clarity of call enhances quality of service					
2.	When a customer is connected to the wrong number after a dial, the quality of service is perceived as poor					
3.	The quality of service is high if the phone ring immediately a customer dialed a number once					
4.	A customer is dissatisfied if he/she is cut off in the middle of a call					

X_4	CUSTOMER CARE	SD	D	N	S	SA
1.	Satisfactory resolution of customer's complaint will increase customers rating of service quality					
2.	Quality of service is enhance when it takes a little time to handle customers complaint					
3.	The politeness and knowlegeability of the frontline staff affect positively the quality of service					
4.	Easy access to customer care service affect the Quality of Service					

X_5	DIVERSITY OF BUNDLE OPTIONS OF SERVICE	SD	D	N	S	SA
1.	The presence of different type and prices of recharge card influences positively the customer's perceived quality of service					
2.	Quality of service will be greatly enhanced, if more bundle options of service are made available.					
3.	Different billing plans results to faster response to customers need					
4.	Different Package recharge cards prizes leads to customers satisfaction					

X_6	PROMOTIONS AND OFFERINGS OF INCENTIVE	SD	D	N	S	SA
1.	Promotion and offering of incentive boost the customers perceived quality of service					
2.	Offering of incentive help cellular mobile service providers to retain their customers					
3.	Promotion leads to customers satisfaction					
4.	Promotion and offering of incentive even without clarity of call enhances Quality of Service					

Y	QUALITY OF SERVICE	SD	D	N	A	SA
1.	Quality of service of cellular mobile network is affected by the price of service					
2.	Availability of service and network coverage influence the quality of service					
3.	Customer's perception of service quality is linked to call quality					
4.	Customer care affect the quality of service					
5.	Market Segmentation /bundle option of service affect quality of service					
6.	Quality of service is influence by promotions and offering of incentive					

APPENDIX B: SPSS ANALYSIS OF RESULT

```
REGRESSION
  /DESCRIPTIVES MEAN STDDEV CORR SIG N
  /MISSING LISTWISE
```

```
  /STATISTICS COEFF OUTS CI(95) BCOV R ANOVA COLLIN TOL CHANGE ZPP
  /CRITERIA=PIN(.05) POUT(.10)
  /NOORIGIN
  /DEPENDENT Y
  /METHOD=ENTER X1 X2 X3 X4 X5 X6
  /CASEWISE PLOT(ZRESID) OUTLIERS(3)
```

Regression

Notes

Output Created		26-Sep-2014 07:37:00
Comments		
Input	Active Dataset	DataSet6
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	293
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.
Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) BCOV R ANOVA COLLIN TOL CHANGE ZPP /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT Y /METHOD=ENTER X1 X2 X3 X4 X5 X6 /CASEWISE PLOT(ZRESID) OUTLIERS(3).
Resources	Processor Time	00:00:00.109
	Elapsed Time	00:00:00.139
	Memory Required	3100 bytes
	Additional Memory Required for Residual Plots	0 bytes

[DataSet6]

Descriptive Statistics

	Mean	Std. Deviation	N
Y	21.9147	4.04887	293
X1	10.9147	1.92217	293

X2	12.9010	1.49672	293
X3	11.1877	1.89689	293
X4	10.6212	2.17626	293
X5	9.8328	1.88433	293
X6	10.8874	2.47542	293

Correlations

		Y	X1	X2	X3	X4
Pearson Correlation	Y	1.000	.187	.127	.299	.217
	X1	.187	1.000	.218	.151	.092
	X2	.127	.218	1.000	.069	-.146
	X3	.299	.151	.069	1.000	.211
	X4	.217	.092	-.146	.211	1.000
	X5	.360	.182	.124	.199	.286
	X6	.080	.042	-.054	.026	.030
Sig. (1-tailed)	Y	.	.001	.015	.000	.000
	X1	.001	.	.000	.005	.058
	X2	.015	.000	.	.119	.006
	X3	.000	.005	.119	.	.000
	X4	.000	.058	.006	.000	.
	X5	.000	.001	.017	.000	.000
	X6	.085	.238	.179	.326	.303
N	Y	293	293	293	293	293
	X1	293	293	293	293	293
	X2	293	293	293	293	293
	X3	293	293	293	293	293
	X4	293	293	293	293	293
	X5	293	293	293	293	293
	X6	293	293	293	293	293

Correlations

		X5	X6
Pearson Correlation	Y	.360	.080
	X1	.182	.042

	X2	.124	-.054
	X3	.199	.026
	X4	.286	.030
	X5	1.000	.052
	X6	.052	1.000
Sig. (1-tailed)	Y	.000	.085
	X1	.001	.238
	X2	.017	.179
	X3	.000	.326
	X4	.000	.303
	X5	.	.185
	X6	.185	.
N	Y	293	293
	X1	293	293
	X2	293	293
	X3	293	293
	X4	293	293
	X5	293	293
	X6	293	293

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method

1	X6, X3, X2, X5, X1, X4[a]	.	Enter

a. All requested variables entered.
b. Dependent Variable: Y

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	.456[a]	.208	.192	3.64050	.208	12.531	6

a. Predictors: (Constant), X6, X3, X2, X5, X1, X4
b. Dependent Variable: Y

Model Summary[b]

Model	Change Statistics	
	df2	Sig. F Change
1	286	.000

b. Dependent Variable: Y

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	996.432	6	166.072	12.531	.000[a]
	Residual	3790.435	286	13.253		
	Total	4786.867	292			

a. Predictors: (Constant), X6, X3, X2, X5, X1, X4
b. Dependent Variable: Y

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.731	2.689		1.388	.166
	X1	.165	.116	.078	1.419	.157
	X2	.221	.150	.082	1.469	.143
	X3	.440	.117	.206	3.753	.000
	X4	.189	.106	.102	1.788	.075
	X5	.565	.122	.263	4.636	.000
	X6	.097	.086	.059	1.120	.264

a. Dependent Variable: Y

Coefficients[a]

Model		95.0% Confidence Interval for B		Correlations		
		Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-1.561	9.023			
	X1	-.064	.394	.187	.084	.075
	X2	-.075	.516	.127	.087	.077
	X3	.209	.670	.299	.217	.198
	X4	-.019	.398	.217	.105	.094
	X5	.325	.805	.360	.264	.244
	X6	-.073	.267	.080	.066	.059

a. Dependent Variable: Y

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	X1	.910	1.098
	X2	.899	1.113
	X3	.920	1.088
	X4	.854	1.171
	X5	.861	1.161
	X6	.991	1.009

a. Dependent Variable: Y

Coefficient Correlations[a]

Model			X6	X3	X2	X5	X1	X4
1	Correlations	X6	1.000	-.014	.068	-.047	-.044	.002
		X3	-.014	1.000	-.058	-.119	-.099	-.168
		X2	.068	-.058	1.000	-.137	-.208	.210
		X5	-.047	-.119	-.137	1.000	-.112	-.269
		X1	-.044	-.099	-.208	-.112	1.000	-.066
		X4	.002	-.168	.210	-.269	-.066	1.000
	Covariances	X6	.007	.000	.001	.000	.000	1.789E-5
		X3	.000	.014	-.001	-.002	-.001	-.002
		X2	.001	-.001	.023	-.003	-.004	.003
		X5	.000	-.002	-.003	.015	-.002	-.003
		X1	.000	-.001	-.004	-.002	.013	-.001
		X4	1.789E-5	-.002	.003	-.003	-.001	.011

a. Dependent Variable: Y

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions			
				(Constant)	X1	X2	X3
1	1	6.846	1.000	.00	.00	.00	.00
	2	.048	11.961	.00	.01	.00	.01
	3	.036	13.860	.00	.18	.05	.00
	dimension1 4	.026	16.309	.00	.02	.00	.16
	5	.023	17.068	.00	.44	.00	.55
	6	.017	20.118	.04	.35	.32	.23
	7	.005	38.149	.95	.00	.63	.04

a. Dependent Variable: Y

Collinearity Diagnostics[a]

Model	Dimension	Variance Proportions		
		X4	X5	X6
1	1	.00	.00	.00
	2	.08	.04	.80
	3	.52	.01	.07
	4	.11	.86	.00
	5	.14	.02	.00
	6	.03	.06	.03
	7	.13	.00	.09

a. Dependent Variable: Y

Casewise Diagnostics[a]

Case Number		Std. Residual	Y	Predicted Value	Residual
dimension0	55	3.120	30.00	18.6416	11.35837
	165	3.120	30.00	18.6416	11.35837
	275	3.120	30.00	18.6416	11.35837

a. Dependent Variable: Y

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	16.9383	25.7305	21.9147	1.84728	293
Residual	-9.49816	11.35837	.00000	3.60291	293
Std. Predicted Value	-2.694	2.066	.000	1.000	293
Std. Residual	-2.609	3.120	.000	.990	293

. Dependent Variable: Y

APPENDIX C: EXCEL SUMMARY OF RESPONDENTS OPINION

S/N	X1	X2	X3	X4	X5	X6	Y
1	12.00	13.00	12.00	13.00	11.00	14.00	20.00
2	11.00	14.00	8.00	10.00	6.00	11.00	9.00
3	10.00	12.00	13.00	12.00	7.00	12.00	24.00
4	14.00	15.00	10.00	9.00	6.00	9.00	15.00
5	12.00	11.00	13.00	11.00	12.00	8.00	26.00
6	12.00	15.00	13.00	11.00	10.00	7.00	24.00
7	12.00	14.00	11.00	9.00	9.00	14.00	17.00
8	11.00	12.00	8.00	7.00	11.00	12.00	22.00
9	14.00	13.00	14.00	13.00	10.00	13.00	23.00
10	11.00	12.00	9.00	11.00	11.00	12.00	21.00
11	9.00	12.00	11.00	12.00	10.00	8.00	24.00
12	11.00	12.00	11.00	10.00	9.00	10.00	13.00
13	12.00	14.00	11.00	9.00	11.00	13.00	22.00
14	11.00	14.00	9.00	12.00	12.00	5.00	21.00
15	12.00	14.00	10.00	12.00	8.00	6.00	24.00
16	9.00	14.00	13.00	12.00	11.00	7.00	25.00
17	12.00	15.00	12.00	8.00	10.00	11.00	21.00
18	9.00	13.00	7.00	13.00	12.00	6.00	18.00
19	10.00	12.00	12.00	11.00	12.00	13.00	24.00
20	9.00	11.00	14.00	8.00	6.00	5.00	22.00
21	12.00	10.00	12.00	11.00	10.00	8.00	19.00

22	11.00	13.00	9.00	10.00	8.00	8.00	16.00
23	8.00	10.00	8.00	7.00	12.00	15.00	16.00
24	6.00	13.00	10.00	8.00	10.00	8.00	21.00
25	8.00	15.00	10.00	7.00	9.00	9.00	20.00
26	10.00	14.00	12.00	12.00	12.00	12.00	19.00
27	10.00	11.00	10.00	8.00	9.00	7.00	19.00
28	11.00	12.00	7.00	14.00	12.00	13.00	22.00
29	11.00	13.00	12.00	13.00	11.00	8.00	20.00
30	9.00	11.00	12.00	12.00	9.00	8.00	22.00
31	10.00	13.00	12.00	13.00	10.00	9.00	25.00
32	11.00	15.00	13.00	11.00	12.00	8.00	22.00
33	12.00	14.00	11.00	9.00	9.00	11.00	17.00
34	12.00	14.00	11.00	9.00	12.00	8.00	17.00
35	13.00	15.00	10.00	9.00	9.00	10.00	17.00
36	13.00	12.00	10.00	11.00	12.00	11.00	19.00
37	10.00	11.00	11.00	12.00	12.00	13.00	24.00
38	14.00	13.00	10.00	13.00	10.00	9.00	18.00
39	10.00	12.00	11.00	6.00	8.00	12.00	19.00
40	10.00	14.00	8.00	6.00	9.00	10.00	26.00
41	11.00	15.00	12.00	8.00	12.00	12.00	27.00
42	11.00	11.00	13.00	13.00	11.00	11.00	18.00
43	8.00	12.00	12.00	12.00	10.00	15.00	20.00
44	9.00	13.00	11.00	10.00	8.00	15.00	15.00

45	11.00	14.00	15.00	12.00	12.00	15.00	26.00
46	12.00	12.00	13.00	10.00	9.00	13.00	21.00
47	8.00	11.00	6.00	12.00	6.00	12.00	16.00
48	11.00	15.00	12.00	9.00	12.00	7.00	26.00
49	13.00	14.00	11.00	11.00	9.00	11.00	27.00
50	8.00	10.00	9.00	13.00	8.00	13.00	18.00
51	8.00	15.00	11.00	10.00	11.00	11.00	24.00
52	10.00	13.00	10.00	12.00	9.00	12.00	26.00
53	7.00	12.00	14.00	10.00	5.00	8.00	16.00
54	7.00	10.00	12.00	13.00	8.00	12.00	25.00
55	12.00	15.00	7.00	9.00	6.00	15.00	30.00
56	9.00	12.00	10.00	13.00	9.00	10.00	20.00
57	10.00	11.00	11.00	4.00	9.00	9.00	24.00
58	8.00	15.00	13.00	14.00	12.00	15.00	26.00
59	11.00	14.00	11.00	10.00	11.00	13.00	23.00
60	15.00	10.00	12.00	9.00	8.00	12.00	20.00
61	8.00	11.00	10.00	12.00	7.00	12.00	14.00
62	12.00	14.00	11.00	6.00	8.00	15.00	15.00
63	14.00	12.00	11.00	11.00	10.00	10.00	26.00
64	10.00	12.00	10.00	12.00	12.00	11.00	23.00
65	13.00	10.00	8.00	10.00	8.00	12.00	22.00
66	13.00	14.00	14.00	11.00	10.00	9.00	18.00
67	9.00	12.00	11.00	12.00	6.00	10.00	20.00

68	7.00	11.00	10.00	8.00	7.00	12.00	23.00
69	13.00	12.00	13.00	12.00	10.00	11.00	26.00
70	11.00	13.00	13.00	11.00	12.00	15.00	25.00
71	11.00	14.00	14.00	10.00	11.00	11.00	18.00
72	12.00	11.00	13.00	11.00	12.00	13.00	25.00
73	10.00	13.00	13.00	12.00	10.00	15.00	27.00
74	11.00	14.00	8.00	10.00	9.00	8.00	22.00
75	14.00	15.00	13.00	15.00	10.00	15.00	25.00
76	10.00	12.00	13.00	13.00	9.00	15.00	28.00
77	13.00	15.00	12.00	14.00	10.00	9.00	26.00
78	11.00	15.00	10.00	9.00	11.00	13.00	22.00
79	12.00	12.00	13.00	12.00	9.00	12.00	23.00
80	10.00	11.00	11.00	15.00	12.00	10.00	26.00
81	8.00	14.00	9.00	5.00	8.00	10.00	14.00
82	9.00	15.00	9.00	5.00	5.00	13.00	14.00
83	9.00	10.00	12.00	12.00	12.00	8.00	21.00
84	10.00	14.00	13.00	10.00	10.00	11.00	23.00
85	13.00	12.00	13.00	11.00	10.00	12.00	27.00
86	11.00	12.00	13.00	12.00	12.00	12.00	23.00
87	13.00	15.00	8.00	12.00	12.00	10.00	25.00
88	10.00	13.00	12.00	8.00	7.00	11.00	25.00
89	13.00	13.00	10.00	12.00	12.00	12.00	24.00
90	14.00	14.00	12.00	10.00	11.00	12.00	26.00

91	12.00	13.00	14.00	12.00	12.00	10.00	24.00
92	13.00	13.00	14.00	12.00	8.00	10.00	24.00
93	11.00	14.00	10.00	11.00	12.00	10.00	24.00
94	12.00	14.00	13.00	13.00	10.00	8.00	24.00
95	14.00	14.00	10.00	9.00	12.00	13.00	25.00
96	10.00	15.00	14.00	11.00	12.00	13.00	23.00
97	14.00	12.00	9.00	12.00	9.00	10.00	26.00
98	13.00	13.00	11.00	9.00	12.00	12.00	28.00
99	13.00	13.00	13.00	10.00	10.00	10.00	22.00
100	10.00	15.00	12.00	10.00	10.00	9.00	28.00
101	11.00	14.00	13.00	11.00	10.00	11.00	27.00
102	13.00	13.00	14.00	9.00	11.00	11.00	26.00
103	15.00	14.00	14.00	12.00	10.00	11.00	26.00
104	11.00	15.00	11.00	8.00	9.00	8.00	27.00
105	13.00	11.00	12.00	13.00	11.00	14.00	25.00
106	12.00	14.00	11.00	9.00	10.00	13.00	29.00
107	12.00	13.00	10.00	12.00	11.00	12.00	23.00
108	10.00	12.00	11.00	13.00	12.00	10.00	23.00
109	12.00	14.00	13.00	14.00	12.00	11.00	27.00
110	13.00	13.00	10.00	12.00	8.00	11.00	21.00
111	12.00	13.00	12.00	13.00	11.00	14.00	20.00
112	11.00	14.00	8.00	10.00	6.00	11.00	9.00
113	10.00	12.00	13.00	12.00	7.00	12.00	24.00

114	14.00	15.00	10.00	9.00	6.00	9.00	15.00
115	12.00	11.00	13.00	11.00	12.00	8.00	26.00
116	12.00	15.00	13.00	11.00	10.00	7.00	24.00
117	12.00	14.00	11.00	9.00	9.00	14.00	17.00
118	11.00	12.00	8.00	7.00	11.00	12.00	22.00
119	14.00	13.00	14.00	13.00	10.00	13.00	23.00
120	11.00	12.00	9.00	11.00	11.00	12.00	21.00
121	9.00	12.00	11.00	12.00	10.00	8.00	24.00
122	11.00	12.00	11.00	10.00	9.00	10.00	13.00
123	12.00	14.00	11.00	9.00	11.00	13.00	22.00
124	11.00	14.00	9.00	12.00	12.00	5.00	21.00
125	12.00	14.00	10.00	12.00	8.00	6.00	24.00
126	9.00	14.00	13.00	12.00	11.00	7.00	25.00
127	12.00	15.00	12.00	8.00	10.00	11.00	21.00
128	9.00	13.00	7.00	13.00	12.00	6.00	18.00
129	10.00	12.00	12.00	11.00	12.00	13.00	24.00
130	9.00	11.00	14.00	8.00	6.00	5.00	22.00
131	12.00	10.00	12.00	11.00	10.00	8.00	19.00
132	11.00	13.00	9.00	10.00	8.00	8.00	16.00
133	8.00	10.00	8.00	7.00	12.00	15.00	16.00
134	6.00	13.00	10.00	8.00	10.00	8.00	21.00
135	8.00	15.00	10.00	7.00	9.00	9.00	20.00
136	10.00	14.00	12.00	12.00	12.00	12.00	19.00

137	10.00	11.00	10.00	8.00	9.00	7.00	19.00
138	11.00	12.00	7.00	14.00	12.00	13.00	22.00
139	11.00	13.00	12.00	13.00	11.00	8.00	20.00
140	9.00	11.00	12.00	12.00	9.00	8.00	22.00
141	10.00	13.00	12.00	13.00	10.00	9.00	25.00
142	11.00	15.00	13.00	11.00	12.00	8.00	22.00
143	12.00	14.00	11.00	9.00	9.00	11.00	17.00
144	12.00	14.00	11.00	9.00	12.00	8.00	17.00
145	13.00	15.00	10.00	9.00	9.00	10.00	17.00
146	13.00	12.00	10.00	11.00	12.00	11.00	19.00
147	10.00	11.00	11.00	12.00	12.00	13.00	24.00
148	14.00	13.00	10.00	13.00	10.00	9.00	18.00
149	10.00	12.00	11.00	6.00	8.00	12.00	19.00
150	10.00	14.00	8.00	6.00	9.00	10.00	26.00
151	11.00	15.00	12.00	8.00	12.00	12.00	27.00
152	11.00	11.00	13.00	13.00	11.00	11.00	18.00
153	8.00	12.00	12.00	12.00	10.00	15.00	20.00
154	9.00	13.00	11.00	10.00	8.00	15.00	15.00
155	11.00	14.00	15.00	12.00	12.00	15.00	26.00
156	12.00	12.00	13.00	10.00	9.00	13.00	21.00
157	8.00	11.00	6.00	12.00	6.00	12.00	16.00
158	11.00	15.00	12.00	9.00	12.00	7.00	26.00
159	13.00	14.00	11.00	11.00	9.00	11.00	27.00

160	8.00	10.00	9.00	13.00	8.00	13.00	18.00
161	8.00	15.00	11.00	10.00	11.00	11.00	24.00
162	10.00	13.00	10.00	12.00	9.00	12.00	26.00
163	7.00	12.00	14.00	10.00	5.00	8.00	16.00
164	7.00	10.00	12.00	13.00	8.00	12.00	25.00
165	12.00	15.00	7.00	9.00	6.00	15.00	30.00
166	9.00	12.00	10.00	13.00	9.00	10.00	20.00
167	10.00	11.00	11.00	4.00	9.00	9.00	24.00
168	8.00	15.00	13.00	14.00	12.00	15.00	26.00
169	11.00	14.00	11.00	10.00	11.00	13.00	23.00
170	15.00	10.00	12.00	9.00	8.00	12.00	20.00
171	8.00	11.00	10.00	12.00	7.00	12.00	14.00
172	12.00	14.00	11.00	6.00	8.00	15.00	15.00
173	14.00	12.00	11.00	11.00	10.00	10.00	26.00
174	10.00	12.00	10.00	12.00	12.00	11.00	23.00
175	13.00	10.00	8.00	10.00	8.00	12.00	22.00
176	13.00	14.00	14.00	11.00	10.00	9.00	18.00
177	9.00	12.00	11.00	12.00	6.00	10.00	20.00
178	7.00	11.00	10.00	8.00	7.00	12.00	23.00
179	13.00	12.00	13.00	12.00	10.00	11.00	26.00
180	11.00	13.00	13.00	11.00	12.00	15.00	25.00
181	11.00	14.00	14.00	10.00	11.00	11.00	18.00
182	12.00	11.00	13.00	11.00	12.00	13.00	25.00

183	10.00	13.00	13.00	12.00	10.00	15.00	27.00
184	11.00	14.00	8.00	10.00	9.00	8.00	22.00
185	14.00	15.00	13.00	15.00	10.00	15.00	25.00
186	10.00	12.00	13.00	13.00	9.00	15.00	28.00
187	13.00	15.00	12.00	14.00	10.00	9.00	26.00
188	11.00	15.00	10.00	9.00	11.00	13.00	22.00
189	12.00	12.00	13.00	12.00	9.00	12.00	23.00
190	10.00	11.00	11.00	15.00	12.00	10.00	26.00
191	8.00	14.00	9.00	5.00	8.00	10.00	14.00
192	9.00	15.00	9.00	5.00	5.00	13.00	14.00
193	9.00	10.00	12.00	12.00	12.00	8.00	21.00
194	10.00	14.00	13.00	10.00	10.00	11.00	23.00
195	13.00	12.00	13.00	11.00	10.00	12.00	27.00
196	11.00	12.00	13.00	12.00	12.00	12.00	23.00
197	13.00	15.00	8.00	12.00	12.00	10.00	25.00
198	10.00	13.00	12.00	8.00	7.00	11.00	25.00
199	13.00	13.00	10.00	12.00	12.00	12.00	24.00
200	14.00	14.00	12.00	10.00	11.00	12.00	26.00
201	12.00	13.00	14.00	12.00	12.00	10.00	24.00
202	13.00	13.00	14.00	12.00	8.00	10.00	24.00
203	11.00	14.00	10.00	11.00	12.00	10.00	24.00
204	12.00	14.00	13.00	13.00	10.00	8.00	24.00
205	14.00	14.00	10.00	9.00	12.00	13.00	25.00

206	10.00	15.00	14.00	11.00	12.00	13.00	23.00
207	14.00	12.00	9.00	12.00	9.00	10.00	26.00
208	13.00	13.00	11.00	9.00	12.00	12.00	28.00
209	13.00	13.00	13.00	10.00	10.00	10.00	22.00
210	10.00	15.00	12.00	10.00	10.00	9.00	28.00
211	11.00	14.00	13.00	11.00	10.00	11.00	27.00
212	13.00	13.00	14.00	9.00	11.00	11.00	26.00
213	15.00	14.00	14.00	12.00	10.00	11.00	26.00
214	11.00	15.00	11.00	8.00	9.00	8.00	27.00
215	13.00	11.00	12.00	13.00	11.00	14.00	25.00
216	12.00	14.00	11.00	9.00	10.00	13.00	29.00
217	12.00	13.00	10.00	12.00	11.00	12.00	23.00
218	10.00	12.00	11.00	13.00	12.00	10.00	23.00
219	12.00	14.00	13.00	14.00	12.00	11.00	27.00
220	13.00	13.00	10.00	12.00	8.00	11.00	21.00
221	12.00	13.00	12.00	13.00	11.00	14.00	20.00
222	11.00	14.00	8.00	10.00	6.00	11.00	9.00
223	10.00	12.00	13.00	12.00	7.00	12.00	24.00
224	14.00	15.00	10.00	9.00	6.00	9.00	15.00
225	12.00	11.00	13.00	11.00	12.00	8.00	26.00
226	12.00	15.00	13.00	11.00	10.00	7.00	24.00
227	12.00	14.00	11.00	9.00	9.00	14.00	17.00
228	11.00	12.00	8.00	7.00	11.00	12.00	22.00

229	14.00	13.00	14.00	13.00	10.00	13.00	23.00
230	11.00	12.00	9.00	11.00	11.00	12.00	21.00
231	9.00	12.00	11.00	12.00	10.00	8.00	24.00
232	11.00	12.00	11.00	10.00	9.00	10.00	13.00
233	12.00	14.00	11.00	9.00	11.00	13.00	22.00
234	11.00	14.00	9.00	12.00	12.00	5.00	21.00
235	12.00	14.00	10.00	12.00	8.00	6.00	24.00
236	9.00	14.00	13.00	12.00	11.00	7.00	25.00
237	12.00	15.00	12.00	8.00	10.00	11.00	21.00
238	9.00	13.00	7.00	13.00	12.00	6.00	18.00
239	10.00	12.00	12.00	11.00	12.00	13.00	24.00
240	9.00	11.00	14.00	8.00	6.00	5.00	22.00
241	12.00	10.00	12.00	11.00	10.00	8.00	19.00
242	11.00	13.00	9.00	10.00	8.00	8.00	16.00
243	8.00	10.00	8.00	7.00	12.00	15.00	16.00
244	6.00	13.00	10.00	8.00	10.00	8.00	21.00
245	8.00	15.00	10.00	7.00	9.00	9.00	20.00
246	10.00	14.00	12.00	12.00	12.00	12.00	19.00
247	10.00	11.00	10.00	8.00	9.00	7.00	19.00
248	11.00	12.00	7.00	14.00	12.00	13.00	22.00
249	11.00	13.00	12.00	13.00	11.00	8.00	20.00
250	9.00	11.00	12.00	12.00	9.00	8.00	22.00
251	10.00	13.00	12.00	13.00	10.00	9.00	25.00

252	11.00	15.00	13.00	11.00	12.00	8.00	22.00
253	12.00	14.00	11.00	9.00	9.00	11.00	17.00
254	12.00	14.00	11.00	9.00	12.00	8.00	17.00
255	13.00	15.00	10.00	9.00	9.00	10.00	17.00
256	13.00	12.00	10.00	11.00	12.00	11.00	19.00
257	10.00	11.00	11.00	12.00	12.00	13.00	24.00
258	14.00	13.00	10.00	13.00	10.00	9.00	18.00
259	10.00	12.00	11.00	6.00	8.00	12.00	19.00
260	10.00	14.00	8.00	6.00	9.00	10.00	26.00
261	11.00	15.00	12.00	8.00	12.00	12.00	27.00
262	11.00	11.00	13.00	13.00	11.00	11.00	18.00
263	8.00	12.00	12.00	12.00	10.00	15.00	20.00
264	9.00	13.00	11.00	10.00	8.00	15.00	15.00
265	11.00	14.00	15.00	12.00	12.00	15.00	26.00
266	12.00	12.00	13.00	10.00	9.00	13.00	21.00
267	8.00	11.00	6.00	12.00	6.00	12.00	16.00
268	11.00	15.00	12.00	9.00	12.00	7.00	26.00
269	13.00	14.00	11.00	11.00	9.00	11.00	27.00
270	8.00	10.00	9.00	13.00	8.00	13.00	18.00
271	8.00	15.00	11.00	10.00	11.00	11.00	24.00
272	10.00	13.00	10.00	12.00	9.00	12.00	26.00
273	7.00	12.00	14.00	10.00	5.00	8.00	16.00
274	7.00	10.00	12.00	13.00	8.00	12.00	25.00

275	12.00	15.00	7.00	9.00	6.00	15.00	30.00
276	9.00	12.00	10.00	13.00	9.00	10.00	20.00
277	10.00	11.00	11.00	4.00	9.00	9.00	24.00
278	8.00	15.00	13.00	14.00	12.00	15.00	26.00
279	11.00	14.00	11.00	10.00	11.00	13.00	23.00
280	15.00	10.00	12.00	9.00	8.00	12.00	20.00
281	8.00	11.00	10.00	12.00	7.00	12.00	14.00
282	12.00	14.00	11.00	6.00	8.00	15.00	15.00
283	14.00	12.00	11.00	11.00	10.00	10.00	26.00
284	10.00	12.00	10.00	12.00	12.00	11.00	23.00
285	13.00	10.00	8.00	10.00	8.00	12.00	22.00
286	13.00	14.00	14.00	11.00	10.00	9.00	18.00
287	9.00	12.00	11.00	12.00	6.00	10.00	20.00
288	7.00	11.00	10.00	8.00	7.00	12.00	23.00
289	13.00	12.00	13.00	12.00	10.00	11.00	26.00
290	11.00	13.00	13.00	11.00	12.00	15.00	25.00
291	11.00	14.00	14.00	10.00	11.00	11.00	18.00
292	12.00	11.00	13.00	11.00	12.00	13.00	25.00
293	10.00	13.00	13.00	12.00	10.00	15.00	27.00