Exploring the Challenges of Improving Mobile Communication Services in Nigeria.

Okonkwo Thaddeus Ogadimma

Department of Computer Science, Imo State University, Owerri, Nigeria.

Abstract

Two-way seamless communication is the key aspect of realizing the vision of mobile communications. There are several standardized wired and wireless communication technologies available for various mobile communication applications. With the recent growth in wireless communication, it can offer standardized technologies for wide, metropolitan, local and personal area networks. Moreover, wireless technologies not only offer significant benefits over wired, such that include low installation cost, rapid deployment, mobility, etc., but also more suitable for remote end applications. Several activities are going on to explore specific applications of these technologies in mobile communication environment. However, the afore-mention is beset with numerous challenges ranging from poor supervision by the regulatory agency like National Communication Commission (NCC) in the case of Nigeria, bad network communication infrastructures leading to poor service delivery. All these have made the usage of communication infrastructures like the GSM Mobile communication unattractive to some extent. This paper discusses the great challenges of continued problems of poor mobile communication infrastructures like low power mobile communication, poor network connections, drop calls and insecurity among others and the subsequent challenges arising from these such as poor service deliverables. The work will attempt to proffer solutions to all these and make recommendations for the way forward.

Keywords: *Communication, Infrastructure, Service Delivery, deliverables, Seamless Communication, Mobile Communication, wireless technologies, standardized technologies.*

1.0 Introduction

Microsoft Encarta, the world encyclopedia (2008)posits:

"Communicationis the process of transmitting and receiving ideas, information, and messages. The rapid transmissions of information over long distances and ready access to information have become conspicuous and important features of human society, especially in the past 150 years, and in the past two decades, increasingly so." Thus, Mobile communication is a communication network that does not involve cable or wire connection between two entities. The current mobile communications technologies are Global System for Mobile Communications (GSM), and Code Division Multiple Access (CDMA), among others.

Nonetheless, INSPEC (2005) posits that Mobile phone subscriptions have grown. Since the liberalization of Nigeria's telecommunication sector in 2000, the industry has become the key source of new jobs in the economy, employing about 6,000 professionals, and overseeing, indirectly close to half a million jobs. It believes that the increases in mobile coverage have many more advantages like improving faster and cheaper communication. For example, in India, fishermen can reduce fish wastage by phoning in advance coastal markets to find out their supply needs. Mobile banking also offers the flexibility and convenience for many customers too.

The increase in mobile technology has also led to a growing attraction for mobile telephones as health interventions. This attraction has been influenced by, among other things, the fact that

mobile phones are functionally easier to use for people with lower levels of skills than those needed for computers or the internet. Irrespective of whether mobile phones are functionally easier to use for those with lower level or higher level skills, mobile communication phones have become useful in data collection of health-related information.

Erkki Liikanen (2004), explaining the **key challenges** for mobile communications, called for the exploitation of the social and economic benefits of it even in the midst those challenges. He said that with penetration rates in excess of 80%, it was then well recognized that Nigeria has some leadership in mobile communication infrastructures made possible by determined and concerted action of the government and the players in the field. Research and Development efforts, according to him, were also been coordinated with standardization, interoperability and the right regulatory and political environment much as paradigm shift is being witnessed as new mobile data services emerge.

The convergence of telecommunications, broadcasting and internet will further result in the proliferation of high-speed multimedia services delivered over mobile networks. Users can avail themselves of high-speed wireless access with the receipt of 3G services and more over a wider area. The global landscape for mobile and wireless communications is also changing as many countries are investing heavily in research for the sake of gaining a competitive advantage. Liikanen believes that **interoperability, the regulatory environment for content and spectrum policy are the major challenges.** To him the emergence of new mobile data services is significant because investing in ICT, re-organizing enterprises between the operators and investing in training and skills could result in the achievement of major productivity increases in that sector.

As the next wave of productivity at work points to mobility and sharing information,

Enterprises will benefit from mobility by extending the wired network to mobile users

With secure, reliable mobile applications enabling them to communicate anytime,

Anywhere. This shall make future mobile communications focus on mobile data services that will give the possibility of access to shared databases anytime, anywhere.

Global competitiveness needs innovative capability and cost-efficiency. Nigeria must focus on innovation as a key driver of competitiveness. This can only be achieved through a comprehensive programme of integrated research activities. *Three main trends dominate research and development today. **First**, increasing complexity, **second**, increasing interdependencies between products and services, and **third**, the growing competition at a global scale – all aim* to achieve common goals and shape the future according to needs and shared values.

Innovation dynamics and the process of innovation itself have changed to collaboration across the traditional boundaries in telecommunication sector which needs to be catalyzed by public action. This is important especially when we look at areas where the technology innovation meets application innovation. Bringing these together into systemic innovation leads to new growth curves; a real challenge for Nigerian research is to be able to support the transition to new paradigms, and new growth curves effectively.

1.1 Background of the Study

Jide Ojo (2010) posits that since its inauguration in 2002, GSM services in Nigeria has been inundated with poor network signals, collection of money for non-committed voice and data services, over congestion, drop calls, delayed voice and data services and lack of adequate information or answers on why these inadequacies do occur. This is in addition to the theft of service by stealing the cell phone that houses the SIM card, inversion of privacy through hacking or cracking encrypted algorithms, unlawful

interception of GSM communications by law enforcement agencies: this is generally done by accessing the digital switches that control calls.

Other challenges include poor Quality of Service (QoS) rendered by the operators with the Nigeria Communications Commission (NCC), that regulates the industry, recently expressing its intention to slam huge fines (on a monthly basis) on the operators to that effect. This is in addition to twin problems of infrastructure decay (particularly epileptic power generation) and poor security, among others. These therefore are some of the challenges people face in the effective utilization of the GSM infrastructure in Nigeria and it is on this basis that this work is being designed.

1.2 Objective of the Research

The primary objective of this project is **to explore the challenges of improving the services of mobile communication in Nigeria.** The expected outcomes shall include, among others to:

- Broaden the scope of knowledge in GSM mobile communication in the country;
- Provide additional research materials for researchers and practitioners in the field;
- Critically examine these challenges with a view to proffering solutions to them for the sake of having a better mobile communication infrastructure.
- Provide a substrate upon which further researches in the area could be built.

1.3 Research Hypothesis

H_o: Poor network infrastructure and high tariffs have no relationship with poor service delivery

H_1: Poor network infrastructure and high tariff have a relationship with poor service delivery.

1.4 Research Methodology

For the sake of implementing this research work, the internationally accepted software engineering standard called ***Structured System Analysis and Design Methodology*(SSADM) was used.** The justification for choosing SSADM in place of other engineering methods as approved by IEE was its waterfall techniques by which systems designs are easily achieved. According to Stalker (1961) SSADM involves the following steps:

i. Formulating the Research Problem (Problem Definition)
ii. Extensive Literature Review
iii. Feasibility Studies
iv. Developing the objectives
v. Systems Analysis
vi. Preparing the Research Design including Sample Design
vii. Collecting the Data
viii. Analysis of Data
ix. Generalization and Interpretation
x. Coding /Testing and
xi. Implementation
xii. Preparation of the Report or Presentation of Results-Formal write ups of Conclusions reached.
xiii. Support & Maintenance

1.5 Scope of Study

The scope of the project would include:

- Exploring the challenges of improving the services of mobile communication in Nigeria and
- Making recommendations on the way forward for the mobile communication industry.

1.6 Statement of Problem

The work aims to explore the challenges of improving the services of mobile communication in Nigeria since according to a report by GSM World (1999), 80 percent of the global mobile market uses GSM services, which faces several problems as a worldwide standard for mobile telephones. These, according to Bredin, J., et al (1999,pages 43-49) and supported by Jide Ojo (2010), include:

- Twin problems of infrastructure decay (particularly epileptic power generation) and poor security.

- Poor quality of service rendered by the operators for which the Nigeria Communications Commission (NCC), is the regulator;
- Invasion of privacy through hacking or cracking encrypted algorithms throughunlawful interception of GSM communications by law enforcement agencies.
- Poor signals, collecting money for non-committed voice and data services, over congestion, drop calls, delayed voice and data services;
- Theft of service by stealing the cell phone that houses the SIM card
- Parlous state of the network due to inability to plan for the failure of public infrastructure like National Power Supply, among others.
- Thin resources of trained man power and infrastructural deficiency such as poor power supply;
- Nefarious activities of social miscreants and some fastidious (hard to please) communities, who don't see anything good in any developmental project, inter alia.

Thus the above challenges are living with GSM services in Nigeria and elsewhere in the world. Various researches in the area have not been able to totally address these problems. Hence this project is poised to make further impact in the field with a view to proffering solutions **to the challenges of improving the services of mobile communication Network in Nigeria.** The above-mentioned problems are cases in point.

1.7 Significance of Study

According to Jide Ojo (2010), GSM services in Nigeria have been inundated with: poor network signals, collection of money for non-committed voice and data services, over congestion, drop calls, delayed voice and data services, etc. The solution to poor networks could range from further increase of network facilities to the provision of better transmitting equipment. Collection of money for non-committed services could be reduced by a better network management infrastructure while over congestion could be managed by further expansion of bandwidth, backbones and moving to the latest Generation of GSM infrastructural facilities like 3G, 3.5G or even 4G and EDGE.

The above study would be quite significant in the following ways:

i. finding solutions to the afore-mentioned challenges will help improve subscribers' confidence in GSM services
ii. Users of GSM phones will find it useful
iii. It will also help the operators of the business to provide user-friendly program to their subscribers.
iv. The government and the regulators will also benefit from the number of added users as a result of improved service of the operators
v. It will encourage research and development in the field
vi. The software will provide jobs to the teaming jobless youths, who would use it in their business centers to better GSM services
vii. It would be used as a reference material by the scholars and researchers in the field.

1.8 Limitations of Study

Due to limited time and resource, the project will be restricted to **exploring the challenges of improving the services of mobile communication in Nigeria.** It will attempt to develop software that answers questions on GSM – oriented mobile communication concept with a view to further informing and educating the stakeholders on GSM project.

2.0 Global System Of Mobile Communication (Gsm)

Jide Ojo (2010) posits that the GSM system was initially designed as a second generation (2G) cellular phone technology. One of the basic aims

was to provide a system that would enable greater capacity to be achieved than the previous first generation analogue systems. GSM achieved this by using a digital TDMA (Time Division Multiple Access) approach. By adopting this technique, more users could be accommodated within the available bandwidth. In addition to this, ciphering of the digitally encoded speech was adopted to retain privacy. Using the earlier analogue cellular technologies, it was possible for anyone with a scanner receiver to listen to calls though a number of famous personalities had been "eavesdropped" with embarrassing consequences.

Realizing the importance of GSM technology, a plan to implement a pan-Nigeria mobile phone network was hatched and a committee on GSM Group was set up. In 1989, work done by the GSM group was transferred to the Nigeria Telecommunication Standards Institute (ETSI). Further works led to the development of a sophisticated digital cell phone system, whose design aims included: good subjective speech quality; a low phone or terminal cost and handheld; support international roaming; good spectral efficiency and offer ISDN compatibility, among others.

The resulting GSM cellular technology that was developed provided for all these. The overall system definition for GSM describes not only the air interface but also the network or infrastructure technology. By adopting this approach it is possible to define the operation of the whole network to enable international roaming as well as enabling network elements from different manufacturers to operate alongside each other, although this last feature is not completely true, especially with older items.

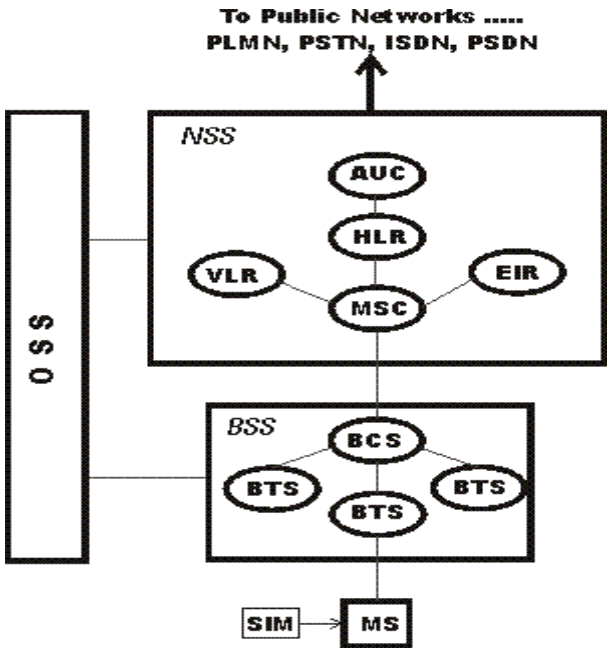
2.1 GSM Services

Speech or voice calls are obviously the primary function for the GSM cellular system. To achieve this, the speech is digitally encoded and later decoded using a vocoder. A variety of vocoders are available for use, being aimed at different scenarios. In addition to the voice services, GSM cellular technology supports a variety of other data services. Although their performance is nowhere near the level of those provided by 3G, they are nevertheless still important and useful. A variety of data services are supported with user data rates up to 9.6 kbps. Services including Group 3 facsimile, videotext and teletex can also be supported.

One service that has grown enormously is the short message service. Developed as part of the GSM specification, it has also been incorporated into other cellular technologies. It can be thought of as being similar to the paging service but is far more comprehensive allowing bi-directional messaging, store and forward delivery, and it also allows alphanumeric messages of a reasonable length. This service has become particularly popular, initially with the young as it provided a simple, low fixed cost.

2.5 GSM Architecture

GSM cellular technology uses 200 kHz RF channels. These are time division multiplexed to enable up to eight users to access each carrier. In this way it is a TDMA / FDMA system. The **BASE Transceiver Stations (BTS**) are organised into small groups, controlled by a **Base Station Controller (BSC**) which is typically co-located with one of the BTSs. The BSC with its associated BTSs is termed the **Base Station Subsystem (BSS).**



GSM Terminology

VLR -Visitor Location Register
HLR- Home Location Register
AUC -Authentication center
EIR -Equipment Identification
MSC -Mobile Switching center
BTS- Base Transceiver Station
BSC -Base Station Controller
SCP- Service control point
SDP -Service Data Point
SSF- Service Switching Functionality
SMSC- Short Message Switching Center
MMSC- Multimedia Messaging Service
USSD -Unstructured Supplementary Service Data
GPRS -General Packet Radio Service
EDGE- Enhanced Data Rates for GSM Evolution
SGSN -Serving GPRS Support Node
GGSN -Gateway GPRS Support Node
HSCSD- High-Speed Circuit-Switched Data
IVR- Interactive voice response

Fig. 1: Basic GSM Elements of GSM Infrastructure: Source: Radio Electronics

Further into the core network is the **MAIN SWITCHING AREA**. This is known as the **Mobile Switching Centre (MSC).** Associated with it is the **Location Registers,** namely the **Home Location Register(HLR)** and the **Visitor Location Register (VLR)** which track the location of mobiles and enable calls to be routed to them.

The above is a simplified diagram of a GSM technology. We shall see more of this in the course of the tutorial. Now, we shall illustrate one of the elements.

❖ **Mobile Station**

According to Radio Electronics (2005), Mobile stations (MS), mobile equipment (ME) or as they are most widely known, cell or mobile phones are the section of a GSM cellular network that the user sees and operates. It was said that the sizes of these equipment have fallen dramatically over the years while the level of functionality has greatly increased. A further advantage is that the time between charges has significantly increased. There are a number of elements to the cell phone, although the *two main elements are the main Hardware and the SIM as shown below.*

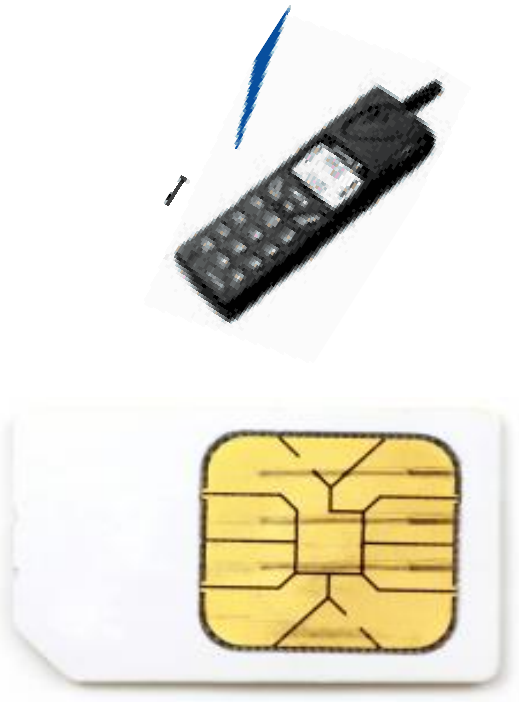


Fig. 2.2: components of mobile phone

According to the Radio Electronics (2005), the hardware itself contains the main elements of the mobile phone including the display, case, battery, and the electronics used to generate the signal, and process the data receiver to be transmitted. It also contains a number known as the

International Mobile Equipment Identity (IMEI). This is installed in the phone at manufacture and "cannot" be changed. It is accessed by the network during registration.

3.0 Challenges Of Mobile (Gsm) Technology

According to Eric Hammer, an eHow Contributor (Apr 09, 2012) GSM technology, which stands for Global Standard for Mobile Communications, is the mobile phone technology standard used in the United States by T-Mobile and AT&T. It is also used in Nigeria and in many other countries in the world. However, there are some problems with the technology, some of which can be solved by switching to the more modern CDMA standard (used in the United States by Verizon Wireless and Sprint-Nextel). He maintained that the challenges of mobile GSM mobile communication include:

Dropped and Missed Calls: He quoted Cellular News as saying that call quality problems, including dropped calls and missed calls are common problems with GSM technology. These problems result directly from the technology in use. GSM technology cannot accommodate as many callers on a single cell tower as the more modern CDMA technology. This means that callers in areas where there are not a preponderance of cell towers may find that the call problems on GSM will be more common.

Security Issues: he said that zdnet UK reports that GSM has a serious security flaw, demonstrated by a hacker who was able to intercept phone calls from a number of GSM-based cellular phones. The problem is based directly on the technology according to this hacker and his solution was to "turn off" the GSM technology (only the older 2G technology though) that is commonly used by people all over the world. The problem is largely mitigated however by the use of the more modern 3G technology that is commonly used (as of November, 2010) on many GSM phones.

Efficiency: he also said that another problem with GSM is a network problem rather than a consumer problem, though it is a consumer problem for those who don't want to see a proliferation of cellular towers. As previously noted, GSM technology can handle fewer callers on a single cellular tower. Therefore, networks who work with GSM must find ever more areas to build GSM cellular towers, causing them to have problems with costs and locations. By the same token, some consumers who prefer not to see a proliferation of cellular towers consider this a problem because the cellular towers must be placed in more and more urban areas, potentially spreading more radiation and causing what some consider a blight on the landscape.

Online Journal of Public Health Informatics * ISSN 1947-2579 * http://ojphi.org* Vol.4, No. 3, 2012, further identified the following as challenges of mobile communication:

Poor mobile network coverage across many parts of Nigeria. Intermittent mobile network from the providers contributes to the high discharge rate of mobile phones since subscribers often have to keep trying a line for several times before they get connected. Eventually, some of the mobile phone subscribers in the NHDSS study area end up forgetting (except those who are able to save their numbers elsewhere) their mobile numbers since the network coverage is virtually non-existent.

Our team has experienced this during data collection of migration events. A respondent who reports that some of the household's members have migrated to another area is asked for the mobile phone number of the migrant. In many instances, fieldworkers are not able to get the mobile numbers because the respondents do not know the numbers. When asked reasons for not knowing the numbers, majority of them sarcastically state that there is no need to know the number since there is no mobile network coverage in their area unless they go to the Zamfara State capital, Gusau.

Limited power supply efforts to expedite data collection and processing are compromised by the virtually non-existent power supply, future efforts to link the HDSS activities with those of the adjacent Nahuche Health Research Centre in tracking immunization defaulters through mobile phone technology (i.e., alerts on service uptake) will be challenging.

High tariff charges on communication. Nahuche posits 'Our field workers often complain about high tariff on airtime recharge cards. They are often unable to call the field office at the Nahuche Research Centre due to insufficient airtime on their mobile phones. While high tariff charges can be managed through budgetary allocation for airtime purchases, the **power supply and mobile network coverage remain an enormous challenge for field operations.'**

3.1 Panacea for The Challenges Above

The answer is simple but doing it is an enormous task.

- **Constant Power Supply:**

Nigeria's power supply is currently erratic and insufficient. Generally, there is no difference between the rural and the urban areas except for the fact that the urban areas by virtue of their status as 'business hubs' tend to push consumers to use electric generators more than often the rural areas. Solar energy, described as the best form of renewable energy, has a very high investment cost but the life span of the solar panel could be as long as 25 years if they are properly installed. Nevertheless, some anecdotal evidence shows that in some states in Nigeria solar panels have failed to deliver the expected results due to corrupt practices associated with procurement of substandard panels. Irrespective of this, solar energy is never exhausted unlike the conventional energy of oil, coal, and gas.

- **Strong Network Coverage In All Communities.**

  This will go a long way to ameliorating drop and aborted but charged for calls witnessed on daily basis by the mobile communication subscribers.

4.0 MATERIALS AND METHODS

4.1 Research Hypothesis

H_o: Poor network infrastructure and high tariffs have no relationship with poor service delivery

H_1 : Poor network infrastructure and high tariff have a relationship with poor service delivery

4.2 The Population

The population would consist of the general public particularly students of Imo State University, Federal University of Technology, Alvan Ikoku Federal College of Education, and Ekeonunwa Market, all in Owerri, Imo State, Nigeria.

4.3 The Sample and the Sampling Technique

By the simple lottery method of selection, four tertiary institutions and a market located within and around Owerri Area of Imo State would be randomly selected. A total of five hundred (500) respondents from these sampled institutions would be expected to respond to the questionnaire. The responses would be regarded as the **observed frequencies** of this research.

One hundred respondents would be selected from each of the five sampled areas using simple balloting with replacement technique. Each of the respondents would have equal chance of being selected so as to make the sampling fair.

4.4 Instrument of Data Collection

Measuring devices that would be utilized in this study would be of three forms:

a) Questionnaire
b) Oral interview (or opinionnaire)
c) Life observation of complaints made by GSM mobile communication users.

The **questionnaire** would be designed to find out the challenges of telecommunication in Nigeria. It would consist of four sections: A, B, C, D and E Section A would test those statements that would reveal role of Poor mobile network coverage in necessitating poor service delivery of GSM mobile communication in Nigeria.

Section B would test the role of limited power supply in necessitating poor service delivery of GSM mobile communication in Nigeria while
Section D would test the role of high tariffs in necessitating poor service delivery of GSM mobile communication in Nigeria.
Section E would consist of open-ended questions to be used for further investigation and discussions.
Oral interview would comprise four simple questions in order to find out from respondents on their experience in the use of GSM mobile communication system.

In furtherance of concretizing the possible service delivery failures as a result of poor systemic errors of mobile communication equipment, life observation of mobile calls would be used by the researcher. It would be used to further explore the attitudes of the respondents toward GSM mobile communication usage.

4.5 Method of Data Collection

A face-to-face administration of the questionnaire would be used. Such would de used also for oral interviews for the respondents. While the first four sections of the questionnaire would be structured, the last part would be open-headed. One of the reasons for this would be to make the subject less suspicious of the researcher's intentions. Live observation of calls would be made. A total of one week would be expected to be used to administer and collect the data for the study.

4.6 Method of Data Analysis

The information collected through the questionnaire, oral interview and life observation of the respondents would be used to find out those research assumptions made earlier on.

5.0 Analysis of Questionnaire

Among the five sections of the questionnaire, four sections A,B,C and D would be used to test first, second, third and fourth factors of bad GSM infrastructure and its twin consequence of poor service delivery respectively. The fifth section would be used during discussions of findings. Responses to each item in the scale would be scored as in the Fido Gayford (1982) five-point Likert scale responses of Strongly Agree, Agree (A), Strongly Disagree (SD), Disagree (D) and Undecided (U)

The non-parametric test of Chi-Square ($X^{2)}$ belonging to Inferential statistics theory would be used for illustrations and analysis.

4.7 Decision Rule

The χ^2 test of independence is to be used to test whether the distribution of the outcome variable is similar across the comparison groups. Here we rejected H_0 and conclude that the distribution of poor service delivery is not independent of bad GSM infrastructure, or that there is a relationship between bad GSM infrastructure and poor service delivery. The test provides an overall assessment of statistical significance. When the null hypothesis is rejected, it is important to review the sample data to understand the nature of the relationship.

Table 1: distribution of questionnaire to the respondents of the sampled institutions

Sampled institutions in Owerri L.G.A	Number Administered	Number Collected	Number Analyzed
Imo State University	100	95	95
Fed. University of Technology	100	97	97
Ekeonunwa Market	100	90	90
Alvan Ikoku Fed. College of Education	100	92	92
Imo Poly Nekede	100	96	96
Total	500	470	470
Percentage	100%	94.0%	94.0%

5.1 Testing the hypothesis

H_0: Poor mobile network coverage, poor GSM technology, limited power supply and high tariffs, have no relationship with poor service delivery (e.g. High discharge rate of mobile phones due to longer trials of calls, drop calls, hacking, poor data collection and processing and low calls rate due to low credit on mobile phones)

H_1 : Poor network infrastructure and high tariff have a relationship with poor service delivery.

We now wish to assess whether there is a relationship between bad GSM infrastructure and poor service delivery. As part of the same survey, respondents were asked how their different networks served them where they lived. The response options were low calls rate, High drop calls rate, Voice/data hacking, etc. The data are shown below.

Table 1: Analysis of Administered Questionnaire – Observed Frequencies

Bad GSM infrastructure \ Poor service delivery	low calls rate	High drop calls rate	Voice/data hacking	**Total**
Poor mobile network coverage	32	30	28	90
poor GSM technology	74	64	42	180
limited power supply	110	25	15	150
high tariffs	39	6	5	50
Total	255	125	90	470

Based on the data, the question is: is there a relationship between **Bad GSM infrastructure andPoor service delivery**? Do you think that the type of network a person uses affects his services from such network? Here we have four independent comparison groups (bad GSM infrastructure consisting of four variables) and a discrete (ordinal) outcome variable with three response options. We specifically want to test whether bad GSM infrastructure and poor service delivery are independent. We will run the test using the five-step approach.

Step 1. Set up hypotheses and determine level of significance.

H_0: Bad GSM infrastructure and poor service delivery are independent

H_1: H_0 is false. $\alpha=0.05$

The null and research hypotheses are written in words rather than in symbols. The research hypothesis is that the grouping variable (bad GSM infrastructure) and the outcome variable (poor service delivery) are dependent or related.

Step 2. Select the appropriate test statistic.

The formula for the test statistic is:

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

The condition for appropriate use of the above test statistic is that each expected frequency is at least 5. In Step 4 we will compute the expected frequencies and we will ensure that the condition is met.

Step 3. Set up decision rule.

The decision rule depends on the level of significance and the degrees of freedom, defined as df = (r-1)(c-1), where r and c are the numbers of rows and columns in the two-way data table. The row variable is the bad GSM infrastructure and there are 4 arrangements considered, thus r=4. The column variable is poor service delivery and 3 responses are considered, thus c = 3. For this test, df = (4-1)(3-1) = 3(2) = 6. Again, with χ^2 tests there are no upper, lower or two-tailed tests.

If the null hypothesis is true, the observed and expected frequencies will be close in value and the χ^2 statistic will be close to zero. If the null hypothesis is false, then the χ^2 statistic will be large. The rejection region for the χ^2 test of independence is always in the upper (right-hand) tail of the distribution. For df = 6 and a 5% level of significance, the appropriate critical value is 12.59 and the decision rule is as follows: Reject H_0 if $c^2 \geq 12.59$.

Step 4. Compute the test statistic.

We now compute the **expected frequencies** using the formula,

Expected Frequency = (Row Total * Column Total)/N.

The computations can be organized in a two-way table. The top number in each cell of the table is the observed frequency and the bottom number is the expected frequency. The expected frequencies are shown in parentheses.

Table 2: Computing Expected Frequencies

	Poor service delivery	low calls rate	High drop calls rate	Voice/data hacking	**Total**
Bad GSM infrastructure	Poor mobile network coverage	32 (48.8)	30 (23.9)	28 (17.2)	90
	poor GSM technology	74 (97.7)	64 (47.9)	42 (34.5)	180
	limited power supply	110 (81.4)	25 (39.9)	15 (28.7)	150
	high tariffs	39 (27.1)	6 (13.3)	5 (9.6)	50
	Total	255	125	90	470

Notice that the expected frequencies are taken to one decimal place and that the sums of the observed frequencies are equal to the sums of the expected frequencies in each row and column of the table.

Recall in Step 2 a condition for the appropriate use of the test statistic was that each expected frequency is at least 5. This is true for this sample (the smallest expected frequency is 9.6) and therefore it is appropriate to use the test statistic.

The test statistic is computed as follows:

$$\chi^2 = \frac{(32-48.8)^2}{48.8} + \frac{(30-23.9)^2}{23.9} + \frac{(28-17.2)^2}{17.2}$$
$$+ \frac{(74-97.7)^2}{97.7} + \frac{(64-47.9)^2}{47.9} + \frac{(42-34.5)^2}{34.5}$$
$$+ \frac{(110-81.4)^2}{81.4} + \frac{(25-39.9)^2}{39.9} + \frac{(15-28.7)^2}{28.7}$$
$$+ \frac{(39-27.1)^2}{27.1} + \frac{(6-13.3)^2}{13.3} + \frac{(5-9.6)^2}{9.6}$$

= 5.78 + 1.56 + 6.78 + 5.75 + 5.41 + 1.63 + 10.05 + 5.56 + 6.54 + 5.23 + 4.01 + 2.20 = 60.5.

Step 5. Conclusion.

We reject H_0 because 60.5 ≥ 12.59. We have statistically significant evidence at a =0.05 to show that H_0 is false or that bad GSM infrastructure and poor service delivery are not independent (i.e., they are dependent or related), $p < 0.005$.

Again, the χ^2 test of independence is used to test whether the distribution of the outcome variable is similar across the comparison groups. Here we rejected H_0 and concluded that the distribution of poor service delivery is not independent of bad GSM infrastructure, or that there is a relationship between bad GSM infrastructure and poor service delivery. The test provides an overall assessment of statistical significance. When the null hypothesis is rejected, it is important to review the sample data to understand the nature of the relationship. Consider again the sample data.

Table 3: Reviewed sample Data

	Poor service delivery	low calls rate	High drop calls rate	Voice/data hacking	**Total**
Bad GSM infrastructure	Poor mobile network coverage	32	30	28	90
	poor GSM technology	74	64	42	180
	limited power supply	110	25	15	150
	high tariffs	39	6	5	50
	Total	255	125	90	470

Because there are different numbers of respondents in each experimental situation, it makes the comparisons of exercise patterns difficult on the basis of the frequencies alone. The following table displays the percentages of respondents in each service delivery category by bad GSM infrastructural plan. The percentages sum to 100% in each row of the table. For comparison purposes, percentages are also shown for the total sample along the bottom row of the table.

Table 4: Percentage Representation of the Total Sample

Bad GSM infrastructure \ Poor service delivery	low calls rate	High drop calls rate	Voice/data hacking
Poor mobile network coverage	36%	33%	31%
poor GSM technology	41%	36%	23%
limited power supply	73%	17%	10%
high tariffs	78%	12%	10%
Total	54%	27%	19%

From the above, it is clear that higher percentages of respondents in Poor mobile network coverage and poor GSM technology reported Voice/data hacking (31% and 23%) as compared to respondents on limited power supply and high tariffs in same voice/data hacking (10% each).

Discussion and Findings

From the above experiment, it was evident that there is a close relationship between Bad GSM mobile communication infrastructure and poor service delivery. We therefore reject the null hypothesis that says otherwise. We can attribute Problems encountered in the use of GSM mobile communication like poor services, huge amount of money paid for services not rendered, bad network, hacking or tampering with user's privacy in the network and poor NCC regulation to bad infrastructural conditions of networks operated in Nigeria.

6.0 Summary

The reach of mobile communication goes far beyond the industry itself. It encompasses systemic innovation. Hence the development of collaboration platforms for services is of utmost importance for all industry. We should encourage the development of communities which can be seen as real "Living Labs" involving all research actors needed for high level research that has high impact for national growth.

Thus, an issue that is critical to the success of GSM as a mobile communication infrastructure and remains critical for the deployment of high-speed mobile data services is **interoperability**.

In a converging environment, new challenges to achieving interoperability emerge. This is because new systems and services are developed with inputs from multiple industries, including telecoms, broadcasting,

internet, computer and media industries. Each of these industries will have different perspectives onStandardization and interoperability.

Interoperability is critical to mass market take-up of new services. Commercial dynamics are the primary drivers towards achieving appropriate interoperability. Regulatory intervention must always be a last resort. While there is much ongoing work on interoperability, Industry needs to take real steps towards interoperability as a matter of urgency.

The deployment of **content** applications over mobile is also fundamental for the mobile communications and content industries and is an essential part of the new data paradigm. The success of new business models is a key factor in the sustainability of the market. To this end the industry should pursue its efforts in open application interface development.

The availability of a clear and predictable regulatory environment like the NCC can facilitate the creation of, and investment in, new products and services. The enforcement of intellectual property rights and the creation of a secure environment for content are crucial for the development of richer services. Effective enforcement of rights can be supported through technical protection measures and Digital Rights

Management technologies. These can help prevent unauthorized use of protected content while enabling new business models to flourish.

7.0 Recommendations

First, the emergence of high speed data services will include corporate and consumer applications involving personal and sensitive data. For these transactions, a **trusted and secure** identification and authentication process is needed. Mobile communication-based authentication is well placed to serve as a basis. It is already assisted by the universal availability of GSM networks and terminals across Nigeria. The industry should agree a common interoperable authentication framework that will ensure general purpose authentication uses across Nigeria.

The second issue is **mobile payments**. There is at present considerable uncertainty regarding the application of international rules on e-money and money laundering to mobile payment services. Any over-regulation of these services threatens the continuing viability of mobile content services. The NCC should work hard to ensure that appropriate rules are put in place for the new mobile payment segment.

The third issue is the continued existence of regulatory and quasi-regulatory barriers to the establishment of new **base stations and masts** in some localities. Unless the stakeholder or operators particularly unite around the NCC Recommendation, there is a risk that the imposition of stricter electro-magnetic limits than those recommended by NCC could represent a continuous barrier for network deployment like 3G and above.

Conclusion

There are grounds for greater optimism for the mobile communication sector. There are signs of improvement. Over the past year, Nigerian mobile operators have launched been trying to launch better backbones with better and expanded bandwidths like 3G and above. The growth of high-speed mobile data services is an exciting opportunity. If grasped, we will realize enormous social and economic benefits – not least through significant gains in productivity. A focus on services and innovative applications will drive the development of the mobile communications sector forward.

Furthermore, Nigeria's power sector reform initiative which was launched in 2005

recognizes the need to improve power sector performance as a critical step in its efforts to address development challenges. Through the 2010 Roadmap, Nigeria revitalized the challenging process of implementing reforms by outlining the government's strategy and actions to undertake comprehensive power sector reform to expand supply, open the door to private investment, and address some of the chronic sector issues hampering improvement of service delivery.

We know that power supply is one of the many challenges Nigeria is expected to address to ensure that the country is on course to meet the MDGs, particularly those related to health. Increased power supply will strengthen, among other things, mobile communication information systems of which the GSM is part.

We hope that the Nigerian Government, the mobile network companies, and the international community at large will consolidate their efforts in addressing the mobile

Network coverage and power supply challenges in order to create an enabling environment for socio-economic development particularly in rural and disadvantaged areas.

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