Comparative Analysis of Global System for Mobile Communication (GSM) Network in Ikot Ekpene Local Government of Akwa Ibom State, Nigeria Using GSM Network Analyzer

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Abstract: - As the erratic nature of the services of cellular networks become increasingly worrisome, the signal strengths and qualities of four available cellular networks operating in Ikot Ekpene Local Government Area, Akwa Ibom State Nigeria are compared to ascertain the network with a better signal strength. Measurement of signal strength (SS) and quality of signal (QoS) at particular time intervals were made for the four networks. The global system for mobile communication (GSM) analyzer is slotted with the subscriber identification module (SIM) card of each service provider of the telecommunication outfit. Results show that the network with the highest values of signal strength has the best quality of service, the average mean signal strengths for the four networks obtained were -86.25dBm, -86.33dBm,-86.71dBm and -86.71dBm and -86.42dBm for MTN Nigeria, Airtel, Globacom and 9 Mobile respectively. Also, the average mean quality of signal for four networks obtained were 43.38%, 43.38%, 43.38%, and 43.25%, for MTN Nigeria, Airtel, Globacom and 9 Mobile Respectively. The study shows that the type of network technology used does not influence the signal strength and quality. Network congestion is not influenced by signal strength but only influenced by number of users and bandwidth.

Key Words: —*GSM, Signal Strength, Signal Quality, Base Station and Base Transceiver Stations.*

I. INTRODUCTION

Mobile phones started to be widely utilized in Nigeria in 2002, since then, the utilization of them has rapidly risen. More and more people use them day by day. Because of the augmenting number of mobile phone users, the numbers of base stations which enable mobile phones to connect to other mobile phones are to be increased to provide a well communication chance.[9] Therefore, base stations are to be mounted closer to each other at a specified distance. Global System for Mobile communication (GSM) signal strength of the various Base Station (BS) will be measured and evaluated at Ikot Ekpene Local Government Area.

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Ikot Ekpene Local Government is known throughout Nigeria as Raffia city or locally simply as "IK" is an historic town in the Southern Nigeria, in Akwa Ibom State.

It is the political and cultural capital of the Annang ethnic group in Nigeria. The town is located on the A 342 highway that parallels the coast between Calabar to the South East and Aba to the West, with the state capital, Uyo to the East.

Umuahia is the next major town to the North. Ikot Ekpene is known as a regional center of commerce with notable exports of palm products, kernels, and raffia products including raffia fibers and its sweet wine, as well as ground crops of yams, cassava and corn [4]. The town is at the coordinate of latitude and longitude of (5,055982ON and 7.877246OE) [11].

The signal strength of MTN, GLO, AIRTEL and 9 Mobile networks will be measured with TECNO Android Mobile receiver from the Base Transceiver Station (BTS) at intervals of 30 seconds. The measured data will be analyze graphically and compared with each other to see the performance of each of the GSM network operators in the study area.

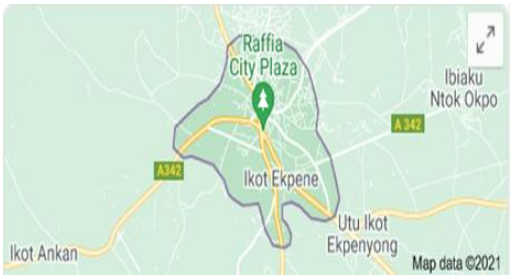

Fig.1. Map of Ikot Ekpene Local Government showing Location of Measurement

II. Statement Of Research Problem

In recent times services rendered by these cellular network has been epileptic and this has attributed to the weakness in the strength of these cellular network in which case the quality of their signals is analyzed with a view to determining the network with better signals quality and at what period of the day signal is strongest .

As the erratic nature of the service of some cellular network become increasingly worrisome, the signal strength of the cellular phone need to be compared and check the cause of reduction in their strength[7].

The problems that is associated to the reduction of GSM signal strength in any location are range, channel reuse, signal limit factor, cellular multipath fading and radio power.

The range, which mobile devices connect reliably to the cell site, is not a fixed figure. It will depend on a number of factors, which are:

- Height of antenna over surrounding terrain (Line-of-sight propagation).
- The frequency of signal in use [2].
- Timing limitations in some technologies (e.g., GSM is limited to 35km, with 70km being possible with special equipment).
- The transmitter's rated power.
- The required uplink/downlink data rate of the subscriber's device.
- Reflection and absorption of radio energy by buildings or vegetation.
- It may also be limited by local geographical or regulatory factors and weather condition [2]

III. Objective Of The Research

- To enable the cellular users to know the range of signal strength and quality of signals of the network they are using in Ikot Ekpene.
- To know if the off peak hours affect the signal strength in Ikot Ekpene.
- To enable the users to know if there is distinction on signal between GSM and CDMA.
- To enable the user to know the distinction between one cellular network and the other based on the quality of the signal.

IV. Scope Of The Research

The research investigation is carry out in Ikot Ekpene Local Government Area of Akwa Ibom State, Nigeria on four cellular networks namely, MTN, Nigeria, Globacom, Airtel and 9 Mobile. The location of the study area is Ikot Ekpene Local Government, Akwa Ibom State Southern Nigeria. The town is located on the A 342 highway that parallels the coast between Calabar to the South East and Aba to the West, with the state capital, Uyo to the East .The town is at the coordinate of latitude and longitude of (5,055982ON and 7.877246OE)[13].

V. GSM Signal Monitoring

GSM Signal Monitoring is an advanced network monitor that helps you to watch the state of cellular network by gathering data about cell towers (Local Area Coverage LAC, Mobile Network Code. MNC, signal strength, speed etc.). The app supports GSM, Universal Mobile Telecommunications System (UMTS) and LTE networks [10].

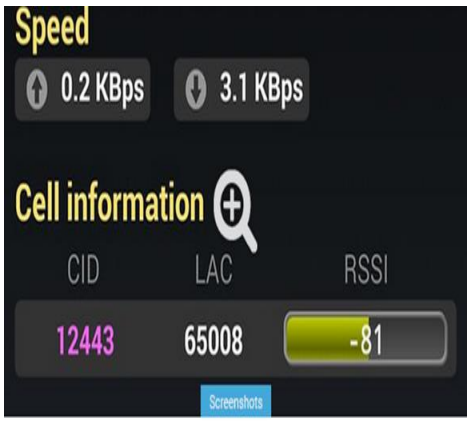

Fig.2. GSM signal monitoring Screen

VI. TERMINOLOGY OF NETWORK CELL INFO LITE 3.12.5.1 APK VERSION

CID - A GSM Cell ID (CID) is a generally unique number used to identify each Base transceiver station (BTS) or sector of a BTS within a Location area code (LAC) if not within a GSM network. In some cases, the first or last digit of CID represents cells' Sector ID [3].

- Value 0 is used for omnidirectional antenna.
- Values 1, 2, 3 are used to identify sectors of tri-sector or bisector antennas.

LAC- Location Area Code:

It is a set of base stations that are grouped together to optimize signaling. Typically, tens or even hundreds of base stations share a single Base Station Controller (BSC) in GSM, or a Radio Network Controller (RNC) in UMTS, the intelligence behind the base stations.

The BSC handles allocation of radio channels, receives measurements from the mobile phones, and controls handovers from base station to base station [12].

To each location area, a unique number called a "location area code" is assigned. The location area code is broadcast by each base station, known as a "base transceiver station" BTS in GSM, or a Node B in UMTS, at regular intervals.

Routing Area:

The routing area is the packet-switched domain equivalent of the location area. A "routing area" is normally a subdivision of a "location area". Routing areas are used by mobiles, which are GPRS-attached. GPRS is optimized for "bursty" data communication services, such as wireless internet/intranet, and multimedia services.

It is also known as GSM-IP ("Internet Protocol") because it will connect users directly to Internet Service Providers.

HSPA- High Speed Packet Access:

Is an amalgamation of two mobile protocols, High Speed Downlink Packet Access (HSDPA) and High Speed Uplink Packet Access (HSUPA), that extends and improves the performance of existing 3G mobile telecommunication networks utilizing the WCDMA protocols [8].

UMTS - Universal Mobile Telecommunications System:

Is a third generation mobile cellular system for networks based on the GSM standard. Developed and maintained by the 3GPP (3rd Generation Partnership Project), UMTS is a component of the International Telecommunications Union IMT-2000 standard set and compares with the CDMA2000 standard set for networks based on the competing CDMA One technology. UMTS uses wideband code division multiple access (W-CDMA) radio access technology to offer greater spectral efficiency and bandwidth to mobile network operators [8].

UMTS specifies a complete network system, which includes the radio access network (UMTS Terrestrial Radio Access Network, or UTRAN), the core network (Mobile Application Part, or MAP) and the authentication of users via SIM (subscriber identity module) cards.

The Radio Network Controller (or RNC) is a governing element in the UMTS radio access network (UTRAN) and is responsible for controlling the Node Bs that are connected to it. The RNC carries out radio resource management, some of the mobility management functions and is the point where encryption is done before user data is sent to and from the mobile. The RNC connects to the Circuit Switched Core Network through Media Gateway (MGW) and to the SGSN (Serving GPRS Support Node) in the Packet Switched Core Network [7].

RSSI- In telecommunications, *received signal strength indicator* is a measurement of the power present in a received radio signal. RSSI is usually invisible to a user of a receiving device. However, because signal strength can vary greatly and affect functionality in wireless networking, IEEE 802.11 devices often make the measurement available to users [2].

A *mobile phone signal* (also known as *reception* and *service*) is the signal strength (measured in dBm) received by a mobile phone from a cellular network (on the downlink). Depending on various factors, such as proximity to a tower, any obstructions such as buildings or trees, etc., this signal strength will vary. Most mobile devices use a set of bars of increasing height to display the approximate strength of this received signal to the mobile phone user. [1]

ASU - Arbitrary Strength Unit:

Is an integer value proportional to the received signal strength measured by the mobile phone. It is possible to calculate the real signal strength measured in dBm (and thereby power in Watts) by a formula. However, there are different formulas for

2G, 3G and 4G networks. In GSM networks, ASU maps to RSSI (received signal strength indicator)[5].

Received signal code power (RSCP):

In the UMTS cellular communication system, received signal code power (RSCP) denotes the power measured by a receiver on a particular physical communication channel. It is used as an indication of signal strength, as a handover criterion, in downlink power control, and to calculate path loss. In CDMA systems, a physical channel corresponds to a particular spreading code, hence the name (Received signal code power) [3].

VII. Research Methodology

The material needed for analysis of signal strength include a GSM Network Cell Info Lite monitor version 3.12.5. APK for android (a software to monitor and analyze the received signal strength indicator (RSSI) and quality of signal of cellular network); laptops, android cell phones with SIM card, the satellite mast that links cellular phone to their base stations and the communication satellite in the orbit around the earth, metre rule and clock.

VIII. Method Of Data Collection And Analysis

The data were collected by measuring the varying signal strength in a repeated pattern to have accurate result. Four different stations were picked within the study area. The stations were the local government headquarters.

The D7 Techno android handset or mobile phone device was set up at the height of 1.5 – 1.7 m above the ground. The signal strength of MTN, Airtel, 9 Mobile and Globacom network were measured simultaneously at a particular station, Android mobile receiver from the base transceiver stations (BTS) at the interval of one hour for 24 hours.

The software functions only with android phones at any time the program is loaded, it automatically monitors and analyses the corresponding data as specified by the administrator.

The results of the primary data were tabulated and subjected to the Pearson Product Moment Correlation (PPMC) Statistical analysis through statistical package for social scientist (SPSS). And compared with each other to see the performance of each of the GSM network operators in the study area. Microsoft excel was used in generating graph plots of measured quantities against time in hours.

The following analyses were carried out on these networks:

To find out how the quality of signal varies with signal strength.

- To find out if the signal strength is affected by peak hour's activities.
- The signal strengths of these networks as they vary with time.
- To discover the hours of the day with higher level of signal strength.
- The quality of signal provided by these networks as their signal strengths vary.
- The mean signal strength and quality of signal for each network.
- The standard deviation in signal strength and quality of signal for each network.

A. Collection of Raw Data

Table.1. Data Obtained for MTN Network

	SIGNAL STRENGTH (Y) dBm				QUALITY OF SIGNAL (Z) %			
	Day1 (Y_1)	Day1 (Y_2)	Day1 (Y_3)	Average (Y_{AV})	Day 1 (Z_1)	Day 1 (Z_2)	Day 1 (Z_3)	Average (Z_{AV})
00:00	-81.00	-79.00	-83.00	-81.00	50 : 00	52 : 00	51 : 00	51 : 00
01:00	-89.00	-90.00	-88.00	-89:00	40 : 00	38 : 00	42 : 00	40 : 00
02:00	-88.00	-89.00	-90.00	-89:00	41 : 00	39 : 00	40 : 00	40 : 00
03:00	-80.00	-89.00	-79.00	-79:00	56 : 00	56 : 00	56 : 00	56 : 00
04:00	-80.00	-79.00	-81.00	-80:00	55 : 00	56 : 00	57 : 00	56 : 00
05:00	-81.00	-84.00	-84.00	-83:00	49:00	49:00	52:00	50:00
06:00	-84.00	-86.00	-85.00	-85.00	46:00	49:00	49:00	48:00
07:00	-82.00	-84.00	-83.00	-83:00	49:00	50:00	51:00	50:00

08:00	-83.00	-86.00	-86.00	-85:00	47:00	49:00	48:00	48:00
09:00	-85.00	-86.00	-87.00	-86:00	45:00	46:00	47:00	46:00
10:00	-85.00	-86.00	-84.00	-85:00	48:00	48:00	48:00	48:00
11:00	-86.00	-87.00	-85.00	-86:00	46:00	47:00	45:00	46:00
12:00	-87.00	-86.00	-88.00	-87:00	45:00	45:00	45:00	45:00
13:00	-86.00	-85.00	-87.00	-86:00	47:00	48:00	43:00	46:00
14:00	-87.00	-78.00	-80.00	-79:00	54:00	57:00	57:00	56:00
15:00	-86.00	-86.00	-86.00	-86:00	47:00	46:00	45:00	46:00
16:00	-100.00	-99.00	-98.00	-99:00	11:00	12:00	13:00	12:00
17:00	-79.00	-79.00	-79.00	-79:00	56:00	56:00	56:00	56:00
18:00	-99.00	-98.00	-100.00	-99:00	12:00	12:00	12:00	12:00
19:00	-77.00	-76.00	-78.00	-77:00	65:00	65:00	65:00	65:00
20:00	-83.00	-83.00	-83.00	-83:00	51:00	50:00	49:00	50:00
21:00	-91.00	-88.00	-88.00	-89:00	41:00	41:00	38:00	40:00
22:00	-93.00	-96.00	-96.00	-95.00	26:00	27:00	28:00	27:00
23:00	-99.00	-100.00	-100.00	-100.00	08:00	06:00	07:00	07:00

Table.2. Data Obtained for AIRTEL Network

Time (Hour)	SIGNAL STRENGTH (Y) dBm				QUALITY OF SIGNAL (Z) %			
	Day 1 (Y_1)	Day 1 (Y_2)	Day 1 (Y_3)	Average (Y_{AV})	Day 1 ($Z_{1)}$	Day 1 (Z_2)	Day 1 ($Z_{3)}$	Average (Z_{AV})
00:00	-80:00	-79:00	-78:00	-79:00	56:00	56:00	56:00	56:00
01:00	-87:00	-87:00	-87:00	-87:00	45:00	44:00	46:00	45:00
02:00	-92:00	-86:00	-88:00	-89:00	40:00	38:00	42:00	40:00
03:00	-82:00	-80:00	-8I:00	-8I:00	51:00	51:00	51:00	51:00
04:00	-87:00	-85:00	-86:00	-85:00	48:00	49:00	47:00	48:00
05:00	-80:00	-82:00	-81:00	-81:00	51:00	51:00	51:00	51:00
06:00	-85:00	-85:00	-85:00	-85:00	48:00	48:00	48:00	48:00
07:00	-81:00	-81:00	-81:00	-81:00	51:00	51:00	51:00	51:00
08:00	-85:00	-86:00	-87:00	-86:00	46:00	47:00	45:00	46:00
09:00	-84:00	-89:00	-88:00	-87:00	44:00	46:00	45:00	45:00
10:00	-85:00	-85:00	-85:00	-85:00	48:00	48:00	48:00	48:00
11:00	-85:00	-86:00	-87:00	-86:00	47:00	48:00	43:00	46:00
12:00	-87:00	-86:00	-85:00	-87:00	45:00	47:00	43:00	45:00
13:00	-83:00	-88:00	-87:00	-86:00	46:00	46:00	47:00	46:00
14:00	-79:00	-82:00	-86:00	-81:00	51:00	52:00	50:00	51:00

15:00	-86:00	-86:00	-86:00	-86:00	46:00	46:00	46:00	46:00
16:00	-100:00	-99:00	-98:00	-99:00	12:00	13:00	11:00	12:00
17:00	-103:00	-103:00	-103:00	-103:00	05:00	05:00	04:00	05:00
18:00	-99:00	-99:00	-99:00	-99:00	12:00	12:00	12:00	12:00
19:00	-92:00	-97:00	-96:00	-95:00	27:00	27:00	27:00	27:00
20:00	-83:00	-83:00	-83:00	-83:00	51:00	51:00	48:00	50:00
21:00	-89:00	-89:00	-89:00	-89:00	40:00	40:00	40:00	40:00
22:00	-73:00	-77:00	-76:00	-75:00	66:00	67:00	65:00	66:00
23:00	-78:00	-76:00	-77:00	-77:00	65:00	66:00	64:00	65:00

Table.3. Data Obtained for GLOBACOM Network

Time (Hour)	**SIGNAL STRENGTH (Y) dBm**				**QUALITY OF SIGNAL (Z) %**			
	Day 1 (Y_1)	**Day 1 (Y_2)**	**Day 1 (Y_3)**	**Average(Y_{AV})**	**Day 1(Z_1)**	**Day 1(Z_2)**	**Day 1(Z_3)**	**Average(Z_{AV})**
00:00	-79:00	-79:00	-79:00	-79:00	57:00	57:00	54:00	56:00
01:00	-77:00	-77:00	-77:00	-77:00	64:00	64:00	67:00	65:00
02:00	-89:00	-89:00	-89:00	-89:00	38:00	42:00	40:00	40:00
03:00	-83:00	-81:00	-82:00	-81:00	51:00	51:00	51:00	51:00
04:00	-81:00	-80:00	-82:00	-81:00	48:00	52:00	51:00	51:00
05:00	-81:00	-80:00	-82:00	-81:00	50:00	52:00	51:00	51:00
06:00	-86:00	-85:00	-86:00	-85:00	48:00	48:00	48:00	48:00
07:00	-95:00	-95:00	-95:00	-95:00	28:00	27:00	26:00	27:00
08:00	-85:00	-87:00	-86:00	-85:00	44:00	48:00	46:00	46:00
09:00	-86:00	-86:00	-86:00	-86:00	46:00	47:00	45:00	46:00
10:00	-82:00	-83:00	-84:00	-83:00	47:00	53:00	51:00	50:00
11:00	-86:00	-85:00	-87:00	-86:00	45:00	47:00	46:00	46:00
12:00	-87:00	-88:00	-88:00	-89:00	40:00	40:00	40:00	40:00
13:00	-85:00	-86:00	-87:00	-86:00	47:00	46:00	45:00	46:00
14:00	-83:00	-83:00	-83:00	-83:00	49:00	51:00	50:00	50:00
15:00	-86:00	-86:00	-86:00	-86:00	45:00	46:00	47:00	46:00
16:00	-99:00	-99:00	-99:00	-99:00	12:00	11:00	13:00	12:00
17:00	-103:00	-104:00	-102:00	-103:00	05:00	05:00	05:00	05:00
18:00	-92:00	-97:00	-96:00	-95:00	27:00	28:00	26:00	27:00
19:00	-95:00	-95:00	-95:00	-95:00	27:00	27:00	27:00	27:00
20:00	-83:00	-84:00	-82:00	-83:00	50:00	50:00	50:00	50:00

21:00	-89:00	-89:00	-89:00	-89:00	40:00	40:00	40:00	40:00
22:00	-85:00	-85:00	-85:00	-85:00	50:00	47:00	47:00	48:00
23:00	-77:00	-78:00	-76:00	-77:00	67:00	64:00	64:00	65:00

Table.4. Data Obtained for 9 Mobile Network

Time (Hour)	**SIGNAL STRENGTH (Y) dBm**				**QUALITY OF SIGNAL (Z) %**			
	Day 1 (Y_1)	**Day 1 (Y_2)**	**Day 1 (Y_3)**	**Average(Y_{AV})**	**Day 1 (Z_1)**	**Day 1(Z_2)**	**Day 1(Z_3)**	**Average(Z_{AV})**
00:00	-83:00	-82:00	-84:00	-83:00	50:00	50:00	50:00	50:00
01:00	-84:00	-85:00	-86:00	-85:00	48:00	48:00	48:00	48:00
02:00	-86:00	-86:00	-86:00	-86:00	45:00	46:00	47:00	46:00
03:00	-85:00	-86:00	-84:00	-85:00	47:00	48:00	49:00	48:00
04:00	-87:00	-87:00	-87:00	-87:00	45:00	46:00	44:00	45:00
05:00	-87:00	-86:00	-86:00	-87:00	45:00	45:00	45:00	45:00
06:00	-86:00	-86:00	-86:00	-86:00	46:00	45:00	47:00	46:00
07:00	-79:00	-80:00	-79:00	-79:00	56:00	56:00	56:00	56:00
08:00	-81:00	-81:00	-81:00	-81:00	49:00	52:00	50:00	51:00
09:00	-88:00	-90:00	-89:00	-89:00	41:00	39:00	40:00	40:00
10:00	-91:00	-89:00	-87:00	-89:00	38:00	41:00	41:00	40:00
11:00	-79:00	-81:00	-77:00	-79:00	56:00	56:00	56:00	56:00
12:00	-81:00	-81:00	-81:00	-81:00	56:00	56:00	57:00	56:00
13:00	-84:00	-82:00	-83:00	-83:00	50:00	50:00	50:00	50:00
14:00	-84:00	-86:00	-85:00	-85:00	48:00	47:00	49:00	48:00
15:00	-89:00	-89:00	-89:00	-89:00	40:00	40:00	40:00	40:00
16:00	-95:00	-94:00	-96:00	-95:00	27:00	27:00	27:00	27:00
17:00	-103:00	-103:00	-103:00	-103:00	5:00	4:00	6:00	5:00
18:00	-100:00	-99:00	-98:00	-99:00	11:00	12:00	13:00	12:00
19:00	-79:00	-78:00	-80:00	-79:00	56:00	56:00	56:00	56:00
20:00	-99:00	-99:00	-99:00	-99:00	12:00	12:00	12:00	12:00
21:00	-77:00	-75:00	-79:00	-77:00	65:00	65:00	65:00	65:00
22:00	-81:00	-84:00	-84:00	-83:00	49:00	50:00	51:00	50:00
23:00	-85:00	-87:00	-86:00	-86:00	46:00	46:00	46:00	46:00

B. Measured Values

Results obtained from the various networks are recorded using tables. The parameters measured in the entire network under consideration are signal strength (SS) in decibel meter dB/m and quality of signal (QOS) in percentage (%).

The signal strength (SS) and quality of signal (QOS) are measured at one-hour time intervals and graphs for the corresponding data will be plotted for data analysis.

IX. Result Analysis

The result analysis is done using statistical tool subjected to pearson product moment correlation (PPMC) statistical analysis through Statistical package for social scientist (SPSS).

A. PPMC Analysis Summary for MTN Network in Ikot Ekpene Local Government Area (L.G.A) Akwa Ibom State

Table.5. Summary of PPMC analysis of the relationship between average signal strength (Y) and average quality of signal (Z) for MTN Nigeria Ikot Ekpene L.G.A

Variables	$\sum Y$	$\sum Y^2$	$\sum YZ$	**r.cal**
	$\sum Z$	$\sum Z^2$		
Signal Strength (Y) dBm	-2070	179498	88498	0.9819
Quality of Signal (Z) %	1051	51157		

Where 95% Accuracy $P \leq 0.05$
Degree Of Freedom DF = 23
Reliability Of Coefficient R = 0.4227

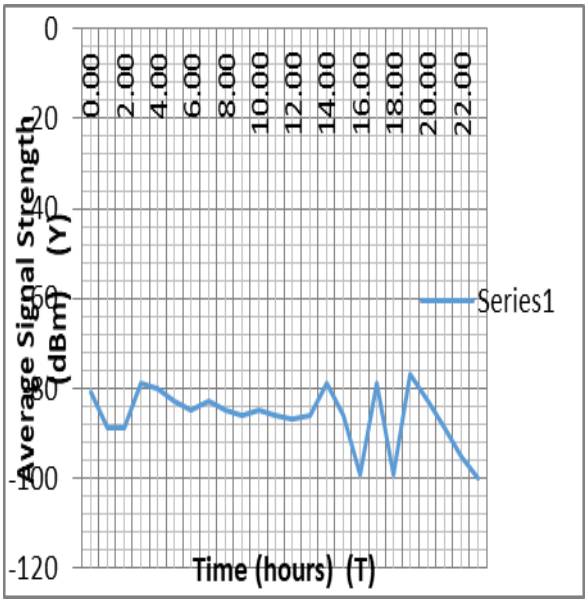

Fig.3. Plot of Average signal strength variation against time for MTN Nigeria in Ikot Ekpene L.G.A

Table.6. Other Calculated Parameter for MTN Network in Ikot Ekepene L.G.A

Parameter	Signal Strength (Y) dBm	Quality of Signal (Z) %
Maximum	-77.00	65.00
Minimum	-100.00	07.00
Range	23.00	58.00
Mean	-86.25	43.38
Standard deviation	6.462	14.72
Variance	41.76	216.68

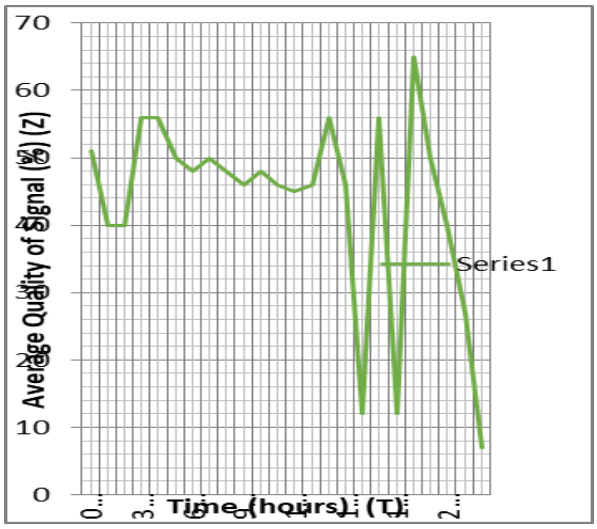

Fig.4. Plot of Average Quality of signal variation against time for MTN Nigeria in Ikot Ekpene L.G.A

Discussion of MTN Network Result Analysis IN Ikot Ekpene Local Government Area Akwa Ibom State Nigeria:

GSM signal monitor known as network cell info Lite with version 3.12.5.1.APK was used in measuring the parameters for this network.

Table.6. and Fig.3. Shows the average maximum signal strength (SS) as high as -77.00dBm at 19:00 hour and average minimum signal strength (SS) as low as -100.00dBm at 23:00 hours.

An average maximum quality of signal (QOS) as high as 65% at 19:00 hours and average minimum quality of signal as low as 07% at 23:00 hours.

A regression coefficient of 0.9819 was found between signal strength and quality of signal. Table.5. and Table.6. Show that signal strength varies between -77.00 dBm and -100.00 dBm

while quality of signal vary between 65% and 07%. The figure also shows a more consistency period between the hours of 01:00 and 02:00.

The regression coefficient obtained from the analysis in table.6. It was found to be significant when compared to the critical value of 0.4227 at 0.05 level of accuracy with 23 degree of freedom (DF). This shows a high positive relationship between signal strength and quality of for MNT network.

B. PPMC Analysis Summary For Airtel Network In Ikot Ekpene Local Government Area (L.G.A) Akwa Ibom State

Table.7. Summary of PPMC analysis of the relationship between average signal strength (Y) and average quality of signal (Z) for AIRTEL Nigeria Ikot Ekpene L.G.A

Variables	$\sum Y$	$\sum Y^2$	$\sum YZ$	r.cal
	$\sum Z$	$\sum Z^2$		
Signal Strength (Y) dBm	-2072	179972	87438	0.9824
Quality of Signal (Z) %	1040	50314		

Where 95% accuracy $P \leq 0.05$

Degree of freedom DF = 23

Reliability of coefficient R = 0.4227

Table.8. Other Calculated Parameter for AIRTEL Network in Ikot Ekepene L.G.A

Parameter	Signal Strength (Y) dBm	Quality of Signal (Z) %
Maximum	-75.00	66.00
Minimum	-103.00	05.00
Range	28.00	61.00
Mean	-86.33	43.33
Standard deviation	6.88203	15.105
variance	41.3623	228.145

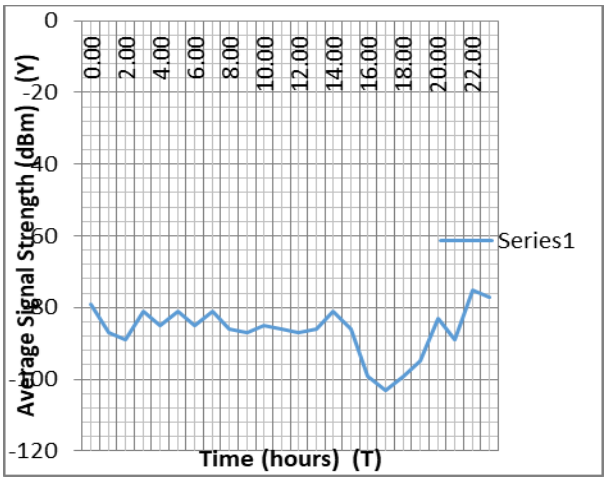

Fig.5. Plot of Average signal strength variation against time for Airtel in Ikot Ekpene L.G.A

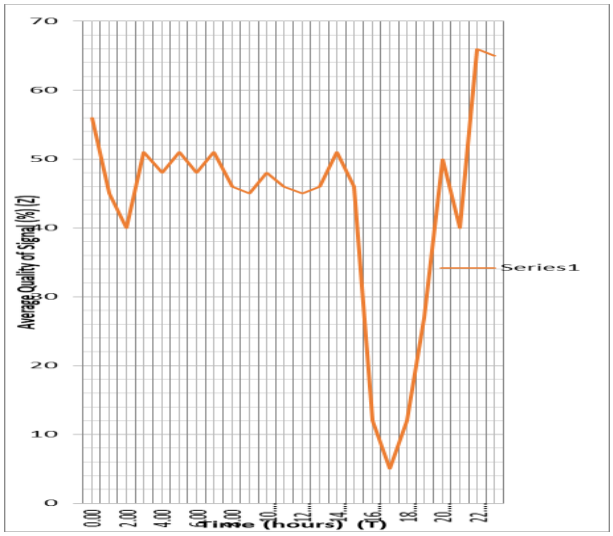

Fig.6. Plot of Average Quality of signal variation against time for Airtel in Ikot Ekpene L.G.A

Discussion of AIRTEL Network Result Analysis in Ikot Ekpene Local Government Area Akwa Ibom State Nigeria:

GSM signal monitor known as network cell info Lite with version 3.12.5.1.APK was used in measuring the parameters for this network. Table.8. and Fig.5. Shows the average maximum signal strength (SS) as high as -75.00dBm at 22:00 hour and average minimum signal strength (SS) as low as -103.00dBm at 17:00 hours.

An average maximum quality of signal (QOS) as high as 66% at 22:00 hours and average minimum quality of signal as low as 5% at 17:00 hours.

A regression coefficient of 0.9824 was obtained from the analysis as seen in table.7. It was found to be significant when compared to the critical value of 0.4227 at 0.05 accuracy with 23 degree of freedom. This reveal a high positive relationship between signal strength and quality signal for Airtel network.

Observing fig.5. And Fig.6. Reveals that signal strength varies between -77.00 dBm and -103.00 dBm while quality of signal vary between 5% and 65%.

C. PPMC Analysis Summary for GLOBACOM Network in Ikot Ekpene Local Government Area (L.G.A) Akwa Ibom State

Table.9. Summary of PPMC analysis of the relationship between average signal strength(Y) and average quality of signal (Z) for GLOBACOM Nigeria Ikot Ekpene L.G.A

Variables	$\sum Y$	$\sum Y^2$	$\sum YZ$	r.cal
	$\sum Z$	$\sum Z^2$		
Signal Strength (Y) dBm	-2081	179498	87636	0.9872
Quality of Signal (Z) %	1040	50314		

Where 95% accuracy $P \leq 0.05$

Degree of freedom DF = 23

Reliability of coefficient R = 0.4227

Table.10. Other Calculated Parameter for GLOBACOM Network in Ikot Ekepene L.G.A

Parameter	Signal Strength (Y) dBµV/m	Quality of Signal (Z) %
Maximum	-77.00	65.00
Minimum	-103.00	05.00
Range	26.00	60.00
Mean	-86.71	43.33
Standard deviation	6.64	14.38
variance	41.12	206.78

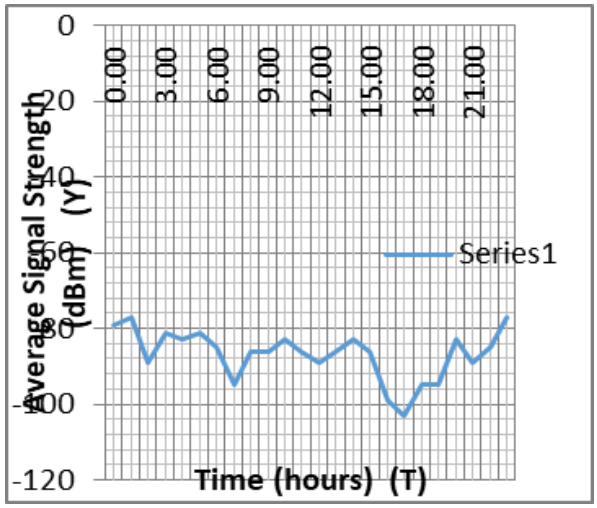

Fig.7. Plot of Average signal strength variation against time for Globacom Network in Ikot Ekpene L.G.A Akwa Ibom State

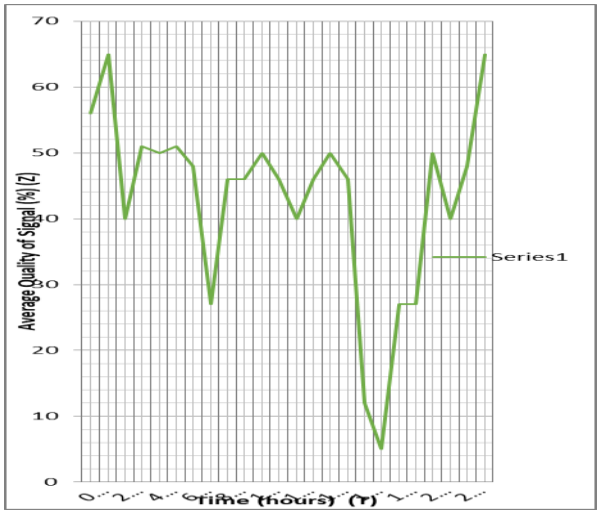

Fig.8 Plot Average Quality of signal variation against time for Globacom Network in Ikot Ekpene L.G.A Akwa Ibom State

Discussion OF GLOBACOM Network Result Analysis in Ikot Ekpene Local Government Area Akwa Ibom State Nigeria:

GSM signal monitor known as network cell info Lite with version 3.12.5.1.APK was used in measuring the parameters for this network. Table.3. and Table.9.

Table.3. shows the average maximum signal strength (SS) as high as -77:00dBm at 1:00 hour and average minimum signal strength (SS) as low as -103.00 dBm at 17:00 hours. An average maximum quality of signal as high as 65% at 01.00 hours and 23.00 hours.

A regression coefficient of 0.9872 was found between signal strength and quality of signal from the analysis. It was found to

be significant when compared to the critical reliability coefficient of 0.4227 at 0.05 with degree of freedom of 23. This reveal a high positive relationship between signal strength and quality of signal for Globacom network.

Fig.7. and 8 shows that the range for signal strength varies between -77.00 dBm and -77.00 dBm ,while that of quality of signal is 65%. The figures also show a more consistency period between 08:00 – 09:00 hours and 18:00 -19:00 hours.

D. PPMC Analysis Summary For ETISALAT Network In Ikot Ekpene Local Government Area (L.G.A) Akwa Ibom State

Table.11. Summary of PPMC analysis of the relationship between average signal strength (Y) and average quality of signal (Z) for 9Mobile Nigeria Ikot Ekpene L.G.A

Variables	$\sum Y$	$\sum Y^2$	$\sum YZ$	**r.cal**
	$\sum Z$	$\sum Z^2$		
Signal Strength (Y) dBm	-2074	180280	87412	0.9853
Quality of Signal (Z) %	1038	50022		

Where 95% accuracy $P \leq 0.05$

Degree of freedom df = 23

Reliability of coefficient r = 0.4227

Table.12. Other Calculated Parameter for 9Mobile Network in Ikot Ekepene L.G.A

Parameter	Signal Strength (Y) dBµV/m	Quality of Signal (Z) %
Maximum	-77.00	65.00
Minimum	-103.00	05.00
Range	26.00	60.00
Mean	-86.42	43.25
Standard deviation	6.76	14.93
variance	45.73	222.98

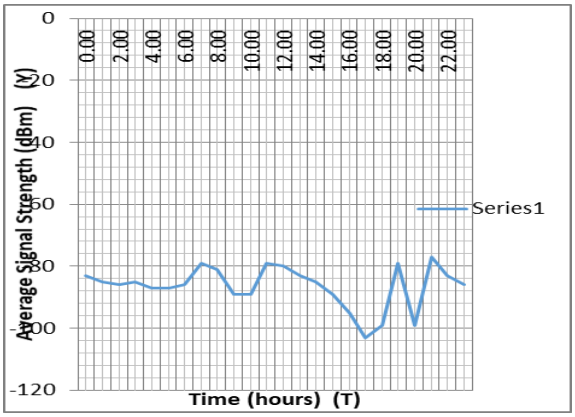

Fig.09. Plot of Average signal strength variation against time for 9 Mobile Network in Ikot Ekpene L.G.A

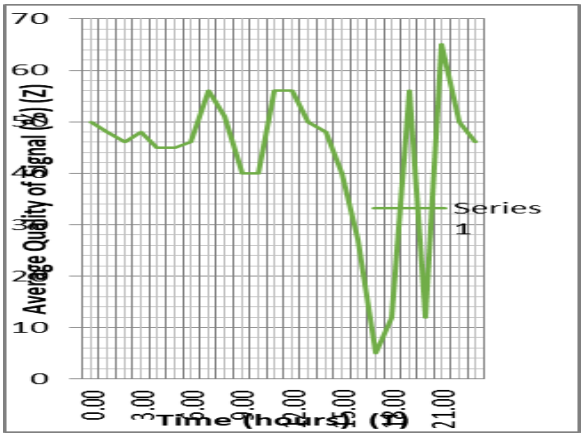

Fig.10. Plot of Average Quality of signal variation against time for 9 Mobile Network in Ikot Ekpene L.G.A

Discussion of 9Mobile Network Result Analysis in IKOT Ekpene Local Government Area Akwa Ibom State Nigeria:

GSM signal monitor known as network cell info Lite with version 3.12.5.1.APK was used in measuring the parameters for this network. Table.3. and Table.11.

Table.3. shows the average maximum signal strength (SS) as high as -77:00dBm at 1:00 hour and average minimum signal strength (SS) as low as -103.00dBm at 17:00 hours. An average maximum quality of signal as high as 65% at 21.00 hours.

A regression or correlation coefficient of 0.9853 was obtained from the analysis. It was found to be significant when compared to the critical reliability coefficient of 0.4227 at 0.05 with degree of freedom of 23. This reveal a high positive relationship between signal strength and quality of signal for Etisalet network.

Fig.9. and 10 shows that the range for signal strength varies between -77.00 dBm and -103.00 dBm, while that of quality of signal varies between 5% to 65%.

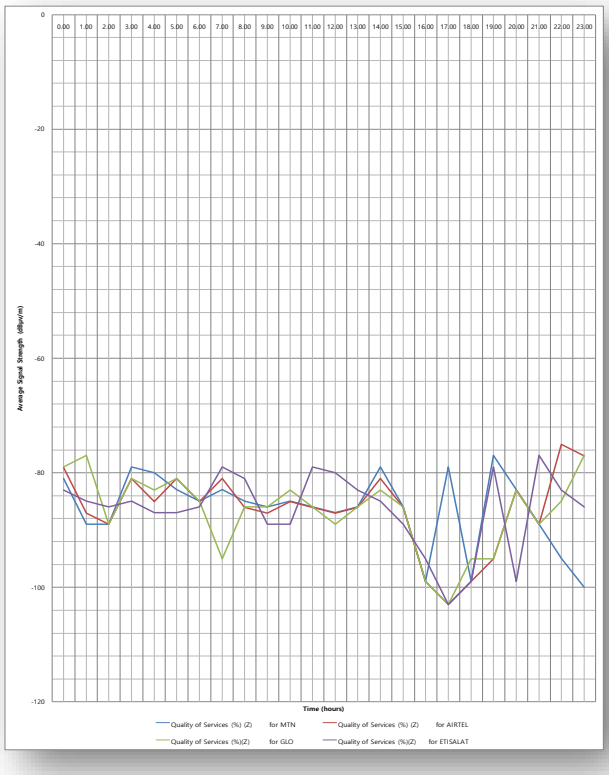

Fig.11. Average Signal Strength Variation with time for four (4) Networks

Table.13. Average Signal Strength Variation with Time for the four (4) Networks

Time (hours) (T)	Signal Strength (dBm)(Y) for MTN	Signal Strength (dBm)(Y) for AIRTEL	Signal Strength (dBm)(Y) for GLO	Signal Strength (dBm)(Y) for 9 MOBILE
00.00	-81.00	-79.00	-79.00	-83.00
01.00	-89.00	-87.00	-77.00	-85.00
02.00	-89.00	-89.00	-89.00	-86.00
03.00	-79.00	-81.00	-81.00	-85.00
04.00	-80.00	-85.00	-83.00	-87.00
05.00	-83.00	-81.00	-81.00	-87.00
06.00	-85.00	-85.00	-85.00	-86.00
07.00	-83.00	-81.00	-95.00	-79.00
08.00	-85.00	-86.00	-86.00	-81.00
09.00	-86.00	-87.00	-86.00	-89.00
10.00	-85.00	-85.00	-83.00	-89.00
11.00	-86.00	-86.00	-86.00	-79.00
12.00	-87.00	-87.00	-89.00	-80.00
13.00	-86.00	-86.00	-86.00	-83.00
14.00	-79.00	-81.00	-83.00	-85.00
15.00	-86.00	-86.00	-86.00	-89.00
16.00	-99.00	-99.00	-99.00	-95.00
17.00	-79.00	-103.00	-103.00	-103.00
18.00	-99.00	-99.00	-95.00	-99.00
19.00	-77.00	-95.00	-95.00	-79.00
20.00	-83.00	-83.00	-83.00	-99.00
21.00	-89.00	-89.00	-89.00	-77.00
22.00	-95.00	-75.00	-85.00	-83.00
23.00	-100.00	-77.00	-77.00	-86.00

Table.14. Average Quality of Signal Variation with time for the four (4) Networks

Time (hours) (T)	Quality of Signal (%) (Z) for MTN	Quality of Signal (%) (Z) for AIRTEL	Quality of Signal (%)(Z) for GLO	Quality of Signal (%)(Z) for 9MOBILE
00.00	51.00	56.00	56.00	50.00
01.00	40.00	45.00	65.00	48.00
02.00	40.00	40.00	40.00	46.00
03.00	56.00	51.00	51.00	48.00
04.00	56.00	48.00	50.00	45.00
05.00	50.00	51.00	51.00	45.00
06.00	48.00	48.00	48.00	46.00
07.00	50.00	51.00	27.00	56.00
08.00	48.00	46.00	46.00	51.00
09.00	46.00	45.00	46.00	40.00
10.00	48.00	48.00	50.00	40.00
11.00	46.00	46.00	46.00	56.00
12.00	45.00	45.00	40.00	56.00
13.00	46.00	46.00	46.00	50.00
14.00	56.00	51.00	50.00	48.00
15.00	46.00	46.00	46.00	40.00
16.00	12.00	12.00	12.00	27.00
17.00	56.00	05.00	05.00	05.00
18.00	12.00	12.00	27.00	12.00

19.00	65.00	27.00	27.00	56.00
20.00	50.00	50.00	50.00	12.00
21.00	40.00	40.00	40.00	65.00
22.00	27.00	66.00	48.00	50.00
23.00	07.00	65.00	65.00	46.00

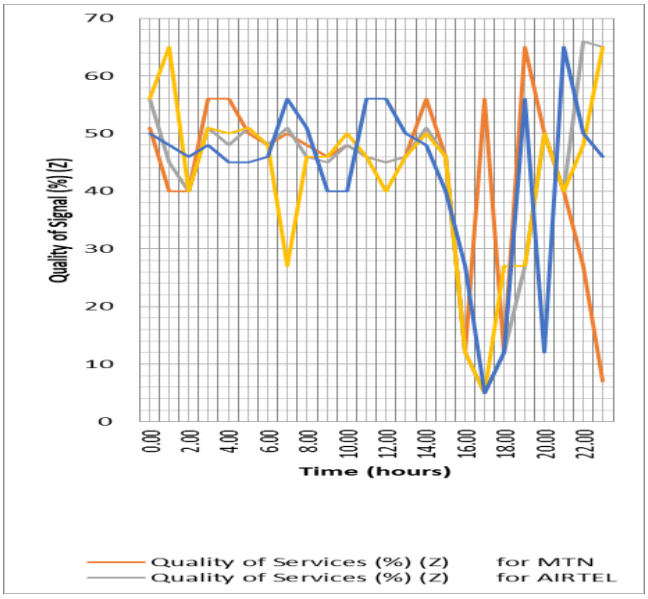

Fig.12. Average` Quality of Signal Variation with time for the four (4) Networks

E. Discussion of the Graph

The signal strength variation across the network is dissimilar i.e do not follow the same pattern or manner as seen in fig.11. The reason is that signal strengths are influenced by distance from the Base Transmitting Station BTS and obstacle. Hence, figure (3, 4, 5, 9 and 11) varies randomly. There is a distinction in the way signal strength varies with time of the day and night. This show that, daytime factor such as network congestion affects signal strength and data transmission within the network. It is observed that signal strength is directly proportional to the quality of signal.

From observation of the quality of signal (QoS) with time in fig.12. It is noted that a dissimilar pattern also occurred. The reason is because quality of signal is influenced by environmental and physical factors such as clouds precipitation, trees, temperature inversions, multipath losses and proximity to base transmitting station (BST).Other factor include the volume of network traffic, mass call event leading to overload of radio channels, roaming, interference by signal from local tower.

F. Comparative Analysis of the Data

The comparative analysis of the data results obtained for the four GSM networks reveal that Globacom Nigeria has the highest mean signal strength (SS) of -86.71dBm with 9 Mobile –86.42 dBm , Airtel -86.33 dBm, and MTN Nigeria have -86.25dBm.

For quality of service (QoS) MTN Nigeria have highest mean of 43.38, Airtel and Globacom Nigeria have 43.33 and 9 mobile have 43.25.

From, the statistical result, it is pertinent to say that Globacom have the best signal strength, while MTN have the best quality of service in Ikot Ekpene Local Government

X. SUMMARY

This research entailed using comparative analysis of GSM signal strength and quality within the four vital and most used network in Ikot Ekpene. Analysis show that there is no clear distinction in the way signal strength varies with respect to time in the day and at night. This revealed that daytime factor such as network congestion do not have any influence on the signal strength but rather influence data transmission within the network. It is observed that signal strength is directly proportional to the quality of signal.

XI. CONCLUSION

The comparative analysis of GSM signal strength reveals that the cellular network technology used has no influence on signal strength and the quality of signal. The factors that affect signal strength and quality of signal are the presence of obstacles (high-rise buildings, tall trees etc.) due to path fading and the distance from the base transmitting stations (BTS).

This research also reveals that network congestion does not have any direct influence on signal strength. In overall, for the four networks under consideration, MTN has the highest received signal strength in Ikot Ekpene, hence the best network so far in Ikot Ekpene. No wonder it continue to enjoy the highest subscriber patronage.

In choosing a network, signal strength should be considered seriously since the quality of signal provided by a network is a function of signal strength of that network.

REFERENCES

[1]. Andrea, F. (2020). History of the International Telecommunication Union (ITU). First Edition, De Gruyter Oldenbourg Publisher.

[2]. Berlo, D.K. (2009). The Process of Communication, New York, Holt, Rinehart and Winston, USA.

[3]. Covind, P. A. (2019). Nonlinear Fiber Optics. 6th Edition, Academic Press Publisher.

[4]. Ette, E.U. (2009). Colonialism and Acculturative Stress among the Annang of Nigeria. Indiana Xlibris Press.

[5]. Freeman, R.L. (2013). Fundamentals of Telecommunications. John Wiley and Sons. Second Edition.

[6]. Fasio, C. and Antonio, D. (2019). Photonic Applications for Radio System and Networks. Artech House Publisher.

[7]. Forouzan, B.A. (2007). Data Communication and Networking. Fourth Edition. Singapore.

[8]. Glistic, S.G and Leppanen, A. (2013). Wireless Communication TDMA versus CDMA Springerverlog, New York Inc.

[9]. Jacob, O. E. (2019). Telecommunication Law and Practice in Nigeria: Perspective on Consumer Protection. Malthouse Press.

[10]. Khan, F. (2009). LTE for 4G Mobile Broad band .Cambridge University Press.

[11]. Noah, Effiong (1988). Minutes of the Ibibio State Union, Uyo, Modern Business Press.

[12]. Sajal, K. D. (2010). Mobile Handset Design. John Wiley & Sons. Texas, USA.

[13]. Udo. E.U. (1993).The History of the Annang People, Calabar, Nigeria. Apcon Press Ltd.