



SURVEY AND EVALUATION OF GSM NETWORKS IN NIGERIA.

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Abstract:

The article tries to identify the key performance indicators and exploited, the experimental/test methods of different GSM networks in Nigeria (MTN, Glo, Airtel and 9Mobile). The results revised show that the KPIs deviate from the recommended values both during the event and non-event period thus the QoS requires an uncompromising improvement in order to curtail further degradation in the services derived by the rapidly increasing subscribers' rate. Only few researchers have studied technical performance and evaluation of the GSM networks. The KPI adopted were Call Setup Time (CST), Call Setup Failure Rate (CSFR), Call Dropped Rate (CDR) and Call Completion Rate (CCSR). Most studies carried out on comparative analysis focused on subscriber's view of quality of service. It was observed that, Airtel has the lowest call setup failure rate across the different locations in the country. This shows comparatively that Airtel is the best. Therefore, going by the KPIs comparison we can infer that Airtel performed better than the other three networks (MTN, Glo and 9Mobile) within the selected locations and the study period from 2015 to 2020.

Keywords: GSM network; key performance indicators; assessment; service providers; quality of service

INTRODUCTION

Since the inception of GSM technology, its growth has been so rapid that Nigeria has been rightly described in various media as one of the fastest growing GSM markets in the world. One of the most important features of GSM operation noticed in the country is the constant growth of the number of subscribers. The year 2001, marked the advent of GSM (Global System for Mobile Communication) technology in Nigeria (Agubor *et al.*, 2016). Three

major players were licensed by the national regulator - Nigerian Communication Commission (NCC) to commence provision of GSM service. This heralded the dawn of a new era - the era of GSM technology. The three players initially were MTN, ECONET (now Airtel) and Mtel. GLO Mobile was later licensed as the fourth Operator. Etisalat (now 9mobile), another GSM provider, became the latest entrant and took the place of Mtel which became moribund and non-operational. Network expansion became massive and aggressive. Subscribers were increasing as mobile penetration reached new heights. This trend has the potential to pose serious problems if the growth of mobile subscribers is not adequately backed up with a corresponding growth in network infrastructure. In Nigeria, this has been the case which has resulted to subscribers' frequent complaints of the quality of service (QoS) rendered by the Operators (Idio *et al.*, 2013). It is because of these complaints that NCC as a regulator has been putting pressure on the Operators to improve on the quality of service offered to their numerous customers and had in several occasions threatened to sanction any Operator that fails to comply. The QoS provided has now become an issue which should be addressed by the Operators in order to retain their respective customer base. Agubor *et al.* (2016) have used four major evaluation parameters-accessibility, interconnectivity, through-switch and service availability to investigate the network performance and quality of service of some GSM networks in Nigeria. A similar method was also used by (Oyebisi and Abdul-Hameed, 2011) in their study of four different service providers in Nigeria. Their report assessed the available telecommunication facilities over a period and the corresponding annual increment in facilities and subscribers. The changes in the competitive landscape among these GSM network operators in Nigeria demonstrate the importance of identifying the determinants of sustainable performance in this sub-sector of the Nigerian telecommunications industry. Despite these, it has been observed that existing studies have not explored a comparative analysis using more than four key performance indicators of the GSM network. Performance evaluation are the most important to the mobile operators as the revenue generation and customer satisfaction are directly related to network performance and quality. The Network needs to be under continuous monitoring and control to maintain and improve the performance of the system (Kumar *et al.*, 2012).

This study is therefore set to investigate the performance of GSM service providers in relation to the QoS being rendered to the end users in the country. The four GSM Operators are MTN Nigeria Ltd, GLO and 9MOBILE. More in-depth analysis was made on the selected GSM networks and based on our findings; possible steps to improve this network are made.

REVIEW OF RELATED WORKS

Many research works had been carried out on quality of service (QoS) measurement, evaluation and performance on various key performance indicator parameters of Mobile Network Operators, causes and how to improve on such QoS. For example, Settapong *et al.* (2016), Yusuf *et al.* (2016), Suhail *et al.* (2017), Ujioghosa (2017) and Ukhurebor (2018) have studied the performance of GSM networks. These authors adopted different approach to collect data from the Mobile Network Operators for QoS, Network performance evaluation namely; Statistical Network data collection from Network Operation Centers (NOCs) and Drive Test models. Aliyu *et al.* (2018) carried out a study on the quality of service of mobile network operators within the Federal Polytechnic Bida campus. This evaluation was undertaken using some KPIs of mobile network services. These KPIs are: Call Setup Time (CST), Call Setup Failure Rate (CSFR), Call Dropped Rate (CDR) and Call Completion Rate (CCSR). Drive test method was used in this study. The work shows that the QoS rendered in the area of study for Mobile Users is not sufficient, unreliable and unsatisfactory. Recommendation was made in the paper on how to improve the QoS of Mobile Network Providers in this area. In (Alabi et al., 2017) a study on the GSM quality of service performance in Abuja Nigeria was carried out. The study investigates network transmission impairment and offers some useful remedies. Sony Ericson phone and transmission environment monitoring system are used to gather data on physical network impairments in selected densely populated areas of Abuja. The results obtained indicate that the quality-of-service performance of Airtel is slightly better than the other three GSM service providers tested within Nyanya, Gwagwalada and Wuse areas in Abuja. Dahunsi *et al.* (2018) evaluated the performance of mobile network operators in Akure metropolis, Nigeria. The result show that the quality of voice service offered by MNOs (network operator code) is not optimal and there is room for improved quality of service. Drive test approach and statistical method are used. The tools used includes; post processing software, transmission environment monitoring software (TEMs), laptop, USB cables, car inverter, GPS. In (Daniel and Joshua, 2018), a study was conducted on four mobile network operators (MTN, Vodafone, Tigo and Airtel) in some selected cities of Accra, Tema and Kumasi in Ghana. It was observed that some of the measured KPIs values were fairly close to the standard set by local (NCA) and the international regulator (ITU) indicating customer should experience fairly good service in those locations, while other values (Traffic channel congestion and call set up time were outside the standard set NCA and ITU which mean customer should experience poor QoS in these areas. Measurements are collected over network

peak time in each area in order to best capture the effects of congestion on call blocking, CSSR and CDR.

In past works, the KPI parameters were compared with the NCC benchmark and acceptable standard for data communication to see the compliances and also determine MNO with best quality of service. For the purpose of this Research, the following materials and tools were used (Table 1).

Table 1. The Key performance indicators and the set threshold (NCC, 2018)

KPI	Acronym	Definition	Target
Call setup success rate	CSSR	Number of the unblocked call attempts divided by the total number of call attempts (1 – blocking probability × 100)	≥ 98%
Traffic channel congestion (with and without handover)	TCH	Is the ratio of the number of unsuccessful TCH requests to the total number of TCH request attempts expressed as percentage	≤ 2% ≤ 4%
Call drop rate	CDR	CDR Is the number of dropped calls divided by the total number of call attempts (1 - Call Completion Ratio) × 100%	≤ 2%
Stand-alone dedicated channel congestion	SDCCH	Is a logical signaling channel that is used for call set-up. Once a call is successfully setup SDCCH is released and RTCH is assigned for the conversation	≤ 1%

Most studies carried out on comparative analysis focused on subscriber’s view of quality of service. Only few researchers have studied technical performance and evaluation of the GSM networks. Again, the few studies carried out on comparative analysis in terms of four key performance indicators are location bound limited to a town or state. This study shows the performance of the various GSM networks in the entire country.

METHODOLOGY

Analysis of variance (ANOVA) and descriptive statistics were the method of analysis most researchers employed. Some used SPSS software. However, this paper adopts the statistical multivariate technique known as principal components analysis (PCA) to evaluate the performance of the various GSM networks in Nigeria. Principal component analysis (PCA) is the process of

computing the principal components and using them to perform a change of basis on the data, sometimes using only the first few principal components and ignoring the rest. PCA is used in exploratory data analysis and for making predictive models. Based on the principal component scores, PCA can examine multivariate relationship and explain the variance in the data while reducing the number of variables to several groups of individuals (Wei *et al.*, 2011). The analysis was carried out using XLSTAT software version 2019.

In order to assess the performance levels of the GSM networks by PCA, the principal components of data set should be first identified. The principal components, which contain most part of information of assessed indexes, can present the GSM network with the best performance correctly.

RESULTS AND DISCUSSION

The summary of the PCA is shown in the Biplots of principal components analysis of the different GSM networks.

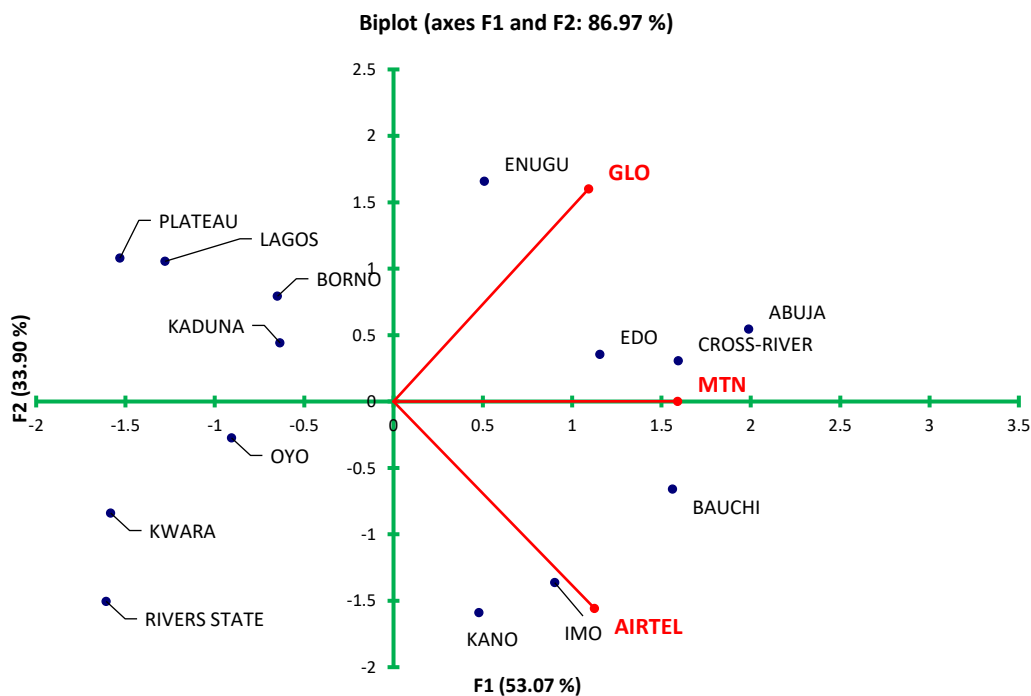


Figure 1. Biplots of principal components analysis of the different GSM networks

Figure 1. it shows the % of subscribers dialing three or more times before getting connected for MTN is very high in four states; Edo, Cross-river Bauchi and Abuja and is slightly high in the other states except Enugu, Kano and Imo were Glo and Airtel shows very high %. Therefore, we can infer that MTN has

more subscribers; for subscribers dialing three or more times before getting connected could have resulted from network congestion. It reveals that MTN subscribers experience network congestion more the other three networks. Several factors may have contributed to this; having too many subscribers, lack of adequate base stations, lack of adequate end to end system, lack of good phones etc.

Table 2. Call Set-up Success Rate (CSSR) [%]

GSM Network	Kano	Niger	Lagos	Abia	Abuja	Edo
MTN	93.08	81	98.2	69.15	94.08	63.02
Glo	89.8	62	91.8	72.88	96.8	87.58
Airtel	90.51	94	97.3	96.47	95.45	69.83
9Mobile	87.33	0	86	94.72	N/A	N/A

N/A - data not available

In Table 2. it shows that MTN has the highest call setup success rate in Kano and Lagos; Glo is high in Edo only; Airtel is high in Niger, Abia, and Abuja. Overall, Airtel has the highest CSSR from the selected locations (states were selected based on available data from past works).

Table 3. Call Set-up Failure Rate (CSFR) [%]

GSM Network	Kano	Niger	Lagos	Abia	Abuja	Edo
MTN	1.78	20	0	30.82	2.44	36.98
Glo	4.86	39	3.6	27.1	0.96	12.42
Airtel	2.89	6	1	3.7	0.98	30.17
9Mobile	5.05	100	2	5.3	N/A	N/A

In table 3, Airtel has the lowest call setup failure rate across the different locations in the country. This shows that Airtel is the best, this agrees with the CSSR result in Table 2.

Table 4. Call Success Rate (CSR) [%]

GSM Network	Kano	Niger	Lagos	Abia	Abuja	Edo
MTN	95	80	92.2	45.17	5.23	63.02

Glo	70	61	88.2	48.57	2.19	87.42
Airtel	94	89*	96.4*	92.03*	3.22	69.83
9Mobile	57	0	84	92	N/A	N/A

In Table 4. we can see that Airtel has the highest % of call success rate across the different states, followed by MTN, this confirms the outcome CSSR and CSFR as shown in Tables 2. and 3.

Assessment of GSM services from service providers' perspective is usually based on some Key Performance Indicators (KPIs). Lawal et al. (2016) utilized five major KPIs (CCSF, TCH-CR, CSSR, DCR, HOSR) to assess the GSM QoS provided by MTN, Nigeria. It was observed that the common experimental or test method used is the drive test while few researchers obtained their data from NCC. Also, some tests were carried out using TEM software; transmission environment monitoring software's. Meanwhile, Analysis of variance (ANOVA) and descriptive statistics were the method of analysis most researchers employed. The results show that the KPIs deviate from the recommended values both during the event and non-event period thus the QoS requires an uncompromising improvement in order to curtail further degradation in the services derived by the rapidly increasing subscribers' rate. In the works of Agubor et al. (2016) the key performance indicators (KPI) for determining the performance of each of the network provider. Using call drop rate (CDR), one of the performance indicators, it was observed that Etisalat had the least value of 0.6% of all the calls initiated during the test. Meanwhile, a more recent study carried out Galadanci and Abdullahi (2018) revealed that the four carriers failed to achieve NCC minimum targets for CSSR, HOSR and call blocking respectively. More than 40% of the samples had poor quality and the five coverage groups were defined, while group 1 and 5 were the best and worst groups respectively since it comprised both the best and poor network operation. The drive test maps were inspected and found out that the four carriers experienced one or more type of signal interruptions. In Lagos state, all the service providers have a high Call Completion Rate of above 90%. Airtel however, had the highest call completion rate indicating highest number of successful calls to the total number of calls initiated. However, in Borno state, the mean value of the signal strength received using the software application

shows that Network A with HSPA -91.91dB and GPRS -73.59Db is the best network in the academic area, Network B with HSPA - 87.27dB and GPRS - 73.43dB has the best network quality in the staff quarters and Network C with HSPA -88.73dB and GPRS -69.85dB is the best network in the student hostel, results above shows that the quality of signal strength depends on location (Adegoke et al., 2019). It was observed that some studies did not indicate the name of the GSM network, they used codes.

It was observed that, Airtel has the lowest call setup failure rate across the different locations in the country. This shows that Airtel is the best. Therefore, going by the KPIs comparison we can infer that Airtel performed better than the other three networks (MTN, Glo and 9Mobile) within the selected locations and the study period from 2015 to 2020 (see Tables 2 – 4). In the order of performance; Airtel, MTN, Glo and 9Mobile. However, MTN have more subscribers than the other three networks.

CONCLUSION AND RECOMMENDATION

Therefore, the network performance assessed in terms of Key Performance Indicators (KPIs) based on statistics generated from drive test measurements and customer feedbacks. The result expected to show that the network accessibility and retainability is unreliable and below regulatory agency's requirements. Airtel has the lowest call setup failure rate across the different locations in the country. This shows that Airtel is the best. Therefore, going by the KPIs comparison we can infer that Airtel performed better than the other three networks (MTN, Glo and 9Mobile) within the selected locations and the study period from 2015 to 2020. Based on the findings from the studies reviewed only one author has used SWOT analysis to analyze the performance one GSM network.

It is therefore recommended that SWOT analysis be used to compare multiple networks. SWOT analysis is a systematic process of determining the position of an organization by selecting some relevant key factors and issues and then considering the Strengths, Weaknesses, Opportunities and Threats in relation to that organization and its competitors. Also, more of the KPIs should be test on the performance analysis, because it was observed that most researchers utilize a maximum of five parameters while they are more than five.

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