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## Global System for Mobile Communication (GSM) Network Performances and Quality of Services Variability in Oyo State, Nigeria

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**Abstract:**

**Introduction:** The study examines the network variability of GSM in Oyo, Oyo State, Nigeria. The effectual administration and monitoring of mobile networks are imperative to forestall colossal loss by network providers and to satisfy the enthusiasm of the end users.

**Aims:** The research is to identify the challenges militating high-quality of services in Nigeria telecom sector and seeking resolutions for effective communications.

**Materials and Methods:** The requisite data is composed through the drive test technique. The Network Signal Info software installed enable per minute logging of the launched signal strength and quality. The composed data were keyed into Statistical Package for the Social Sciences (SPSS) computer software for quantitative analysis. The network signal variability is substantiated using one way Analysis of Variance (ANOVA).

**Results:** The result shows that the signal quality variability in MTN, Globacom as well as Airtel network in the study area were not statistically significant as  $p > 0.05$ . This justified the fairly dissemination of MTN, Globacom and Airtel signal quality and its inconsequential variations across the entire city of Oyo Town. Conversely, the variation in quality of 9Mobile network shows statistically significant values as  $p < 0.05$ . The feeble signal quality results in poor communication and calls for distortion across the research areas.

**Conclusion:** The study affirms that MTN and Globacom are the best networks for transactions at Oyo followed by Airtel and 9Mobile. The study hereby recommends the installations of Base Transceiver stations (BTS) to improve the strength and quality of the mobile network signals.

**Keywords:** Signal variability, signal strength, signal quality, Base Transceiver stations (BTS), mobile network, computer software.

All co-authors agreed to have their names listed as authors.

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## 1. INTRODUCTION

Effective telecommunication and quality service delivery are the backbone of every societal growth. Excellence service is regarded as the collective result of network presentation which regulates an extent of satisfaction of mobile subscribers. Accurate radio network planning is essential for good Quality of Service [1]. The revenue generation by service providers and customer fulfillment are directly proportional to network performance and quality of services. The mobile users incessant experiencing of call distortions, pitiable network interconnectivity, congestion, blocked calls, echoes and calls dropped is the evidence of GSM service nuisance and displeasure in Nigeria [2]. The quality of service coupled with telecom network performances are distorted by mobile operators' multimedia service varieties demands and increase in the quantity of mobile subscriptions [3].

The main challenge militating telecom sector in Nigeria is the quest, discovery and seeking resolution to the factors upsetting high-quality of service. The effectual administration and monitoring of mobile networks are imperative to forestall colossal loss by network providers and government as well to satisfy the enthusiasm of the end users [4]. The minimum Quality of Service standards in network transmission delivery is set up by Nigerian Communications Commission (NCC) for the telecom industry. A set of assessable pre-specified service conditions in terms of end-to-end performance such as delay variance, possibility of packet loss and bandwidth is projected to be convinced by network to the subscribers. The motivating force liable for the progressive tendency in the telecoms is the suitable necessities considered necessary for excellent data services and quality spectral competence [5].

The principal financially viable activities of Oyo Metropolitan are flourished farming, artisans, marketing, civil service and trading of the citizens. The city is blessed with many higher institutions of learning like Emmanuel Alayande University of Education, Oyo, Ajayi Crowther University, Oyo, Atiba University, Oyo, Federal College of Education (Special), Oyo, Federal School of Survey, Oyo and a lot of Public and Private Primary and Secondary Schools. The town also hosts the headquarters of four Local Governments Areas namely; Atiba, Oyo West, Oyo East and Afijio Local Governments Areas. Conversely, a balanced and reliable cell phone communication gadget is more of inevitability comparatively to a luxury in ancient town. Admirable superiority and competence cellular networks are vital in the area owing to, field research, academics, office operations, business transactions and population growth. Thus, it is essential to ascertain precise assessment and optimization of the networks at the research site. This informed this study on Global System for Mobile Communication (GSM) Network Performances and Quality of Services Variability in Oyo State, Nigeria.

## 1. REVIEW OF INTERRELATED STUDIES

Innumerable scholarships by veteran researchers have contributed on the Global System for Mobile Communication Network Performances and Quality of Services Variability as shown in Table 1. A lot of investigators implemented the drive test process with Key Performance Indicator (KPIs) examination which merely ascertains complications of parametrical stuffs. In contrast, the drive test technique with the network signal variability authenticated in this research using one way Analysis of Variance (ANOVA) for relative analysis of signal strength and quality permits an unfathomable statistical analysis on the subject matter. The applied Statistical Package for the Social Sciences (SPSS) computer software provides quantifiable, qualitative and comparative investigation of mean values of signal strength and quality. This methodology offered better-quality results equated to the KPIs.

**Table 1: Review of Literatures**

S/N	Authors	Title	Research Method/ Results	Gaps Filled by Present Study
1.	Elechi et al. (2020) [6]	Cellular planning of GSM network in Rivers State, Nigeria.	Erlang B technique was employed to determine the behavior of GSM network. The research discovered that some calls were denied when the traffic load is greater than, or too close to the voice channels. But perform well when the voice channels are greater than traffic load.	Drive test method with the network signal variability substantiated using one way Analysis of Variance (ANOVA) for relative analysis of signal strength and quality.
2.	Ewona et al. (2022) [7]	Measurement and Performance Assessment of GSM Networks using Received Signal Level.	The log files acquired during the driving test were made conceivable through TEMS 15.1 investigation software. It was detected that 96.50%, 93.60%, 95.40%, and 93.70% of the drive test routes for MTN, Airtel, Globacom and 9mobile network possessed good signal quality.	Drive test method with the network signal variability verified using one way ANOVA for relative analysis of mean values of signal strength and quality.
3.	Oluyemi et al. (2019) [8]	Performance Evaluation of a selected Cellular Mobile Operator in Ibadan Metropolis.	A drive test method was adopted to acquire KPIs for accessibility, retainability, mobility, and service integrity, in comparison with the NCC-defined target for each.	Drive test method with ANOVA signal variability adopted gave improved result to KPIs.
4.	Galadanci & Abdullahi (2018) [9]	Performance Analysis of GSM Networks in Kano Metropolis of Nigeria	Drive Test with KPIs method was adopted. The research verified that network S quality is the poorest trailed by Q and R, whereas quality of P is the best.	Drive test technique with ANOVA signal variability adopted gave value-added result to KPIs.

## 2. MATERIALS AND METHODS

The essential data is collected in Oyo Metropolis using drive test technique. The four infinix cell phones with SIM cards are installed on Network Signal Info software to enable per minute logging of the lunched signal strength. The machinery is simply applied regardless of cellular or Wi-Fi (WLAN) link [10, 11]. The average mean values for signal strength (dBm) and quality were deduced respectively by the Received Signal Strength Indicator (RSSI) and at Arbitrary Strength Unit (ASU) of all researched networks at a

preference location throughout Oyo Metropolis [12, 13, 14]. The KPIs parameters examined in the study area are Traffic channel congestion rate (TCHCR), Standalone Dedicated Control Channel (SDCCH), Call Setup Success Rate (CSSR), Hand over Success Rate (HOSR) and Call Drop Rate (CDR) [15, 16]. The data collected were entered into Statistical Package for the Social Sciences (SPSS) computer software for quantitative examination. The network signal variability is verified using one way Analysis of Variance (ANOVA) for comparative analysis of mean values of signal strength and quality [17, 18].

### 3. RESULTS AND DISCUSSION

Table 2 presents average mean values of data for signal strength [Received Signal Code Power (RSCP)], signal quality and examined KPIs parameters that include CSSR, HOSR, DCR, SDCCH and TCH for the four GSM network operators.

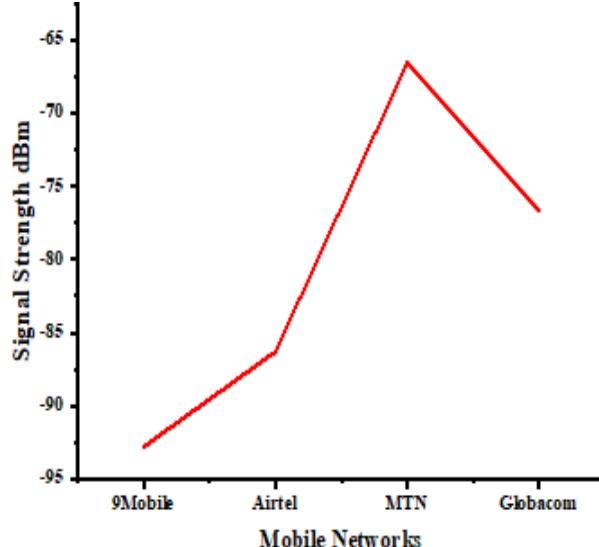
**Table 2: GSM Network Performances and Quality of Services Result in Oyo, Oyo State, Nigeria (2022) [16]**

Network Operators	Signal Quality ( $\bar{X}$ )	RSCP (dBm) ( $\bar{X}$ )	KPI ( $\bar{X}$ )				
			CSSR (%)	TCHCR (%)	DCR (%)	SDCCH (%)	HOSR (%)
9Mobile	42.54	-92.78	92.86	7.69	7.14	-1194.54	92.31
Airtel	44.48	-86.29	96.00	4.17	4.00	-2278.18	95.83
MTN	84.26	-66.59	98.00	2.04	2.00	-4754.90	97.96
Globacom	64.28	-76.61	97.20	2.88	2.80	-3340.28	97.12

The result in Table 2 reveals MTN signal with the highest and strongest strength of  $-66.59 \text{ dBm}$ , very much trailed by Globacom network of  $-76.61 \text{ dBm}$ , Airtel and 9Mobile recorded the least and weakest signal strength average values of  $-86.29 \text{ dBm}$  and  $-92.78 \text{ dBm}$  respectively across the city. Results obtained as shown in Table 1 from the KPIs valuations indicates average network performances in compares to threshold level goals fixed by Nigeria Communication Commission (NCC). The KPIs benchmarks by NCC revealed that  $\text{CSSR} \geq 98\%$ ,  $\text{CDR} \leq 2\%$ ,  $\text{TCHCR} \leq 2\%$ ,  $\text{HOSR} \geq 98\%$ ,  $\text{SDCCH} \leq 1\%$  and the best signal coverage (RSCP) is  $-85.00 \text{ dBm}$  [15].

**Table 3: GSM Network Signal Strength ANOVA Result in Oyo State, Nigeria (2022) [16]**

Network Operators	RSCP (dBm) ( $\bar{X}$ )	N	SD	DF	SS	Sig
9Mobile	-92.78	48	12.983	47	8090.53	0.0069
Airtel	-86.29	48	15.414	47	11404	0.1786
MTN	-66.59	48	14.256	47	9755.83	0.2141
Globacom	-76.61	48	14.677	47	10339.63	0.1916

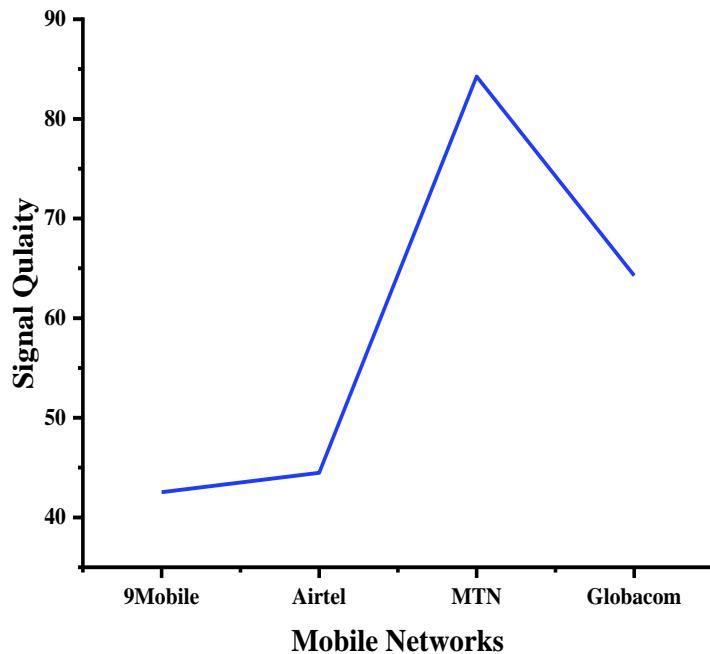


**Figure 1: GSM Signal Strength Variability in Oyo**

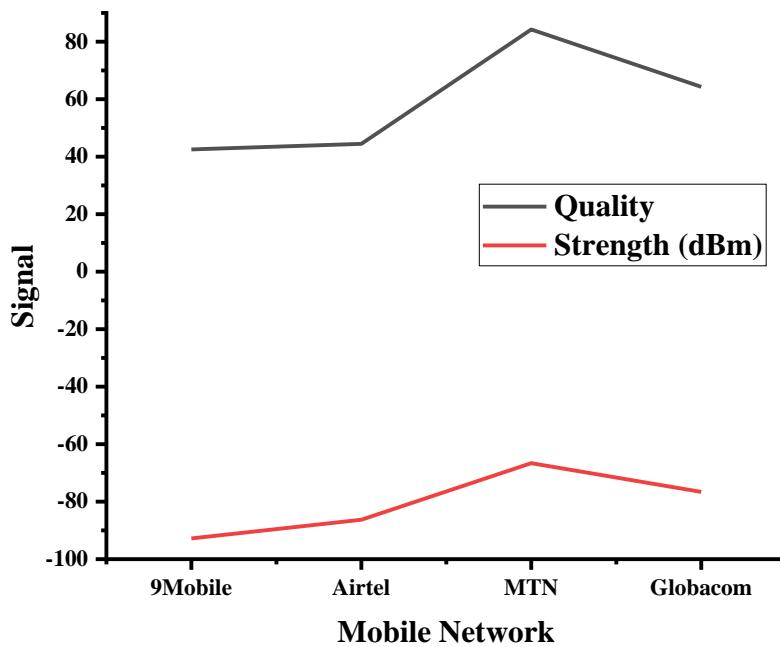
The mean values of signal strengths for the four networks in Oyo Town were compared statistically by one way Analysis of Variance (ANOVA) as presented in Table 3, Figure 1 and Figure 3. The network signals strength variability for MTN, Globacom and Airtel were not significant statistically as  $p > 0.05$ , while that of 9Mobile were statistically significant as  $p < 0.05$ . This illustrates significant network variations of 9Mobile across the city which is very bad for transactions and emergency communication. However, the strong signal strength of MTN, Globacom and Airtel in the study enhances good networking, business transaction, academic research and flourishing marketing across all the four local government areas in Oyo Town. The weak signal strength in the research area is associated to radio power attenuation, channel reuse, cellular multipath fading and signal limit factor problems.

**Table 4: GSM Network Signal Quality ANOVA Result in Oyo, Oyo State, Nigeria (2022) [16]**

Network Operators	Signal Quality ( $\bar{X}$ )	N	SD	DF	SS	Sig
9Mobile	42.54	50	1.9817	49	192.42	0.0466
Airtel	44.48	50	3.2866	49	529.28	0.0739
MTN	84.26	50	3.4982	49	599.62	0.3558
Globacom	64.28	50	2.8859	49	408.08	0.3174



**Figure 2: GSM Signal Quality Variability in Oyo**



**Figure 3: GSM Signal Strength and Quality Variability in Oyo**

The average mean values of signal quality for the four observed networks were also related statistically by ANOVA as presented in Table 4, Figure 2 and Figure 3. Result shows that the signal quality variability in MTN, Globacom as well as Airtel network in the city was not statistically significant as  $p > 0.05$ . This vindicated the impartially distribution of MTN, Globacom and Airtel signal quality and its insignificant variations across the entire city of Oyo Town. In contrast, the inconsistency in quality of 9Mobile network displays statistically significant values as  $p < 0.05$ . The weak signal quality results to poor communication, calls drop, echo and calls distortion across the research areas.

#### 4. CONCLUSION

The results obtained from the study reveals that the efficiency of every mobile cell call is a function of the signal strength and quality. The network signal strength and quality of MTN and Globacom are strong and effective in Oyo Metropolis. The Airtel recorded averagely fair signals with little fluctuation while the 9Mobile network was very weak and not encouraging with remarkable substantial echelons of signal instability perceived transversely in the entire local governments of Oyo City. MTN and Globacom networks were considered as the best dependable network in the ancient city of Oyo experiencing just minimal call falls, network failure and call biases. This is closely trailed by Airtel and 9Mobile system with maximum call drop, network outage and call distortions experienced by subscribers especially in Afijio and many parts of Oyo East Local Government areas. The research is limited to the four local

governments in Oyo (Atiba, Oyo West, Oyo East and Afijio Local Governments Areas) to examine the signal viability in rural, less urban and cities which represents the required areas of Oyo State.

This study recommended the installations of relevant facilities and Base Transceiver stations (BTS) to improve the strength and quality of the mobile network signals in the aforementioned areas. Generally, as a matter of urgency, there is a need for recurrent development and elevation of network boosters for all networks to lessen plunged calls, entree catastrophes, and dead zones for the effective business transaction, academic research and smooth running of day to day activities of the citizenries in Oyo.

### **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

### **AUTHORS' CONTRIBUTIONS**

Sheu, A. L. was the lead author that specialized on: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing-review & editing. Azeez, I. A., Aremu, O. A., Suleman, K. O. and Oyeshola H. O. all focused on Manuscript preparation, reviewing, and editing.

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