**ANALYSIS OF QOS OF MTN AND GLO IN SOME SELECTED AREAS IN UMUAHIA ABIA STATE**

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**ABSTRACT**

This research is on the analysis of Quality of service (QoS) of MTN and GLO in Umuahia, Abia State, Nigeria. Umuahia environment was used as a test-bed for the drive test of this study. The investigation was conducted form June to November 2023. The GSM networks studied were MTN and Glo. The study was conducted using ASCOM infrastructure of Nigerian Communication Commission (NCC). The primary data obtained from this investigation was later compare with secondary data from NCC reference QoS dataset which gave the same result. Consequently, NCC Key Performance Indicators (KPI) data was leveraged in making the deductions. The result from the investigation shows that the bad quality of service came across by these operators was not entirely as a result of the traffic channel that is readily accessible but from other influences that include the congestion of the channels. Conclusively, the outcomes demonstrate that the call QoS outcomes in this research is still a far cry from the expectations of customers, and recommend that more concentration ought to be focused to enhancing the quality of service for greater effectiveness.

Keywords: Quality of service (QoS), GSM, KPI, Channels, Networks

**1.0 Introduction**

The socio-economic setting of Nigeria has been positively changed afterwards the rollout of wireless moveable offerings across Nigeria (Idigo *et al.,* 2020). The development and the overall voguism of wireless telecommunication treat by Nigerians produce giant earnings to the moveable Providers and to the authority in the course of reissuing license and tax fees. Evenly, the citizenries are not additionally forsaken regarding profit from the offerings of Wireless Telecommunication, not as a method of passing facts thousands of individuals had additionally benefited regarding job opportunities in Nigeria (Juwah, 2019).

Nonetheless, the network provided by these providers have continued to observe series of complains from the members regarding inadequacy of offerings (QoS) given in the state. The lamentable component of these circumstances is the fact that all the moveable members are continually impacted. On account of this issue, a few of members are undecided on that moveable Provider to sign to and consequently making the members to emigrate from one moveable contacts Provider to the other in look for of a greater offering (Kuboye, *et al.,* 2021)

The essential drive of this study is that the members also in Umuahia but additionally everywhere like to observe quick and dependable telecommunication business activities and get data for their finances (Odii and Onuoha 2018). This survey was undertaken as said by the inadequacy of articulate and information encounter in Umuahia. to have an idea on the reason for unreliable articulate and information and furnish several functional references.

2.0 LITERATURE REVIEW

2.1 QoS in GSM networks

The Quality of service may differ from situation to situation and from person to person. Quality consults to the classic of something when in comparison with other things like it, whereas, intends application, treat or facilities, or any mixture of these offerings, that is given remarkably for communications between contacts (Okonedo, 2018). Quality of service is the description or measurement of the general effectiveness of a network, as an example a telephony or device contacts or a cloud services, in particular the effectiveness seen by the users of the links. To quantitatively degree quality of service, various narrated facets of the connections are repeatedly considered (Olatokun and Nwonne, 2018). The definition of Quality of service only differ in verbiage but after all entails determining in-case perceived delivery meets, exceeds or fail to encounter member goal. it's basically the level of assured to a user.

Meanwhile, Opele *et al.,* (2020) defined QoS from the perspective of users as the level and trend of disagreement amongst the moveable Users perceptions and prospect, or the scope to that a service meets or exceeds possibility. Hence, Quality of service is the differences between members expectations and perceptions of service given by a provider (Aliyu *et al.,* 2018)

Fundamentally, Quality of Service (QoS) includes absence of intrusion and tones on the circuit, excellent quality speech, appropriate loudness point, elevated sign brawn, minimum call obstructing, minimum call dropping, highest handoff and excellent information rates for multi-media applications (Suhail *et al.*, 2107).

Meanwhile, all these influences have not been accomplished perfectly in the Telecommunication industry. Making an accomplished call without interruption is a main dream of all mobile subscribers. This, but sometimes, had not been conceivable because of inadequacy encounter by the e users (Suhail *et al.*, 2017)

Agubor *et al.,* (2016) utilized guide test procedure to assess quality of service of mobile network operators in Lagos state in which three major towns Ikoyi, Abule-Egba and Agege were covered. Call Drop Rate (CDR), among the effectiveness indicators was measured in this work. It was complied with that Etisalat had the fewest worth of 0.6% of all the calls started whilst the test. The weaknesses of this work were that one performance indicators were assessed as against this work where Eight performance indicators were measured.

**2.2 QoS perceived by the mobile users**

This expresses the mobile user’s insight of the quality levels that are obtained or encountered, that are generally denoted by the amount of approval and not in the technical terms. Hence, the levels of QoS as perceived by the mobile users must be interpreted into QoS influences to match the rest of perspectives. Call Setup Time (CST), Call Drop Rate (CDR), Call Setup Success Rate (CSSR), and Call Setup Failure Rate (CSFR) are some of the KPI parameters used in evaluating and estimating the QoS alleged by the mobile user for a mobile service provider as it seriously affects the users experience and expectation, (Gopal and Kuppusamy, 2015)

**3.0 Materials and Method**

For the purpose of this Research, the following materials were used:

i. Ascom equipments, a leading provider of Mission-Critical Communications Network Testing division

ii.Trace mobile: A mobile supporting GSM and GPRS equipped with special software.

**iii.** Global Positioning System(**GPS**): It is a satellite system that provides users with location of the measurement point

**iv.**  Personal Computer (**PC)**: It is a computer equipped with interface carte RS 232 in order to make the link between the serial output of the MS and the serial port of the PC.

Umuahia environment was used as a test-bed for the drive test of this study. The investigation was conducted form June to November 2022. The GSM networks studied are MTN and Glo. The study was conducted using ASCOM infrastructure of NCC. The primary data obtained from this investigation was later compare with secondary data from NCC reference QoS dataset which gave the same result (NCC, 2017). Consequently, NCC KPI data was leveraged in making the deductions.

**a. Call set up success rate**

 This is the ratio of the number of successful seizure of Standalone Dedicated Congestion Channel (SDCCH) to the total number of request of seizure. Call set up success rate is given as shown in equation (1).

$CSSR=\frac{N\_{sz}}{N\_{RZ}}$ (1)

Where $C\_{sr}$ is the Call set up success rate, $N\_{sz}$ is the number of successful seizure of SDCCH, $N\_{RZ}$ is the total number of request of seizure.

b. **Call drop rate**

This metrics determines the rate of calls that was not successfully complete. It is given as shown in equation (2).

$$CDR=\frac{TCH\_{a}}{TCH\_{b}} (2)$$

Where CDR is the Call Drop Rate**,** $TCH\_{a}$ is the channel drop rate after assignment, and $TCH\_{b}$ is the channel drop rate before assignment.

**c. Rate of successful handover (**$H\_{sr}$**)**

This metrics defines the rate of successful handover calls. It is given as shown in equation (3).

$$ H\_{sr}=\frac{N\_{sr}}{T\_{hr}} (3)$$

Where$H\_{sr}$, is the rate of successful handover, $N\_{sr}=intracell+intercell hand over$ and $T\_{hr}$ is the total number of handover request

**d. Call completion rate**

This defines the rate of successful completion of incoming and outgoing calls. This index is calculated as shown in equation (4).

$$CCR=\frac{C\_{s}}{C\_{r}} (4)$$

Where CCR, is the Call Completion Rate, $C\_{s}$ is the incoming calls, $C\_{r}$ is the outgoing calls.

**e. Call quality factor**$\left(C\_{qf}\right)$

This index is gives the call quality ratio. It is given as shown in equation (5).

$$C\_{qf}=\frac{N\_{ra}}{N\_{c}} (5)$$

Where $C\_{qf}$ is the Call Quality Factor,$N\_{ra}$ is the total number of abandonment rate, $N\_{c}$ is total number of calls.

**h. Call arrival rate (**$C\_{R}$**)**

This is the total number of calls a contact center receives within a specific time period. The time frame can be expressed by day, hour, or minute. This metric is given as shown in equation (6).

$$C\_{r}=\frac{N\_{c}}{T\_{t}} (6)$$

Where $C\_{R}$ is the Call Arrival Rate,$N\_{c}$ is the total number of calls, $T\_{t}$ is total time.

Table 1: Average QoS KPI’s data set for the various network operators in Umuahia, Abia State, Nigeria in June, 2023.

|  |  |  |  |
| --- | --- | --- | --- |
| KPI | NCC | MTN NIG | GLO NIG |
| CSSR | **0.9** | **0.89** | **0.86** |
| HSR | **0.9** | **0.8** | **0.9** |
| CDR | **0.02** | **0.04** | **0.05** |
| AUR | **1** | **0.9** | **0.81** |
| AWT | **0.5** | **0.65** | **0.68** |
| CQF | **0.98** | **0.90** | **0.75** |

Table 2 shows the average QoS KPIs data set for the various network operators in Umuahia, Abia State, Nigeria in July 2023.

Table 2: Average QoS KPI’s data set for the various network operators in Umuahia, Abia State, Nigeria in July, 2023.

|  |  |  |  |
| --- | --- | --- | --- |
| KPI | NCC | MTN NIG | GLO NIG |
| CSSR | **0.9** | **0.88** | **0.90** |
| HSR | **0.9** | **0.79** | **0.91** |
| CDR | **0.02** | **0.036** | **0.057** |
| AUR | **1** | **0.93** | **0.85** |
| AWT | **0.5** | **0.51** | **0.321** |
| CQF | **0.98** | **0.93** | **0.891** |

Table 3 shows the average QoS KPIs data set for the various network operators in Umuahia, Abia State, Nigeria in August 2023.

Table 3: Average QoS KPI’s data set for the various network operators in Umuahia, Abia State, Nigeria in August 2023

|  |  |  |  |
| --- | --- | --- | --- |
| KPI | NCC | MTN NIG | GLO NIG |
| CSSR | **0.9** | **0.92** | **0.90** |
| HSR | **0.9** | **0.78** | **0.89** |
| CDR | **0.02** | **0.03** | **0.033** |
| AUR | **1** | **0.94** | **0.83** |
| AWT | **0.5** | **0.54** | **0.61** |
| CQF | **0.98** | **0.89** | **0.91** |

Table 4 shows the average QoS KPIs data set for the various network operators in Umuahia, Abia State, Nigeria in September 2023.

Table 4: Average QoS KPI’s data set for the various network operators in Umuahia, Abia State, Nigeria in September 2023

|  |  |  |  |
| --- | --- | --- | --- |
| KPI | NCC | MTN NIG | GLO NIG |
| CSSR | **0.9** | **0.95** | **0.90** |
| HSR | **0.9** | **0.85** | **0.93** |
| CDR | **0.02** | **0.05** | **0.01** |
| AUR | **1** | **0.92** | **0.83** |
| AWT | **0.5** | **0.5** | **0.3** |
| CQF | **0.98** | **0.91** | **0.91** |

Table 5 shows the average QoS KPIs data set for the various network operators in Nigeria in October 2023.

Table 5: Average QoS KPI’s data set for the various network operators in Umuahia, Abia State, Nigeria in October 2023

|  |  |  |  |
| --- | --- | --- | --- |
| KPI | NCC | MTN NIG | GLO NIG |
| CSSR | **0.9** | **0.9** | **0.874** |
| HSR | **0.9** | **0.891** | **0.91** |
| CDR | **0.02** | **0.033** | **0.03** |
| AUR | **1** | **0.9** | **0.88** |
| AWT | **0.5** | **0.25** | **0.40** |
| CQF | **0.98** | **0.98** | **0.83** |

Table 6 shows the average QoS KPIs data set for the various network operators in Umuahia, Abia State, Nigeria in November 2023.

Table 6: Average QoS KPI’s data set for the various network operators in Umuahia, Abia State, Nigeria in November 2023.

|  |  |  |  |
| --- | --- | --- | --- |
| KPI | NCC | MTN NIG | GLO NIG |
| CSSR | **0.9** | **0.93** | **0.91** |
| HSR | **0.9** | **0.80** | **0.9** |
| CDR | **0.02** | **0.013** | **0.033** |
| AUR | **1** | **0.91** | **0.83** |
| AWT | **0.5** | **0.373** | **0.264** |
| CQF | **0.98** | **0.94** | **0.92** |

**4.0 RESULTS AND DISCUSSION**

Figure 1 shows the plot of the various network operators KPI data set in Umuahia, Abia State, Nigeria in the Month of June, 2023.



Figure 1: KIP data set in Umuahia, Abia State, Nigeria in the Month of June, 2023.

From figure 1, the NCC benchmark for CSSR in the month of June was 0.9. MTN CSSR was 0.89, and Glo was 0.86. MTN were very close to the NCC benchmark. The Glo’s CSSR of 0.86 was less below the NCC benchmark of 0.9. Therefore, in the Month of June, MTN results for CSSR were the best for the selected networks. The NCC benchmark for HSR in the Month of June was 0.9. MTN has a HSR of 0.8 and Glo was 0.9. The results show that Glo has a better HSR as compared to MTN. The NCC benchmark for CDR in the Month of June was 0.02. MTN has a CDR of 0.04 and Glo was 0.05. From the results, it shows that the Glo has the worst CDR in the month under review.

The NCC benchmark for AUR for the month of June was 1. MTN AUR was 0.9, while Glo has AUR result of 0.81. The result shows that MTN result was the best for the month of June. The NCC benchmark for AWT in the month of June was 0.5. MTN and Glo AWT results were 0.65 and 0.68 respectively for the month under review. This implies that none of the networks was able to attain a benchmark close to NCC stipulation in the month of June. The CQF specified by NCC in the month of June was 0.98. MTN has a CQF of 0.90, Glo result for CQF was 0.75. This implies that Glo network has the worst CQF, while MTN has a better CQF in the Month of June.

From the results of the KIP above, it was seen that none of the networks was able to reach or exceed the KIP standard set by NCC in the month of June, except Glo that reached the NCC HSR of 0.9 in the month of June.

Figure 2 shows the plot of the various network operators KPI data set in Umuahia, Abia State, Nigeria in the Month of July, 2023.



Figure 2: KPI data set in Umuahia, Abia State, Nigeria in the Month of July, 2023.

From Figure 2, the benchmark of the NCC set for CSSR in the month of July was 0.9. MTN has a CSSR of 0.88 and Glo 0.9. This implies that the Glo network is better in terms of the CSSR in the month of July. The HSR specified by NCC for the month of July was 0.9. MTN has HSR of 0.79 and Glo 0.91. This implies that in the month under review, Glo has a better HSR than other networks, while MTN has the worst HSR in the same month. The NCC benchmark for CDR for the month of July was 0.02. MTN has a CDR of 0.036 and Glo was 0.057. From the result, it could be seen that the Glo network has the worst CDR in the month of July. Also the benchmark set by NCC for AUR in the month of July was 1. MTN and Glo results of AUR were 0.93 and 0.85 respectively. From the result, it could be seen that MTN has the best AUR, while Glo has the worst AUR in the month of July. The NCC AWT for the month of July was 0.5. MTN and Glo result for AWT for the same month was 0.51 and 0.321 respectively. The result shows that Glo has the best AWT in the month of July. The NCC CQF result for month of July was 0.98. MTN and Glo results for CQF in the month of July were 0.93 and 0.891 respectively. The result shows that Glo has a better CQF as compared to MTN in the month of July. The entire results of comparison in the month of July shows that most of the networks considered failed to reach or exceed the recommended NCC benchmark for the various KPIs in the month of July. Glo CSSR and HSR reached the NCC benchmark of 0.9 and 0.91 respectively. Also the AWT of Glo was 0.321, which was better than that of NCC with AWT of 0.5.

Figure 3 shows the plot of the various network operators KPI data set in Umuahia, Abia State, Nigeria in the Month of August, 2023.



Figure 3: KPI data set in Umuahia, Abia State, Nigeria in the Month of August, 2023.

As seen in Figure 3, the NCC CSSR for the month of August was 0.9. MTN has CSSR of 0.92 and Glo was 0.90. The result shows that the MTN CSSR exceeded the NCC benchmark in the month of August. The HSR for NCC in the month of August was 0.9. MTN has HSR of 0.78, and Glo, 0.89. The result implies that none of the network reached the stipulated NCC benchmark in the month of August. MTN has the worst HSR in the month under review. The NCC benchmark for CDR in the month of August was 0.02. MTN has CDR of 0.03 and Glo 0.033. This shows that none of the network operators was able to attain the NCC CDR specification in the month of August. The NCC AUR specification for the month of August was 1. MTN AUR was 0.94 and Glo was 0.83. The result shows that MTN has a better AUR than Glo in the month of August. In the month of August 2023, the NCC AWT was set at 0.5, MTN, and Glo was 0.4 and 0.61 respectively. In this month, Glo has the worst AWT in the month under review. The NCC benchmark for CQF in the month of August was 0.98. MTN and Glo results were 0.89 and 0.91 respectively. From the result, it was seen that Glo has a better CQF than MTN and the computational results.

From the summary of the results of the KPI data of the selected network in August 2023, it could be seen that MTN has a better CSSR which exceeds that of NCC. In terms of other KPI parameters, none of the network operators was able to reach the standard set by the NCC.

Figure 4 shows the plot of the various network operators KPI data set in Umuahia, Abia State, Nigeria in the Month of September, 2023.



Figure 4: KPI data set in Umuahia, Abia State, Nigeria in the Month of September, 2023.

Considering the month of September as shown in Figure 4, the NCC CSSR standard was 0.9, MTN 0.95, and Glo was 0.9. From the result, it was seen that MTN outperformed both the NCC benchmark and Glo CSSR of 0.9. The HSR standard set by NCC was 0.9. MTN has HSR of 0.85 and Glo was 0.93. The result shows that Glo network has the best HSR while MTN has the worst HSR in the month under review. The CDR data set of NCC for the month of September was 0.02. MTN has a CDR of 0.05 and Glo was 0.01. The data shows that Glo has the best CDR, while MTN has the worst CDR in the month of September. Considering the data set for AUR, NCC benchmark was 1, MTN 0.92 and Glo was 0.83. From the results, it could be seen that MTN has a better AUR, while Glo has the worst AUR in the month of September. The NCC benchmark of AWT in the month of September was 0.5, MTN 0.5 and Glo 0.3. The results show that the Glo network has the best AWT in the month of September, 2023. The NCC benchmark for CQF in the month of September was 0.98, MTN and Glo was 0.91 respectively. The result shows that none of the networks was able to reach the CQF set by NCC in the Month of September. From the results of the data set analyzed in the month of September, it could be seen that Glo has the best CDR, while MTN has the best CSSR in the month under review.

Figure 5 shows the plot of the various network operators KPI data set in Umuahia, Abia State, Nigeria in the Month of October, 2023.



Figure 5: KPI data set in Umuahia, Abia State, Nigeria in the Month of October, 2023.

From figure 5, the NCC benchmark for CSSR in the month of October was 0.9. MTN has CSSR of 0.9 and Glo 0.874. The result shows that both the MTN reached the benchmark set by the NCC, while Glo was lagging behind the benchmark. The HSR set by NCC for the month of October was 0.9. MTN has a HSR 0f 0.891, while Glo was 0.91. The result shows that the Glo network has the best HSR, while MTN has the worst HSR in the month under review. The NCC benchmark for CDR in the month of October was 0.02. MTN has CDR of 0.033 and Glo 0.03. The result shows that the entire network failed to attain the NCC CDR benchmark 0f 0.02 in the month of October. The NCC benchmark for AUR in the month of October was 1. MTN has AUR of 0.9 and Glo 0.88. The result shows that MTN has a better AUR than the other networks in the month of October 2023. The NCC AWT standard in the month under consideration was 0.5. MTN has an AWT of 0.25 and Glo 0.40. The result shows that all the considered networks superseded the NCC’s AWT of 0.5 recommended in the month of October, with MTN taking the lead. The benchmark set by NCC for CQF in the month of October was 0.98. MTN has a CQF of 0.98, and Glo 0.83. The results show that MTN reached the set target of NCC, while Glo was behind the standard set by NCC in the month of October. From the entire data analysis, it could be seen that the networks performed better in terms of AWT as compared to NCC benchmark. MTN performed very well in CSSR, AUR, AWT and CQF, while Glo is better in the area of HSR.

Figure 6 shows the plot of the various network operators KPI data set in Umuahia, Abia State, Nigeria in the Month of November, 2023



Figure 6: KPI data set in Umuahia, Abia State, Nigeria in the Month of November, 2023.

From figure 6, the NCC CSSR for the month of November was 0.9. MTN has a CSSR of 0.93 and Glo 0.91. From the result, it could be seen that both MTN and Glo outperformed the CSSR standard set by NCC in the month of November. The HSR standard set by NCC in the month of November was 0.9. MTN has HSR of 0.8 and Glo was 0.9. The result shows that Glo network has a better HSR than the other networks in the month under review. In the same month, the CDR standard set by NCC was 0.02. MTN has a CDR of 0.013 and Glo 0.033. The result shows that MTN has the best CDR in the reviewed month. The NCC benchmark for AUR in the month of November was 1. MTN has AUR of 0.91 and Glo 0.83. The result shows that MTN has a better AUR than other networks. It could be seen that none of the networks was able to reach the standard set by NCC for AUR in the month of November. In the month of November 2023, the NCC AWT was set at 0.5. MTN and Glo were 0.373, and 0.264 respectively. The data set shows that the entire network performed better than the NCC benchmark with Glo having the best AWT. The NCC benchmark for CQF in the month of November was 0.98. MTN has a CQF of 0.94 and Glo was 0.92. From the result, it could be seen that none of the network reached the CQF benchmark set by the NCC in November, 2023.

The entire result of November 2023 shows that MTN performed better than other networks in the areas of CSSR, while the AWT of Glo was 0.264 which was better than that of NCC.

**5.0 CONCLUSION**

It was complied with that these connections operators need to enhance the quality of service provided to their teeming customers. The call drop rate and call set-up rate were elevated for the two contacts operators as at the time of this survey. It is displayed that the traffic channel was readily accessible whilst the period of investigation and evaluation and the handover success rate was agreed to accept judging by the NCC standard.

It could be inferred from the investigation that the bad quality of service came across by these operators is not therefore the traffic channel that is readily accessible but from other influences that include the congestion of the channels. But sometimes, more concentration ought to be focused to enhancing the quality of service for greater effectiveness. Conclusively, the outcomes demonstrate that the call QoS outcomes in the place of survey is still a far cry from the expectations of customers.

**REFERENCES**

Agubor, C. K. , Chukwuchekwa, N.C, Atimati, E. E., Iwuchukwu, U. C., & Ononiwu, G. C. (2016). Network Performance and Quality of Service Evaluation of GSM Providers in Nigeria: A Case Study of Lagos State. International Journal Of Engineering Sciences & Research Technology (IJESRT) 3(9), 256 -263

Aliyu, A. N., Alenoghena, C.O., Salihu, A.B., Mahmood, M. K., &Onu,C. (2018).Performance Analysis of Mobile Network Services: A Case Study on the Federal Polytechnic Bida, Nigeria. International Journal of Information Processingand Communication (IJIPC), 6 (1), 56-66 Suhail *et al.*, 2107)

Gopal, B.G., &Kuppusamy, P.G.,(2015).A Comparative Study on 4G and 5G Technology for Wireless Applications. IOSR Journal of Electronics and Communication Engineering (IOSR JECE), 10 ( 6), 67-72

Idigo V.E., Azubogu A.C.O., Ohaneme C.O. and Akpado K.A. (2020). Real-Time Accessments of QoS of mobile cellular Networks in Nigeria. International Journal of Engineering Inventions, 4: [www.ijeijournal.com](http://www.ijeijournal.com), pp.64-*6*8.

Juwah, E. (2019). Implementation of Mobile Number Portability in Nigeria. Office of the Executive Vice-Chairman/CEO Nigerian Communications Commission- pp.64-*6*8.

Kuboye B.M, Alese B.K, and Fajuyigbe O. (2021) “Congestion Analysis on the Nigerian Global system for Mobile Communications (GSM) Network”- Pacific Journal of science and tech.

Nigerian Communications Commission (2017). Nigerian Communications Act 2017 Mobile Number Portability Regulations 2017. Retrieved from [http://www.ncc.gov.ng/index.php?option=com/67. Accessed 14 September 2021](http://www.ncc.gov.ng/index.php?option=com/67.%20Accessed%2014%20September%202021).

Odii J.N. and Onuoha C. ( 2018). A Review of Number Portability in Global System for Mobile. African Journal of Computing & ICT, Vol 5. No. 3. Pp. 15-22.

 Okonedo B. (2018) NCC moves to implement number portability. *Business Day*, [On-line] June 22, 2018. http://businessdayonline.com/ARCHIVE/index.php?option=com\_content&view=section&layout=blog&id=14&Itemid. Accessed 14 September 2021.

Olatokun W., and Nwonne, S. (2018) Determinants of Users’ Choice of Mobile Service Providers in the Nigerian Telecommunications Market” African Journal of Computing & ICT, Vol 5. Pp213-224

Opele, A.M., Afolabi, O. J. , and Adetayo, H. O., (2020). Service quality and preference for mobile Telecommunications service providers among students of tertiary institutions in Lagos state. Nigerian Journal of Technology (NIJOTECH) 39 (2), 484 – 492

Suhail, A. M., Maaruf, A.,AbdelRahman, H. H.,Mahdi,H.M., &Muzafar,A.G. (2017). Simulation and Analysis of Quality of Service (QoS) Parameters of Voice over IP (VoIP) Traffic through Heterogeneous Networks. International Journal of Advanced Computer Science and Applications (IJACSA), 8( 7),242 -248