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Quality of Service (QoS) Assessment and User Satisfaction in Telecommunication Networks across Edo State, Nigeria.

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ABSTRACT
This study investigated telecommunication networks in Edo State, Nigeria, aiming to assess the quality of service (QoS) levels and their impact on user satisfaction. The quality of service (QoS) provided by networks is a pivotal factor influencing user experiences and overall satisfaction. By administering structured questionnaires to telecommunication service users and employing a stratified sampling technique, this study captures quantitative data on user perceptions, preferences, and experiences. The research employs descriptive statistics, correlation analysis, and multiple regression analysis to uncover insights into the factors influencing user satisfaction. The findings reveal different levels of QoS across various network parameters, with network reliability, call quality, and data speeds emerging as significant determinants of user satisfaction. The regression analysis highlights the predictive power of these factors on user satisfaction, with call quality and overall network reliability demonstrating the most substantial impact. Additionally, demographic and experiential factors such as gender, age group, education level, and area of residence influence user perceptions but to a lesser extent compared to QoS metrics. The study provided recommendations aimed at enhancing infrastructure, optimizing network performance, improving call quality and data speeds, enhancing customer service, promoting digital literacy, engaging with communities, and fostering collaboration among stakeholders. These recommendations provide strategic guidance for telecommunication service providers, regulatory bodies, and policymakers to address challenges and improve user satisfaction in telecommunication networks across Edo State, Nigeria.

Keywords: Quality of Service (QoS), Telecommunication Networks, User Satisfaction, Edo State.

I. INTRODUCTION

The world has become a global village with telecommunication being an indispensable tool in the entire process of globalization [1]. Recently, mobile telephony has become one of the fastest growing and most demanding telecommunications applications especially since the introduction of the second generation (2G)-based Global System for Mobile communications (GSM) [2]. Telecommunication networks have revolutionized the way societies connect, communicate and conduct business, becoming an indispensable part of modern life. In Nigeria, the rapid expansion of telecommunication infrastructure has played a crucial role in bridging geographical divides, enabling digital transactions and enhancing access to information. After more than a decade of mobile phone operation in Nigeria, the network has witnessed improvement in terms of better coverage and availability but the quality of service (QoS) generally is still not being satisfactory, especially during major events when there is mobility of people [3, 4]. Edo State, situated in the southern region of Nigeria, represents a dynamic landscape where the influence of telecommunication networks is particularly pronounced. With a population of over three million people, Edo State represents a significant market for telecommunication service providers, making it imperative to understand the dynamics of QoS and user satisfaction within this context.

The quality of service (QoS) offered by telecommunication networks has emerged as a critical determinant of user experiences and satisfaction. QoS encompasses a range of performance indicators, including network reliability, data speeds, call quality and accessibility. One of the challenges of quality of

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service in telecommunication is congestion [5]; congestion in telecommunication engineering means the unavailability of network resources (bandwidth, frequency, time and code slots or power) when the subscribers requested the resources for use to initiate call in GSM network [6]. The attainment of satisfactory QoS levels is imperative for meeting user expectations and enabling seamless communication and data usage. Cellular network performance and QoS evaluation are the most important steps for mobile operator as the revenue and customer satisfaction is directly related to network quality and performance [4, 7].

As technology evolves and user expectations escalate, there often exists a gap between the promised QoS and the actual service delivered. When perceived service quality falls short of expectations, a service quality gap occurs [8]. This gap can be attributed to factors such as network congestion, infrastructure limitations and technical challenges. This discrepancy is not unique to Edo State; it is a global concern faced by telecommunication providers striving to meet the demands of an increasingly digitally connected population. The relationship between QoS and user satisfaction is intricate. Users have become familiar with dependable and consistent telecommunication services. When QoS falls short of expectations, it can lead to frustrations, disrupted communication and negative perceptions of service providers. Conversely, satisfactory QoS fosters positive user experiences, enabling seamless voice calls, smooth internet browsing and efficient data transactions.

Given Edo State's regional significance and the transformative role of telecommunication networks, understanding the QoS dynamics and its impact on user satisfaction becomes imperative. This study investigated the intricacies of QoS assessment and user satisfaction within the telecommunication networks of Edo State. By doing so, it aims to contribute data-driven insights that can guide improvements in service quality, policy formulation and resource allocation.

II. RESEARCH METHODOLOGY

A. Study Area

The study was conducted in Edo State, Nigeria, focusing on urban, suburban and rural areas within the state. Edo State is located in the southern region of Nigeria, bordered by Kogi and Anabra State to the East, Ondo State to the west, Delta State to the South, and Kogi State to the North. It lies approximately between Latitude 5°44'60"N to 7°33'45"N and Longitude 5°05'45"E to 6°38'18"E. The capital city of Edo State is Benin City, which serves as a major urban center and administrative hub. According to the 2006 census, Edo State has a population of 3,233,366 persons [9].

B. Method of Data Collection

The method of data collection for this research involves the administration of structured questionnaires to telecommunication service users in Edo State, Nigeria. These questionnaires were designed to gather quantitative data on users' perceptions of Quality of Service (QoS) and overall satisfaction with telecommunication services. The questionnaires encompass various aspects; including network reliability, call quality, data speeds, and overall satisfaction levels. To ensure a comprehensive representation of the telecommunication user population, a stratified sampling technique was employed. This approach aims to capture diversity across different regions and demographics within the state, thereby enhancing the applicability of the findings. Through the systematic administration of questionnaires and strategic sampling, the research seeks to gather reliable and representative data, enabling a thorough analysis of QoS dynamics and user satisfaction levels in Edo State's telecommunication networks.

C. Sample Size and Sampling Technique

The sample size and sampling technique for the study were meticulously determined to ensure the robustness and representativeness of the data collected. With a population size of 280 telecommunication service users spread across urban, suburban, and rural areas of Edo State, cluster sampling with Neyman allocation was utilized to select respondents. Cluster sampling involves dividing the population into clusters based on geographical regions or other natural groupings and then randomly selecting entire clusters to participate in the study. Neyman allocation, a method commonly employed in cluster sampling, allows for the allocation of sample size across clusters proportionally to their size within the population. This approach ensures that each geographical area is adequately represented in the sample, reflecting the diversity of telecommunication usage patterns and preferences across different urban, suburban, and rural settings within Edo State.

The Neyman Allocation formula is as follows:

$$nh = \frac{Nh}{N} \times n$$

where:

nh = sample size for cluster h

Nh = total population size of cluster h

N = total population size

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n = total sample size

D. Data Analysis

The methods of data analysis in this research were descriptive statistics, correlation and multiple regression analysis.

a. Descriptive Statistics

Descriptive statistics served as the initial step in analyzing the collected data, providing a clear summary and understanding of key features such as central tendency, variability, and distribution of the variables related to Quality of Service (QoS) and user satisfaction in telecommunication networks across Edo State, Nigeria. Measures such as mean, median, mode, and range was calculated to describe the data, offering insights into the overall patterns and characteristics observed. Additionally, frequency distributions and graphical representations were utilized to visually present the data and identify any notable trends or outliers. Descriptive statistics facilitate a comprehensive overview of the dataset, enabling researchers to identify potential areas of interest and focus for further analysis.

b. Correlation Analysis

Correlation analysis was conducted to examine the relationships between different QoS metrics and user satisfaction levels within the telecommunication networks of Edo State. This statistical technique assessed the strength and direction of associations between pairs of variables, providing insights into which QoS parameters are most strongly correlated with user satisfaction. Pearson's correlation coefficient was computed based on the nature of the variables and the assumptions of the data. Correlation analysis helps to identify potential patterns and dependencies within the dataset, guiding the selection of variables for inclusion in the subsequent multiple regression analysis.

c. Multiple Regression Analysis

Multiple regression analysis was employed to model the relationship between multiple QoS metrics and user satisfaction, taking into account the simultaneous effects of several independent variables on the dependent variable. This statistical technique permits the examination of how changes in QoS metrics, such as network reliability, call quality, and data speeds, collectively predict changes in user satisfaction scores within the telecommunication networks of Edo State. Through the estimation of regression coefficients and their associated significance levels, multiple regression analysis provided insights into the relative importance of each QoS metric in influencing user satisfaction, controlling for the effects of other variables.

III. RESULTS AND DISCUSSION

3.1 Results

The presented tables encapsulate the findings of a comprehensive survey conducted in 2024, aiming to explore various facets of network usage and user satisfaction among respondents. Covering a diverse array of demographic and experiential factors, the tables provide a detailed overview of the surveyed population. Beginning with the gender distribution in Table 1, the subsequent tables explore the age demographics, educational background, and residential distribution of the respondents in Tables 2, 3, and 4, respectively. Moving forward, Tables 5 and 6 examine the details of network service providers and quality of service assessment, shedding light on user preferences and experiences. The assessment culminates in Table 7, illuminating user satisfaction levels with network providers, thus presenting a comprehensive overview of the survey findings.

Table 1: Gender of Respondents

Sex	Frequency	Percentage	Valid percentage	Cumulative Percentage
Male	182	65	65	65
Female	98	35	35	100
Total	280	100	100	

Source: Field Data, 2024.

Table 2: Age of the Respondents

Age Group (Yrs)	Frequency	Percentage	Valid percentage	Cumulative Percentage
20 and Below	33	11.8	11.8	11.8
21 – 30	82	29.3	29.3	41.1
31 – 40	66	23.6	23.6	64.7

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41 – 50	54	19.3	19.3	84
51 – 60	32	11.4	11.4	95.4
61 and above	13	4.6	4.6	100
Total	280	100	100	

Source: Field Data, 2024.

Table 3: Respondents' Level of Education

Level of Education	Frequency	Percentage	Valid percentage	Cumulative Percentage
Primary	Nil	0	0	0
Secondary	28	10	10	10
First Degree	182	65	65	75
Masters	70	25	25	100
PhD	Nil	0	0	
Total	280	100	100	

Source: Field Data, 2024.

Table 4: Area of Residence in Edo State

Area of Residence	Frequency	Percentage	Valid percentage	Cumulative Percentage
Urban	105	37.5	37.5	37.5
Sub-Urban	133	47.5	47.5	85
Rural	42	15	15	100
Total	280	100	100	

Source: Field Data, 2024.

Table 5: Users Service Provider(s)

Users Service Provider(s)	Frequency	Percentage	Valid percentage	Cumulative Percentage
MTN	42	15	15	15
GLO	35	12.5	12.5	27.5
Airtel	7	2.5	2.5	30
GLO + Airtel	7	2.5	2.5	32.5
9Mobile + Airtel	7	2.5	2.5	35
MTN + GLO	133	47.5	47.5	82.5
MTN + GLO + Airtel	49	17.5	17.5	100
Total	280	100	100	

Source: Field Data, 2024.

Table 6: QoS Assessment

Reliability of Network (Scale: 1-5, with 1 being very poor and 5 being excellent)	Frequency	Percentage	Valid percentage	Cumulative Percentage
Scale 1	7	2.5	2.5	2.5
Scale 2	49	17.5	17.5	20
Scale 3	140	50	50	70
Scale 4	63	22.5	22.5	92.5
Scale 5	21	7.5	7.5	100
Total	280	100	100	
Call Quality of Network (Scale: 1-5, with 1 being very poor and 5 being excellent)	Frequency	Percentage	Valid percentage	Cumulative Percentage
Scale 1	28	10	10	10
Scale 2	14	5	5	15

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Scale 3	126	45	45	60
Scale 4	84	30	30	90
Scale 5	28	10	10	100
Total	280	100	100	
Data Speed of Network (Scale: 1-5, with 1 being very poor and 5 being excellent)	Frequency	Percentage	Valid percentage	Cumulative Percentage
Scale 1	42	15	15	15
Scale 2	56	20	20	35
Scale 3	126	45	45	80
Scale 4	28	10	10	90
Scale 5	28	10	10	100
Total	280	100	100	
Overall Quality of Network (Scale: 1-5, with 1 being very poor and 5 being excellent)	Frequency	Percentage	Valid percentage	Cumulative Percentage
Scale 1	35	12.5	12.5	12.5
Scale 2	42	15	15	27.5
Scale 3	119	42.5	42.5	70
Scale 4	70	25	25	95
Scale 5	14	5	5	100
Total	280	100	100	

Source: Field Data, 2024.

Table 7: User Satisfaction with network providers

User Satisfaction with Network Providers (Scale: 1-5, with 1 being very poor and 5 being excellent)	Frequency	Percentage	Valid percentage	Cumulative Percentage
Scale 1	42	15	15	15
Scale 2	70	25	25	40
Scale 3	112	40	40	80
Scale 4	49	17.5	17.5	97.5
Scale 5	7	2.5	2.5	100
Total	280	100	100	

Source: Field Data, 2024.

Table 8 presents correlations between various network quality metrics and user satisfaction, revealing notable relationships. In Table 9, a model summary displays the predictive power of different variables on user satisfaction, with an impressive R-squared value indicating the model's effectiveness. Table 10 presents regression coefficients, highlighting the magnitude and significance of predictors such as call quality and overall network reliability.

Table 8: Correlation Analysis

S/N	Variable Vs User Satisfaction	Pearson Correlation Coefficient
1	Reliability of Network Vs User Satisfaction	0.5863
2	Call Quality of Network vs. User Satisfaction	0.3424
3	Data Speed of Network vs. User Satisfaction	0.3517
4	Overall quality of Network vs. User Satisfaction	0.5078

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Table 9: Model Summary

Model	R Squared	Adj. R Squared	F-Statistics
1	0.780	0.775	163.7
Predictors: G, AG, EL, AR, SP, R, CQ, DS, OQ			

Table10: Regression Coefficients

S/N	Coefficients	Std Error	P-value
	Gender	0.080	0.247
	Age Group	0.031	0.005
	Education Level	0.048	0.004
	Area of Residence	0.034	0.253
	Service Provider	0.016	0.703
	Reliability	0.027	0.012
	Call Quality	0.037	0.000
	Data Speed	0.038	0.002
	Overall Quality	0.056	0.000

3.2 DISCUSSION

The discussion of the findings from this research provides valuable insights into the dynamics of telecommunication services and user experiences within Edo State, Nigeria. The R-squared value of 0.780 indicates that approximately 78.0% of the variance in user satisfaction can be explained by the independent variables included in the model. This suggests that the model accounts for a substantial portion of the variability in user satisfaction levels, making it a reliable tool for understanding the factors influencing user experiences. The assessment of QoS metrics revealed varying levels of performance across different aspects of telecommunication networks. Reliability of the network emerged as a significant factor influencing user satisfaction, with a Pearson correlation coefficient of 0.5863 indicating a moderately strong positive relationship between network reliability and user satisfaction. This finding underscores the importance of ensuring consistent and dependable network connectivity to enhance user experiences and satisfaction levels. Additionally, call quality and data speed were also found to be positively correlated with user satisfaction, although to a lesser extent, with correlation coefficients of 0.3424 and 0.3517, respectively. These results highlight the multifaceted nature of QoS and the need for telecommunication providers to prioritize improvements in network reliability, call quality, and data speed to meet user expectations and enhance overall satisfaction levels.

The regression analysis further explained the relative importance of various factors influencing telecommunication user satisfaction levels. Gender, age group, education level, area of residence, service provider, reliability, call quality, data speed, and overall quality were identified as predictors of user satisfaction, with each factor contributing differently to the overall satisfaction levels. Among these predictors, call quality and overall network reliability emerged as the most significant drivers of user satisfaction, as evidenced by their relatively higher regression coefficients and lower p-values. This underscores the critical role of these factors in shaping user perceptions and experiences with telecommunication services. Conversely, factors such as gender, area of residence, and service provider demonstrated relatively weaker associations with user satisfaction, suggesting that they may have less pronounced effects on overall satisfaction levels.

IV. CONCLUSION

The assessment of QoS metrics, including network reliability, call quality, and data speeds, indicates that telecommunication networks in Edo State generally provide satisfactory services to users. However, there are areas for improvement, particularly in network reliability, where connectivity issues may persist in certain regions, especially rural areas. Additionally, while call quality and data speeds are generally rated favorably by users, enhancements in these areas can further improve overall user satisfaction levels. User satisfaction levels were found to be influenced by various demograp hic and experiential factors, including gender, age group, education level, area of residence, and service provider. While these factors may play a role in shaping user perceptions, the analysis revealed that network reliability, call quality, and data speeds have a more significant impact on overall user satisfaction. This

underscores the importance for telecommunication providers to prioritize improvements in these key areas to enhance user experiences and satisfaction levels across the board.

V. RECOMMENDATIONS

Premised from the comprehensive analysis of QoS metrics, user perceptions, and satisfaction levels, the following recommendations aim to provide strategic guidance for telecommunication service providers, regulatory bodies, and policymakers:

1. **Invest in Infrastructure Upgrades:** Telecommunication providers should prioritize investments in infrastructure upgrades to enhance network reliability and coverage, particularly in underserved rural areas. By expanding network coverage and deploying advanced technologies, providers can ensure consistent and reliable connectivity for users across all regions of Edo State.
2. **Optimize Network Performance**: Continuous monitoring and optimization of network performance are essential to maintain high-quality service delivery. Telecommunication providers should conduct regular audits of their networks to identify and address areas of congestion, latency, or signal interference that may affect call quality and data speeds.
3. **Improve Call Quality and Data Speeds:** To enhance user satisfaction levels, telecommunication providers should focus on improving call quality and data speeds. This can be achieved through the deployment of technologies such as Voice over LTE (VoLTE) and 5G networks, which offer higher voice and data transmission rates, reduced latency, and improved call clarity.
4. **Enhance Customer Service**: Establishing dedicated customer service channels and investing in training for customer service representatives can improve user experiences and satisfaction levels. Telecommunication providers should ensure prompt resolution of user queries, complaints, and technical issues to foster trust and loyalty among customers.
5. **Community Engagement and Outreach**: Engaging in community outreach programs and initiatives can help telecommunication providers better understand the needs and preferences of users, especially in rural and underserved areas. By actively participating in community events and forums, providers can gather valuable feedback and insights to inform their service enhancement strategies.
6. **Promote Digital Literacy:** Promoting digital literacy and awareness initiatives can empower users to make informed choices about telecommunication services and utilize them more effectively. Telecommunication providers should collaborate with educational institutions, government agencies, and community organizations to offer training programs and resources on digital skills and internet usage.
7. **Collaborate with Stakeholders:** Collaboration with government agencies, industry stakeholders, and technology partners can facilitate knowledge sharing, resource pooling, and collective problem-solving efforts. Telecommunication providers should engage in partnerships and collaborative initiatives to address common challenges, leverage synergies, and drive positive change in the telecommunication ecosystem.

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