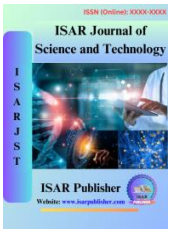
OPEN ACCESS



ISAR Journal of Science and Technology
Abbriviate Tittle- ISAR J Sci Tech
ISSN *(Online)*- 2584-2056
https://isarpublisher.com/journal/isarjst
Vol-2, Iss-3 (Mar- 2024)

OPEN ACCESS

Evaluating the Performance of GLO 3G Data Network in Bali Metropolis of Taraba State, Nigeria

Chibueze Okoro[1*], Adamu Umar[2]

Electrical/Electronic Engineering Department Federal Polytechnic Bali, Taraba State.

***Corresponding Author**

Chibueze Okoro

Electrical/Electronic Engineering Department Federal Polytechnic Bali, Taraba State.

Article History

Received: 29.02.2024
Accepted: 04.03.2024
Published: 19.03.2024

Abstract: *The rapid expansion of mobile data usage in developing countries necessitates the evaluation of data network performance to enhance service delivery and customer satisfaction. This study evaluates the performance of the GLO 3G data network in Bali Metropolis, Taraba State, Nigeria. The research assesses the network's quality, speed, and reliability, considering their impact on the overall user experience. The study employs a mixed-methods approach, combining quantitative data from network performance measurements and user surveys to gather comprehensive insights. For the quantitative aspect, network performance metrics, such as throughput, latency, and signal strength, are collected using specialized software installed on smartphones distributed across the study area. On the other hand, the qualitative aspect involves conducting surveys to understand users' perceptions, satisfaction levels, and usage patterns related to the GLO 3G data network. The findings of this study will shed light on the strengths and weaknesses of the GLO 3G data network in the Bali Metropolis. The evaluation will identify potential areas for improvement, enabling service providers to optimise their network infrastructure and address customer concerns effectively. Moreover, the research will contribute to the existing knowledge on telecommunications in developing regions, providing valuable insights for policymakers and stakeholders seeking to enhance digital connectivity and bridge the digital divide in Nigeria.*

Keywords: *GLO 3G, data network, performance evaluation, mobile data, user experience.*

Introduction

In an era characterized by the relentless pursuit of technological advancement and digital connectivity, reliable and high-speed mobile data networks have become essential for individuals, businesses, and governments. With its burgeoning population and rapidly growing digital landscape, Nigeria is no exception to this global trend. The availability and performance of mobile data networks play a pivotal role in facilitating communication, commerce, education, and various other facets of daily life. Among the prominent telecommunication service providers in Nigeria, Globacom Limited (GLO) has been a critical player, offering a range of data services, including 3G connectivity, to its subscribers.

This study evaluates the performance of GLO's 3G data network in Bali Metropolis, a significant urban center in Taraba State, Nigeria. Understanding the performance of this network is crucial, as it directly impacts the digital experiences of residents, businesses, and visitors in the region. A thorough analysis of GLO's 3G network performance in Bali Metropolis will shed light on its strengths and weaknesses, providing valuable insights for network optimization and service improvement.

To ensure the accuracy and validity of our evaluation, we will employ a combination of quantitative research methods. This research will encompass network speed and reliability assessments, user surveys, and interviews to capture the perspectives of those who rely on GLO's 3G data network in the Bali Metropolis.

In this introductory section, we will briefly overview the importance of mobile data networks in modern society and the significance of GLO as a telecommunications service provider in Nigeria. Furthermore, we will outline the research objectives and methodology for this study.

As we examine GLO's 3G data network performance in Bali Metropolis, it is essential to recognize the evolving nature of telecommunications technology and the dynamic needs of users in a rapidly changing digital landscape. The findings of this study will contribute to the broader discourse on telecommunications infrastructure in Nigeria and can guide efforts to enhance mobile data services for the benefit of all stakeholders.

PERFORMANCE EVALUATION OF 3G MOBILE DATA NETWORK: EMPHASIS ON USER EXPERIENCE

1. Data Transfer Rates and Throughput

One of the primary indicators of quality of service in a 3G data network is data transfer rates, often measured in Mbps. Faster data transfer rates translate to quicker downloads and smoother multimedia streaming experiences for users. According to Gupta and Malik (2019), improvements in data transfer rates significantly enhance user experience, leading to higher user engagement and greater customer loyalty.

***Corresponding Author:** Chibueze Okoro

2. Network Reliability and Availability

Network reliability refers to the ability of a 3G data network to maintain consistent and uninterrupted connectivity. Jain and Sharma (2018) found that users' perception of network reliability directly influences their satisfaction with the service. Frequent call drops or data interruptions can lead to frustration and dissatisfaction among users, underscoring the importance of a reliable network for positive user experiences.

3. Latency and Response Time

Latency, measured in milliseconds, represents the time data travels from the user's device to the network server and back. Lower latency ensures quicker response times for web browsing, online gaming, and other real-time applications. Ahmad, Khan, and Choudhary (2021) observed that reduced latency in 3G data networks positively correlates with enhanced user experience and perceived service quality.

4. User Satisfaction and Retention

User experience in a 3G data network significantly influences overall user satisfaction and retention. A study by Al-Harbi, Ghoneim, and Al-Mutairi (2019) demonstrated a robust positive relationship between user experience and customer loyalty. Networks that consistently provide high-quality service are more likely to retain users and attract new subscribers, contributing to sustained business success for mobile network operators.

5. Impact of Network Congestion

Network congestion can significantly impact the quality of service and user experience in a 3G data network. As active users increase, network resources may become strained, leading to slower data speeds and increased latency. Al-Banna and Al-Naami (2020) found that managing network congestion is crucial for maintaining QoS and ensuring a satisfactory user experience during peak usage.

The evaluation of GLO's 3G data network performance was carried out using quantitative research methods. Key performance indicators (KPIs) such as data transfer rates, network coverage, signal strength, and availability will be meticulously measured and analyzed to gauge the overall efficiency and reliability of the network (Oluwole & Adeyemi, 2021). Additionally, parameters such as Received Signal Code Power,Energy per Chip over InterferenceRatio (Ec/Io), and Radio Link Control Downlink throughput will be examined to assess the network's responsiveness and stability during data transmission.

Generally, this research seeks to enhance GLO's 3G data network performance in Bali Metropolis, empowering its residents and businesses to harness the full potential of seamless digital connectivity. By unravelling the network's strengths and challenges, this study endeavours to pave the way for an inclusive, digitally empowered future for the dynamic semi-urban landscape of Bali Metropolis in Taraba State.

Significance of Study

The findings of this research endeavour will be instrumental in aiding GLO and other stakeholders in the telecommunications industry to optimize network resources, enhance service delivery, and cater to the specific data requirements of the Bali Metropolis. Moreover, the study's outcomes will serve as vital inputs for the Nigeria Communication Commission (NCC), policy-makers and regulatory bodies, contributing to formulating informed policies and guidelines that promote a conducive environment for digital connectivity and technological progress.

METHODOLOGY

This study utilized several materials and tools, including a Garmin Global Positioning System (GPS), W995 TEMS mobile phone, and SIM card. The study also employed TEMS 15.1 investigation software on a laptop, a USB hub, a car inverter, and a car.

The SIM card was inserted into the TEMS phones to commence the drive test, and the TEMS investigation software was installed on the laptop. The TEMS phone was powered by connecting it to the laptop through a USB hub. The GPS, powered by the laptop, provided the location information for the drive test. During the extensive drive test measurement, various Key Performance Indicators (KPIs), including Received Signal Code Power (RSCP),Energy per Chip over Interference Ratio (Ec/Io), Radio Link Control Downlink Throughput (RLC DL),Primary Scrambling Code (PSC) and coverage, were collected from base stations within Bali metropolis, Maihula, and Gazabu communities, using the TEMS investigation software, which was running on a Windows 10 operating system laptop.

In summary, this research employed a range of materials and tools to conduct an in-depth analysis of GLO's mobile network's KPIs.

MEASURED PARAMETERS

Received Signal Code Power (RSCP)

RSCP signifies the power assessed by a receiver on a specific physical communication channel. It serves as a signal strength indicator, aids handover decisions, contributes to downlink power control, and facilitates path loss calculations.

Energy per Chip over Interference Ratio (Ec/Io)

Ec/Io measures received signal quality in wireless communication systems. It gauges the ratio of signal energy per chip to interference. This metric is vital for CDMA and WCDMA networks. (Andrews and Ghosh, 2019).

Primary Scrambling Code (PSC)

The Primary Scrambling Code (PSC) is a unique identifier assigned to cells in WCDMA networks. It aids signal differentiation and synchronization and is crucial for signal quality assessment and network management. (Holma, andToskala, 2011).

Best RLC DL throughput

Best RLC DL throughput' refers to the highest achievable data transfer rate in the downlink direction (from the network to the user) using a mobile network's Radio Link Control (RLC) protocol. This metric evaluates the maximum capacity of the data link layer to transmit information efficiently. It's a key network performance indicator, influencing user experience and service quality. The maximum speed limit for a 3G network, as described by the 3GPP, is 2Mbps (2048kbps).

RESULTS

The performance evaluation of the GLO 3G data network was analyzed based on their KPI data obtained from a driving test. A summary of the drive test result for RSCP, Ec/Io, and Best RLC DL Throughputare given in Table 1, Table2, Table3, Figure 1, Figure 2, and Figure 3, respectively summarizing coverage results. In contrast, Figure 4, summarizes coverage plots and Figure5 is a combined summary of all coverage results.

Table 1. Showing RSCP Counts

RANGE	INDICATOR	COUNT	PERCENTAGE COUNT (%)
80 to Max	EXCELLENT	250	14
90 to 80	VERY GOOD	173	10
95 to 90	GOOD	169	9
100 to 95	FAIR	124	7
105 to 100	POOR	205	12
110 to 105	VERY POOR	453	26
Min to -110	DEGRADED	395	22

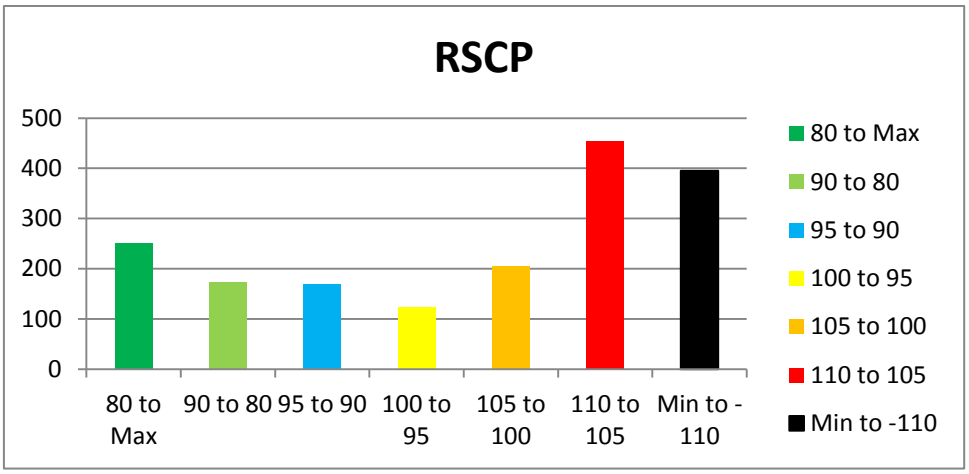


FIG. 1a:Bar Chart depicting the ranges and counts of the RSCP level

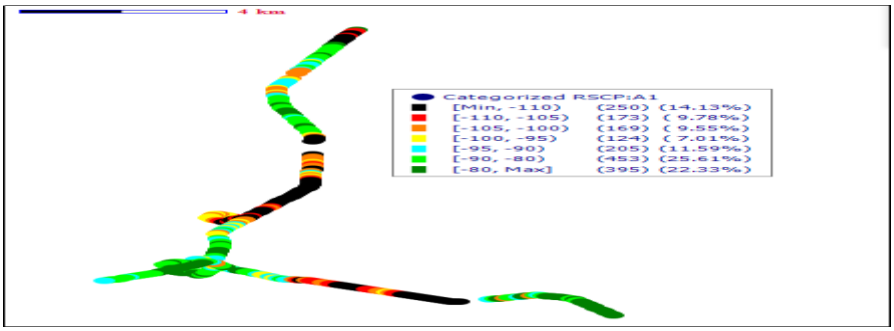


FIG. 1b: Analysis of RSCP on Mapinfo

Table 2. Showing Ec/Io Counts

RANGE	INDICATOR	COUNT	PERCENTAGE COUNT (%)
8 to Max	EXCELLENT	818	46
8 to 10	VERY GOOD	289	16
10 to 12	GOOD	230	13
12 to 14	FAIR	134	8
14 to 16	POOR	113	6
16 to 20	VERY POOR	185	11

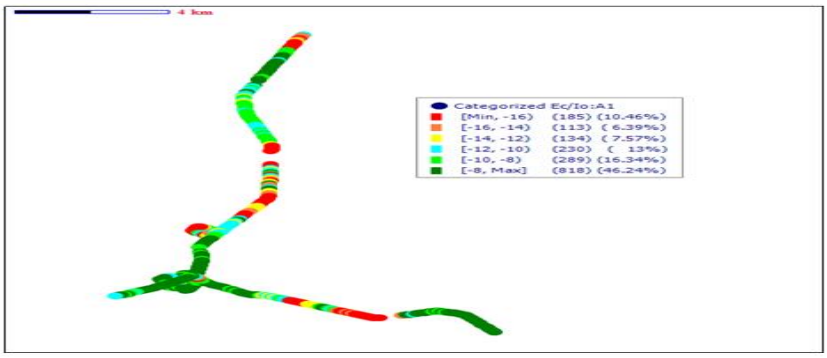


FIG. 2a: Analysis of Ec/Io on Mapinfo

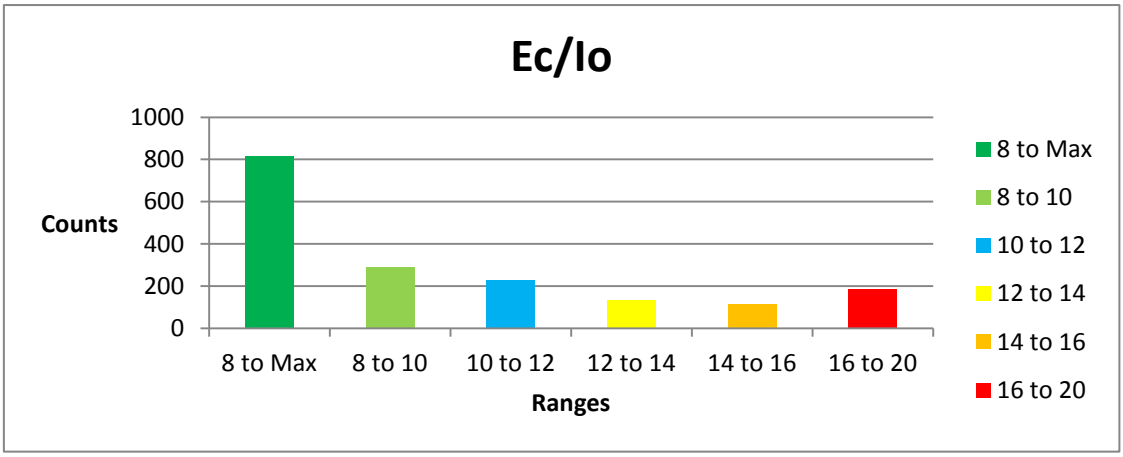


FIG. 2b: Bar Chart depicting the ranges and counts of the Ec/Io

Table 3. Showing RLC DL Throughput Counts

RANGE (kbps)	COUNT	PERCENTAGE COUNT (%)
Min to 1	120	8
1 to 256	175	11
256 to 512	47	3
512 to 1024	148	10
1024 to 2048	330	21
2048 to 4096	425	27
4096 to Max	319	20

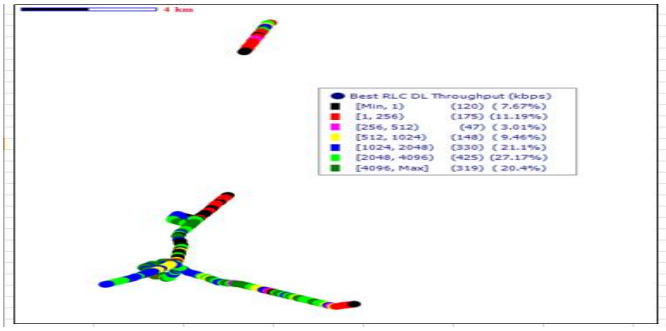


FIG. 3a: Analysis of RLC DL Throughput on Mapinfo.

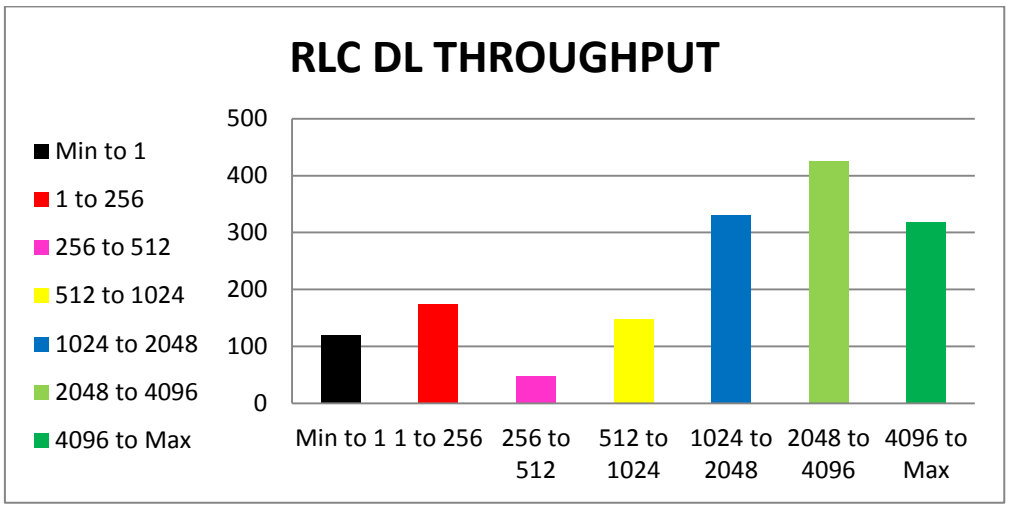


FIG. 3b: Bar Chart depicting RLC DL Throughput

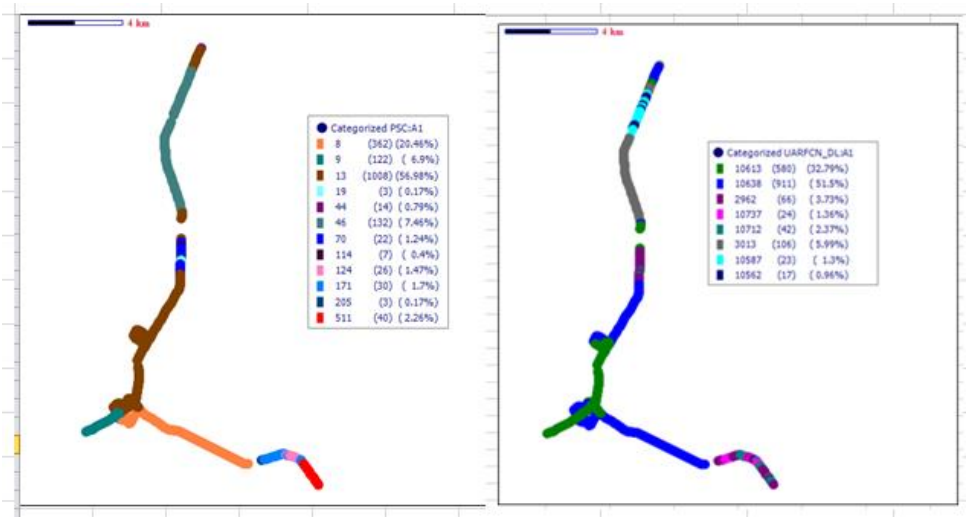


FIG 4. Showing PSC and UARFCN Coverage

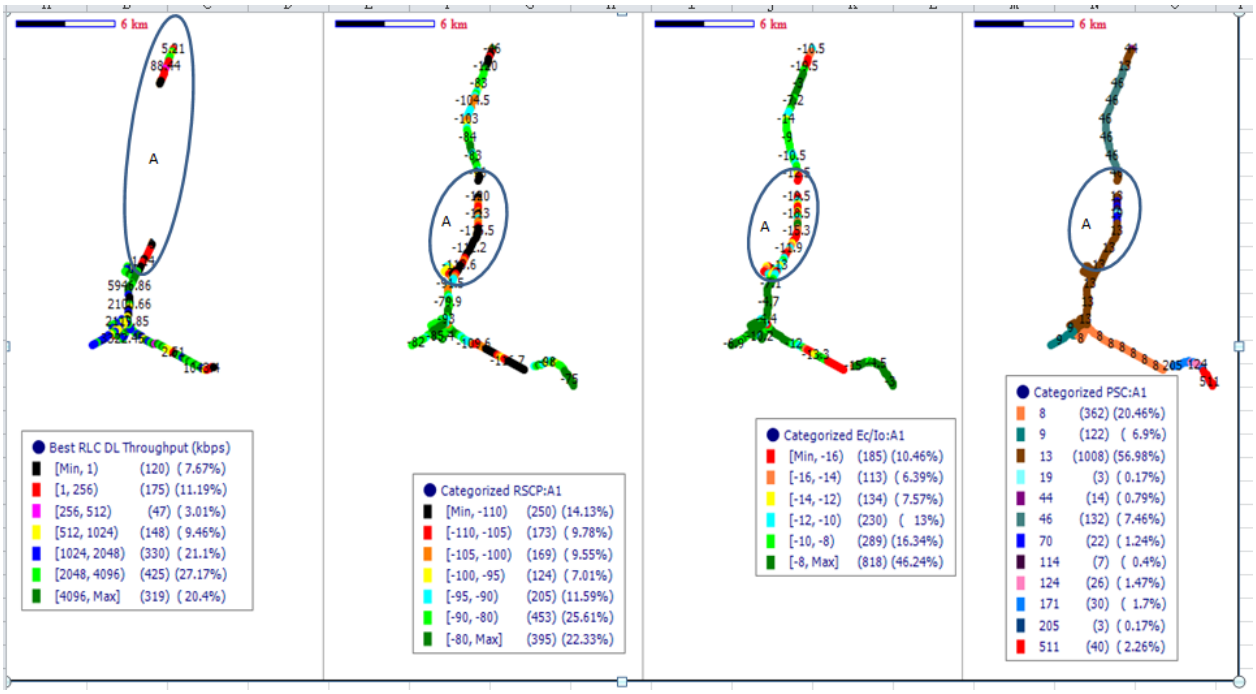


FIG 5. Overall view of RLC/RSCP/Ec/Io & /PSC Mapinfo analysis.

DISCUSSION OF RESULT

The analysis of the data obtained shows that the quality of GLO data service within Bali, Maihula and Gazabu is not optimal. It can be deduced that the RSCP range of -80 to 0 (DB) covers just 14%. In comparison, the Ec/Io range of -8 to Max covers 46% of the total coverage area both of which fall below the 75% being stipulated by the Nigeria Communication Commission (NCC) of the entire coverage area. The maximum throughput recorded was about 20% of the total coverage.

Patch A Analysis: Poor DL throughput due to poor coverage and quality and low dominance from serving PSCs 19, 205, 70 & 368

CONCLUSION & RECOMMENDATION

Conclusion

The RSCP along Bali-Maihula road is very bad due to inefficient line of sight and vegetative coverings, resulting in failed Packet Sessions during the drive test. The Nigeria Communication Commission (NCC) should take more strict measures against the service providers, ensuring proper optimization is done regularly to meet set KPIs.

Recommendation:

The authors arrived at the following recommendations;

i. Physical Optimization is required around serving PSCs 19, 205, 70 & 368 to improve coverage, quality & DL throughput.
ii. Electrical and Mechanical tilts should be carried out on PSC 70 to rule out any overshooting issue.
iii. Azimuth adjustment should be carried out on TR378 TR019 (PSCs 70) to improve coverage, quality and download speed in Federal Polytechnic Bali Premises and Bali town.

References

1. Ahmad, W., Khan, M. U., & Choudhary, G. (2021). A Comprehensive Study on Network Latency Optimization Techniques in 5G Networks. *IEEE Access*, 9, 16503–16522. https://doi.org/10.1109/ACCESS.2021.3050329
2. Al-Harbi, A., Ghoneim, A., & Al-Mutairi, A. (2019). Evaluating the Quality of Experience for Mobile Broadband Users: A Survey. *Journal of Computer Networks and Communications*, 2019, 1–16. https://doi.org/10.1155/2019/5171486
3. Andrews, J. G., Ghosh, A., & Muhamed, R. (2007). *Fundamentals of WiMAX: understanding broadband wireless networking*. Pearson Education.
4. Gupta, R., & Malik, H. (2019). A Comprehensive Review on Quality of Service (QoS) in Wireless Sensor Networks. *Wireless Personal Communications*, 107(2), 1521–1553.
5. Holma, H., & Toskala, A. (Eds.). (2007). *WCDMA for umts: hspa evolution and lte*. john Wiley & sons.
6. Jain, R., & Sharma, A. (2018). A Comprehensive Study on Mobile Network Reliability. *International Journal of Computer Applications*, 180(14), 12–16. https://doi.org/10.5120/ijca2018917769
8. Oluwole, O., & Adeyemi, A. (2021). Evaluation of GLO's 3G Data Network Performance: A Quantitative Analysis. *International Journal of Scientific & Technology Research*, 10(4), 3800–3806.