

Evaluation of Voice Quality Levels in Mobile Communication: A Case Study of Oyo State, Nigeria

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Abstract: *Nigeria with infant GSM mobile subscribers is mostly concerned about the quality of services they received from the GSM operators in the country. Nigeria is also concerned about the factors affecting voice quality such as degradation of speech (voice), messages and other anomalies encountered. The paper focuses on the evaluation of voice quality of some GSM operators in the country. It looks into seven items used to measure the dimension of voice quality such as echo of the sender's voice, distortion in the receiver's voice, volume of the receiver's voice and overall voice quality perception. In this paper a survey design was used. The sample consists of 300 subscribers and these were selected by stratified random sampling technique. Questionnaire containing twenty six (26) items on factors affecting voice quality level in mobile communication was administered to the various categories of subscribers of mobile communication in Oyo State, Nigeria. Mean and standard deviation was used to answer six research questions. Results show that the highest overall mean opinion score is 3.10 and the least value is 2.93. It therefore implies that the voice quality levels are above average for the four GSM service providers under investigation*

Keywords: *Global System for Mobile Communication (GSM), Voice Quality, Distortion, Subscribers, wireless communication and G.S.M operators*

1. INTRODUCTION

In the early 1990s, the communication industry was virtually at stand still. It became obvious that the Nigeria Telecommunication (NITEL) could not meet the high demand for telephone lines and quality of service needed by the public. NITEL was as notorious for its unreliability as it was for the nepotism of its officials (Cadwalader et al, 2002). Of 32 years of national existence since independence, about 500,000 lines were available for the population of 80 million people. On the international level, Nigeria was lagging behind in the standards of International Telephone Union (ITU).

The search to revamp the sector and keep pace with rapid global development led to government policy of privatization and deregulation in the Telecommunication (telecom) industry. The telecom sector reforms commenced when Nigeria identified with global trend that liberalization of telecommunication was essential for rapid growth and that private sector participation was essential for attracting financial resources, innovations and new technology (Ndukwe, 2004). Thus, Nigeria Communication Decree 75 of 1992 was promulgated to liberalize the telecom industry and open the gate for private sector participation as well as establishing National Communication Commission (NCC) as the regulatory authority.

In spite of the improvement in which wireless communication has over the traditional means of communication, Chinthananda et al, (2001) reported that the performance of wireless communication is still being degraded by many transmission impairments including fading, co-channel interference and noise. He reported that poor voice quality is the major phenomenon

which makes wireless transmission a challenge when compared to fiber, coaxial cable, line of sight microwave or even satellite transmission.

According to the Oxford Learner's Dictionary voice is defined as the sound or sounds produced through the mouth by a person speaking or singing, and quality is also defined as the standard of something when it is compared to other things like it; how good or bad something is. We can therefore say that voice quality is the standard of sound produced through speech by G.S. M subscribers when communicating with each other. Akbar and Behnam (1999) reported that poor voice quality is the primary cause of the performance degradation in wireless systems and the central among other challenges facing the radio engineer. Therefore, it demands a lot of attention from communication system designers.

The goal of any communication system is to provide to the receiver, a signal that is strong enough to overcome all forms of interference as well as to ensure that the received signal is free from distortion and fading (Oladejo, 2009) and (Katz, 1994). Unfortunately, the wireless mobile channel has made it difficult to achieve these goals. This is because, unlike the fixed channel, the wireless channel or mobile system usually experiences fading which normally results in fluctuation of Signal to Noise Ratio (SNR) which leads to poor voice quality, slow link speed and dropped calls (Albert, et al, 2002). Hence, a lot of attention should be given to voice quality. This is the motivation behind this work because being able to combat it will contribute greatly towards moving the communication industry forward.

2. EMPIRICAL REVIEW OF MOBILE TELEPHONE OPERATORS

Presently, we have about four main GSM mobile operators i.e the ZAIN, ETISALAT, MTN and GLOMOBILE. Therefore, the total subscriber base for connected fixed and mobile lines rose from 866,782 in 2001 to 47,205,063 (Ojekunle, 2008). This is an average growth rate of 668.25% annually. Overall, 46,338,281 new telephone lines have been taken up since year 2001, a phenomenal increase of 5,346.01%.

2.1. ECONET / V-Mobile / CELTEL / ZAIN/AIRTEL

CELTEL Company was initially established as ECONET wireless in 2000 by private institutional investors and three state governments. It later changed to VEE Network Limited (Trading as V-MOBILE NIGERIA). In 2006, 65% of the company was acquired by CELTELL International at the cost of \$1.005 billion. CELTELL International and CELTEL Nigeria are later owned by the ZAIN group (formerly MTC), a leading provider of mobile telecommunication in the Middle East and Africa and later to AIRTEL. As at the end of 2007, the subscriber base of the company stands at 32.145 million in 22 countries (retrieved from <http://www.celtell.nigeria.com>).

2.2. MTN

MTN Nigeria is part of the MTN Group, Africa's leading cellular telecommunication company. On May 16, 2001, MTN became the first GSM Network to make a call following the globally lauded Nigeria G.S.M auction conducted by the Nigeria communication commission earlier in the year. Thereafter the company launched full commercial operation beginning with Lagos, Abuja and Port- Harcourt.

MTN paid \$285 million for one of four GSM licenses in Nigeria in January 2001. Since launched in August 2001, MTN has steadily deployed its services across Nigeria. It now provides services in 223 cities and towns, more than 10,000 villages and communities and a growing number of highways across the country, spanning the 36 states of Nigeria and the capital territory, Abuja.

The company's digital microwave transmission backbone, the 3,400 kilometer Y'ello Bahn was commissioned by president Olusegun Obasanjo in January 2003 and was reputed to be the most extensive digital microwave transmission infrastructure in all of Africa. The Y'ello Bahn has significantly helped to enhance call quality on MTN Network (retrieved from <http://mtnonline.com>).

2.3. GLO Mobile

GLO mobile launched its services on August, 2007. In its first year of operation, GLO mobile became the fastest growing GSM network in Africa, achieving a record of one million subscribers

and covering over 87 towns in just nine months. The subscriber figure at the moment stands at over 18 million with coverage extending to over 40 thousand cities, towns, communities and major roads, thus making the company the second largest operator in Nigeria.

Prominent among the innovations GLO mobile has introduced are the per seconds billing, Blackberry, Multimedia messaging service (MMS), Magic Plus, Glo Direct, Glo mobile internet, Glo fleet manage, M-Banking and Glo Mobile Office.

While competitors argued that per second billing (PSB) was not possible until 2007 and that no network in the world has been able to launch with PSB, Globacom introduced the billing platform at launch. This caused a stir in the industry and is regarded as the most innovative landmark in communications industry since the introduction of GSM services in Nigeria in 2001. (Retrieved from <http://www.gloworld.com>)

2.4. ETISALAT

In March 2007, a Nigerian company, Emerging Market Telecommunication service Ltd, In partnership with Mubadala Development company, the United Arab Emirates government owned company was issued a 15 years renewable Unified Access Service license (UASL) for \$400 million. The company was allocated the fifth license frequency in 900MHz and 1008 MHz band to offer mole service and provide fixed line, voice, data services and established international gateway.

Emirates telecommunication corporation, ETISALAT (formerly EMIRTEL) is the operating partner and holds 40% interest in the telecommunication industry. Mubadala holds 3% interest, while the remaining shares are for Nigerian investors. The entry into Nigeria of ETISLAT will be its 15th market globally and its 11th in Africa. The company currently operates in 14 marketing areas providing over 34 million customers with fixed lines, mobile, television and internet service.

3. FRAMEWORK ON QUALITY OF SERVICE

With the commencement of the GSM mobile service in Nigeria in 2001, many Nigerians have come to appreciate the new technology advancement irrespective of the cost implications. However, the general populace and subscribers are mostly concerned about the degradation of speech (voice) messages and other anomalies encountered during use, like the echo, the time delay in hearing the receiver's voice, the level of distortion and the degree of cross talk and call breaking. The anomalies greatly affect the quality of service given to the users of GSM in Nigeria. These factors, which affect voice quality, require much attention because they are very important to the design constraints for mobile communication system. Persistent quality problems, most especially the poor voice service quality, will lead to the users of service becoming dissatisfied and moving to other service providers.

4. SOME USEFUL TERMINOLOGIES

Noise: This is typically any service noise on the line or in a voice mail message in addition to the voice signal. Noise will leave the conversation intelligible but still far from excellent.

Hum and intermittent popping tones are examples when the calling and receiving parties can understand each other, but with some efforts, some noises are so severe that the voice becomes unintelligible.

Voice Distortion: This is the problem that affects the voice itself. This is further subdivided as follows

Echoed Voice: Echo is when the voice is repeated on the line. It can be heard at either end of the call in varying degrees and with many combinations of delay and loss within the echoed signal.

Garbled Voice: A garbled voice is one in which the actual character of the voice is altered to a significant degree and often has a fluctuating quality. On some occasions the voice becomes unintelligible.

Volume Distortion: Volume distortion problems are associated with incorrect volume levels, whether constant or in flux

Cross talk: Cross talk occurs when you can hear someone else's conversation on the line, and the other parties cannot hear you. There are also forms of cross talk where all parties can hear each other, but the common cause of this problem is when the signal of one party is induced into the other.

Call Set up Time: This is defined as the time lag between dialing the last digit of the phone number and hearing the first dial tone. It is used to assess how quality end-to-end conversations are established.

Call Dropping: This is the inability to get connected to a network due to over stretching of the network

Call Breaking: This is the inability to complete a call or is the termination of a call before the completion of conversation.

5. METHODOLOGY

Questionnaire has been designed in a clear, understandable and unambiguous manner.

The purpose of the questionnaire was to ensure the respondent's perception of the voice quality of the four GSM operators in the country. The measure adopted is from the international telecommunication union telecommunication standardization commendation on the telephone transmission quality (subjective opinion test). Seven items were used to measure the dimension of voice quality: echo of the sender's voice, noise on the line, degree of cross talk, time delay in hearing the receiver's voice, distortion in the receiver's voice, volume of the receiver's voice and overall quality perception. All items were measured on a five-point scale.

6. PURPOSE OF THE STUDY

The aim of this study was to evaluate the voice quality level of four GSM Service providers i.e. Etisalat, Zain, Globalcom and MTN. To achieve this, assessment of level of echo on the line, level of noise, time delay in hearing receiver's voice, level of distortion and degree of crosstalk was done through questionnaire.

Research question

The following questions were answered

1. How do users/subscribers rate the level of echo while making calls?
2. How do users/subscribers rate the level of noise on the line they are using?
3. How do users/subscribers rate the time delay in hearing the receiver's voice?
4. To what extent does the distortion affect the receiver's voice while making calls?
5. How do users/subscribers rate the volume of the receiver's voice while making calls?
6. How do users/subscribers rate the degree of crosstalk while making calls?

7. DESIGN OF THE STUDY

Survey design was used for the study. Study was designed to get information from the respondents. Six hypotheses were identified and tested using mean (X) and standard deviation (SD)

8. STUDY AREA SAMPLE POPULATION

The research focus is on the mobile communication industry in Nigeria located in Oyo state. This was stratified into three strata- Oke-ogun, Ibadan/Ibarapa and ogbomoso/Oyo. In each stratum respondents were chosen from each location. The mobile telecommunication industry covers Electronic transmission, reception of information by wire, radio and optical or other electromagnetic system between specific places. The industry is made up of different categories of operators which offer varied services, in addition to the internet and data service providers. There are three broad categories of mobile telecom operators; the fixed wire/wireless service provider such as the licensed second national operator (GLOBACOM), a number of fixed

wireless operators (otherwise known as Private Telecommunication operators (P.T.O) and those operating the fixed wireless technology.

- The cellular operators such as MTN communication, ETISALAT and ZAIN wireless. The two dominant GSM operators; NITEL and GLOBACOM also hold high digital mobile licenses to provide cellular services based on the GSM technology and other services.
- The long distance operator such as Nepskon communication limited and mobile telecoms service limited.

The period covered by the study is between 2011/2012

9. INSTRUMENTS FOR DATA COLLECTION

Structured questionnaire of 26 items was used for data collection. Questionnaire items were generated through the literature review and were drawn to reflect the research questions. The questionnaire items consisted of two sections. Section A was structured to obtain personal data from all categories of respondents. It contains items 1 to 3 while section B aimed at eliciting information that will provide answers to the research questions of the study. The scale used has five response categories. The scale value is as follows: Excellent (1), Very Good (2), Good (3), Poor (4), Very Poor (5).

10. METHOD OF DATA COLLECTION

The questionnaire was administered and collected by the researchers, 350 copies of the questionnaire were administered to the subscribers while 300 of them were duly filed and returned.

11. METHOD OF DATA ANALYSIS

The means and standard deviations were used to analyze the research questions. Any item with mean response of 2.50 and above is regarded appropriate while any item below 2.50 is regarded inappropriate.

12. RESULTS AND DISCUSSION

The data obtained were analyzed according to the research questions. For the research questions 1, 2, 3, 4, 5 and 6, data for answering these questions were derived from section B of the questionnaire. For the research question 1, item number 1 of table 1 has mean rating scores above 2.50 for Zain, Globalcom and MTN indicating that the level of echo is low i.e. appropriate while item number 1 of table 1 has mean rating score below 2.50 for Etisalat indicating that the level of echo is quite high i.e. inappropriate.

For the research questions 2 and 3, item numbers 2 and 3 of table 1 have means rating above 2.50 for all the GSM service providers under investigation indicating that the level of noise and time delay on the line is quite low and therefore appropriate.

For research question 4, item number 1 of table 2 has mean rating scores above 2.50 for Etisalat and MTN alone, indicating that the volume of receiver's voice is quite adequate for these service providers while Zain and Globacom have mean rating below 2.50 indicating that the volume of receiver voice is inappropriate.

Research questions 5 and 6 for items 2 and 3 of table 2 show that the mean ratings are above 2.50 for all the GSM service providers under investigation. This indicates that the distortion and degree of crosstalk are very low and therefore appropriate.

Table 3 depicts the overall quality perception and therefore shows that the overall voice quality perception for all the four GSM service providers are all above 2.50 indicating that the levels are above average.

It was also observed from data collection that MTN has the highest percentage number of subscribers (46.03%), followed by Globacom (37.75%), Zain (13.58%) and Etisalat (2.64%) in that order.

Table1. Mean Rating and Standard Deviation of Respondents on Levels of Echo, Noise and Time Delay

	Condition	Mean	Sample	Standard deviation	Remark
1	Level of echo on the line				
a.	Etisalat	2.38	8	1.302	Inappropriate
b.	Zain	2.56	41	1.184	Appropriate
c.	Globacom	2.60	114	1.150	Appropriate
d.	MTN	2.85	139	1.169	Appropriate
2.	Level of noise on the line				
a.	Etisalat	4.12	8	1.958	Appropriate
b.	Zain	3.22	41	1.573	Appropriate
c.	Globacom	3.32	111	1.573	Appropriate
d.	MTN	3.53	135	1.465	Appropriate
3.	Time delay in hearing receiver's voice				
a.	Etisalat	2.86	7	1.574	Appropriate
b.	Zain	3.17	41	1.657	Appropriate
c.	Globacom	3.01	114	1.549	Appropriate
d.	MTN	3.16	136	1.346	Appropriate

Table2. Mean Rating and Standard Deviation of Respondents on Levels of Volume of Receiver's Voice, Distortion and Degree of Crosstalk

	Condition	Mean	Sample	Standard deviation	Remark
1	Volume of receiver's voice				
a.	Etisalat	3.50	8	1.927	Appropriate
b.	Zain	2.41	41	1.161	Inappropriate
c.	Globacom	2.38	114	0.981	Inappropriate
d.	MTN	2.52	134	1.115	Appropriate
2.	Level of distortion				
a.	Etisalat	2.75	8	0.886	Appropriate
b.	Zain	3.35	40	1.578	Appropriate
c.	Globacom	3.32	114	1.328	Appropriate
d.	MTN	3.41	135	1.266	Appropriate
3.	Degree of crosstalk				
a.	Etisalat	3.00	8	1.309	Appropriate
b.	Zain	3.08	40	1.248	Appropriate
c.	Globacom	3.02	111	1.000	Appropriate
d.	MTN	3.10	134	0.928	Appropriate

Table3. Overall Voice Quality Perception

	Mobile Service Provider	Mean	Sample	Standard deviation	Remark
a.	Etisalat	3.10	47	1.493	Appropriate
b.	Zain	2.97	244	1.401	Appropriate
c.	Globacom	2.93	672	1.264	Appropriate
d.	MTN	3.09	813	1.215	Appropriate

13. CONCLUSION

The results obtained from the study indicate that the voice quality levels are above average for the four (4) GSM service providers under investigation. Considering the overall voice quality from the sample study, the highest mean opinion score is 3.10 and the least opinion score is 2.93. These values were representation of the state of the network in Oyo State of Nigeria as at the time the study was conducted. The results show that improving voice quality should be top priority of GSM service providers

At this juncture, the growth in number of operators has translated to more employment opportunities in mobile telephony alone, about 4,500 direct jobs has been created and 45,000 indirect employment covering such areas as distributorship and dealership, recharge card hawkers and air time retailers. More operators mean increased range of quality of service. The entrance of multiple operators in the telecom sector, particularly the mobile segment coupled with intensifying competition rivalry, has had resounding success in the industry in terms of growing subscriber base, decreasing tariff, widening coverage area and improving quality of service.

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