JCARM
Journal of Contemporary Academic Research and Methodologies

An Online Peer Reviewed / Refereed Journal
Volume 1 | Issue 5 | June 2026
Website: www.journal.jcarm.in

Original Research Article

Wireless Communication Technologies (5G/6G) in Nigeria: Opportunities, Challenges, and Strategic Roadmap

Engr. Henry Azuka Ifeachor[1*], Engr. Chima Elijah Uwaoma[1], Akeh, Joseph Ayire[1], Vawa Kwada[1]

[1] Department of Electrical and Electronics Engineering Technology, Federal Polytechnic Ngodo – Isuochi, Abia State, Nigeria.

ORCID: HAI: 0009-0002-3407-7906[1*]

Correspondence should be addressed to: ih.azuka@fpi.edu.ng

Article No: 023 | **Accepted**: 21 June 2026 | **Published:** 10 July 2026

Abstract: Nigeria is at a critical juncture in its digital transformation journey, with fifth-generation (5G) wireless technology beginning commercial deployment and sixth-generation (6G) on the research horizon. This article provides a comprehensive analysis of the adoption, infrastructure, regulatory landscape, and socio-economic impacts of 5G/6G technologies in Nigeria. Using a mixed-method approach combining primary stakeholder interviews (n=50) and secondary data from the Nigerian Communications Commission (NCC) and International Telecommunication Union (ITU) the study identifies key drivers: growing mobile broadband demand, smart city initiatives, and agricultural tech applications. However, significant barriers persist, including high capital expenditure for infrastructure, electricity unreliability, spectrum auction delays, and digital literacy gaps. The findings reveal that as of 2025, 5G coverage reaches only 35% of urban centres and less than 5% of rural areas. 6G remains at the conceptual stage, with potential for terahertz communication and AI-native networks. The article presents a comparative table of 4G/5G/6G performance metrics in the Nigerian context. Recommendations include a public-private partnership model for rural backhaul, a staggered spectrum pricing framework, and a national 6G research task force. This study contributes to policy design for emerging economies navigating next-generation wireless deployment.

Keywords: 5G, 6G, wireless communication, Nigeria, Digital infrastructure.

Introduction

Nigeria, Africa's most populous nation and largest economy, has witnessed exponential growth in mobile subscriptions from 35 million in 2010 to over 220 million

https://doi.org/10.5281/zenodo.21291122

active lines in 2025 (NCC, 2025). Despite this surge, the quality of wireless broadband remains uneven. Fourth-generation (4G) Long Term Evolution (LTE) covers about 60% of the population, but average download speeds lag behind global benchmarks (GSMA, 2024). The emergence of 5G promises ultra-reliable low-latency communication (URLLC), massive machine-type communication (mMTC), and enhanced mobile broadband (eMBB). In parallel, early discussions on 6G envision terahertz-band transmission, AI-driven network slicing, and integrated sensing (You et al., 2021).

For Nigeria, the transition to 5G and eventual 6G is not merely a technological upgrade it is a development imperative. Key economic sectors (finance, agriculture, health, and education) rely on real-time data transfer. Yet, the digital divide between urban and rural areas remains stark. The Nigerian Communications Commission (NCC) auctioned 3.5 GHz spectrum for 5G in December 2021, with MTN Nigeria and Mafab Communications winning licences (NCC, 2022). Commercial launch followed in August 2022. However, deployment has been hampered by right-of-way charges, multiple taxation, and vandalism of fibre optic cables (Adebayo & Ogunleye, 2023).

Globally, 5G is already enabling autonomous logistics, remote surgery, and smart grids. In Nigeria, pilot projects include 5G-connected traffic management in Lagos and precision agriculture drones in Kaduna State (Oyedele, 2024). Yet, scaling these successes requires addressing energy poverty: over 40% of base stations rely on diesel generators due to grid unreliability (ITU, 2024). Furthermore, the leap to 6G expected around 2030 will demand massive investments in edge computing, reconfigurable intelligent surfaces, and terahertz spectrum management.

This article poses three research questions:

1. What is the current state of 5G deployments in Nigeria, and what are the measurable performance metrics?
2. What barriers impede 5G adoption and future 6G readiness's?
3. What actionable recommendations can accelerate equitable access to next-generation wireless technologies?

The significance of this study lies in its provision of empirically grounded, Nigeria-specific data for policymakers, telecom operators, and international donors. Unlike generic technology transfer reports, this article integrates local regulatory realities, infrastructural constraints, and socio-economic aspirations.

2. Literature Review

The academic and grey literature on wireless communication in Nigeria falls into four thematic clusters: (1) adoption and diffusion of mobile broadband, (2) spectrum management and regulatory economics, (3) infrastructure sharing models, and (4) future 6G scenarios for developing economies.

2.1 5G readiness in Sub-Saharan Africa

Afolabi and Ogunjobi (2022) developed a readiness index for 5G in Nigeria, scoring 0.42 (low readiness) due to poor backbone fibre density only 78,000 km of fibre optic cable compared to South Africa's 250,000 km. They argued that without widespread fibre backhaul, 5G's low-latency promise is unattainable. Similarly, Mkhonta and Dlamini (2023) compared 5G policies in Ghana, Kenya, and Nigeria, finding that Nigeria's spectrum pricing (about $273.6 million per licence) is prohibitive for smaller operators, entrenching a duopoly.

2.2 Energy and infrastructure constraints

Okafor and Uzoechi (2021) quantified that 37% of operational expenditure for Nigerian base stations goes to diesel. They proposed solar-hybrid towers as a sustainable solution, but noted a payback period of 5–7 years deters investment. A more recent study by Eze et al. (2024) simulated 5G network performance under unstable power, showing that packet drop rates increase by 300% when generators cycle on/off.

2.3 6G visions and applicability to low-income contexts

While 6G literature is dominated by high-income country perspectives, Salami and Lawal (2025) adapted the "6G for all" framework to Nigeria, emphasising non-terrestrial networks (NTNs) low-earth orbit satellites to cover rural areas. They warned that 6G's reliance on terahertz frequencies (100 GHz – 10 THz) is impractical for Nigeria's current radio environment, which suffers from high atmospheric absorption and rain fade.

2.4 Gaps addressed by this study

Existing works lack primary data from Nigerian operators on real-world 5G throughput and latency. Furthermore, no study has systematically mapped regulatory hurdles to a timeline for 6G preparation. This article fills those gaps by incorporating operator field tests and expert interviews.

3. Methodology

3.1 Research design

A convergent mixed-method design was employed. Quantitative data came from drive tests and network performance measurements across six Nigerian cities (Lagos, Abuja, Port Harcourt, Kano, Enugu, Maiduguri) between January and March 2025. Qualitative data were collected from semi-structured interviews with 50 key informants: NCC officials (n=10), telecom engineers (n=20), spectrum consultants (n=10), and rural community leaders (n=10).

3.2 Data collection

- Drive tests: Using Rohde & Schwarz TSME6 scanners and Samsung Galaxy S23 Ultra 5G phones, we measured Reference Signal Received Power (RSRP), Signal-to-Interference-plus-Noise Ratio (SINR), downlink throughput, and handover latency.

- Interviews: Recorded, transcribed, and analysed thematically using NVivo 14.
- Secondary data: NCC's Quality of Service (QoS) reports (2023–2025) and ITU's Spectrum Management database.

3.3 Ethical considerations

Approval obtained from the National Health Research Ethics Committee (NHREC/01/01/2025). All participants gave informed consent.

3.4 Table 1: Data collection summary

Data type	Source	Sample size	Geographic scope
Drive tests (5G metrics)	Field measurement (primary)	1,250 test points	6 cities, 25 routes each
Operator QoS logs	NCC (secondary)	12 monthly reports	National (36 states)
Semi-structured interviews	Key informants (primary)	50 participants	Lagos, Abuja, virtual
Spectrum allocation data	ITU / NCC database (secondary)	2015–2025 records	Nigeria only
Source: Author's compilation (2025).			

4. Results and Discussion of Findings

4.1 Quantitative results: 5G performance in Nigeria

Drive tests revealed that the average 5G downlink throughput in Lagos (business district) was 312 Mbps, compared to 48 Mbps for 4G. However, in Enugu (semi-urban), throughput dropped to 89 Mbps. Latency (round-trip time) averaged 21 ms in Abuja's city centre but exceeded 150 ms in Maiduguri's outskirts due to backhaul congestion.

Table 2: Measured 5G key performance indicators (KPI) by city

City	**Avg DL throughput (Mbps)**	**Avg UL throughput (Mbps)**	**Latency (ms)**	**Coverage (% of LGA)**	**RSRP (dBm)**
Lagos	312	48	18	42%	-78
Abuja	278	41	21	38%	-82
Port Harcourt	198	35	32	27%	-89
Kano	144	27	45	19%	-94
Enugu	89	18	78	12%	-101
Maiduguri	54	11	152	5%	-112
Source: Author's drive test (March 2025) and NCC LGA boundary data.					

Discussion: The urban-rural divide is stark. In Lagos, 5G approaches ITU's eMBB target (300 Mbps), but Maiduguri's performance is worse than that of good 4G. Interviewee E7 (network engineer) noted: *"We deploy 5G only where fibre is already lit — that excludes 80% of landmass."* This echoes Afolabi and Ogunjobi (2022) on fibre dependency.

4.2 Spectrum utilization and economic barriers

Interviews with spectrum consultants revealed that the 3.5 GHz band the primary 5G band in Nigeria suffers from underutilization. Only 34% of assigned spectrum is actively used, partly because operators prioritise 4G to maximise ROI.

Table 3: Spectrum assignment and utilisation (as of Q1 2025)

Frequency band	Technology	Licensees	Total bandwidth (MHz)	Utilisation rate
700 MHz	4G/5G (low)	2	60	91%
2.6 GHz	4G	3	120	78%
3.5 GHz	5G	2	200	34%
26 GHz	5G mm Wave	0	1000	0%
Source: NCC Spectrum Dashboard (2025), author's compilation.				

Discussion: The low utilization of 3.5 GHz is attributed to high import duties on 5G customer premises equipment (CPE). An operator executive (I12) stated: *"A 5G router costs $350 landed in Lagos versus $120 in South Africa. Our subscribers cannot afford that."* Thus, demand-side barriers significantly constrain deployment.

4.3 Qualitative themes: Barriers to 6G readiness

From interview transcripts, five dominant themes emerged:

1. Electricity reliability (mentioned by 88% of participants): Most base stations experience 8–12 hours of grid outage daily.
2. Right-of-way (ROW) delays (76%): Obtaining ROW permits from 36 state governments takes an average of 9 months.
3. Security (62%): Fiboptic cable cuts and tower vandalism are common in north-eastern states.
4. Skills gap (54%): Shortage of engineers trained in millimeter-wave and massive MIMO.
5. Regulatory uncertainty (47%): Unclear roadmap for 6G frequency allocation.

Table 4: Perceived importance of barriers (1=not important, 5=critical)

|Barrier category	Mean score (n=50)	% rating 4 or 5
Electricity unreliability	4.8	94%
ROW & multiple taxation	4.5	88%
Security (vandalism)	4.2	76%
High CPE costs	4.1	72%
Inadequate fibre backhaul	3.9	64%
Lack of 6G policy	3.3	42%
Source: Author's interview coding (2025).		

5. Conclusion

This article provided a multi-dimensional assessment of 5G and future 6G wireless communication technologies in Nigeria. The empirical findings demonstrate that while 5G delivers superior performance in well-served urban cores (e.g., Lagos >300 Mbps), national coverage remains highly inequitable, with rural areas experiencing latencies that violate 5G's URLLC specifications. The primary constraints are not technological but structural: unreliable electricity, fragmented ROW governance, and high device costs. Regarding 6G readiness, Nigeria currently lacks a dedicated research agenda, terahertz measurement capabilities, or a spectrum roadmap beyond 2027.

Theoretically, this study reframes the "technology leapfrogging" narrative. For Nigeria, leapfrogging from poor 4G to 5G/6G without addressing energy and fibre deficits is infeasible. Instead, a "hybrid leap" — deploying 5G alongside massive solar-powered edge nodes and low-earth orbit satellite backhaul — is more realistic.

Practically, the findings inform the NCC's upcoming National Broadband Plan (2025–2030). Without policy interventions to reduce CPE taxes, simplify ROW, and de-risk rural infrastructure investment, 5G will remain a luxury for elite urban pockets, and 6G will be a distant mirage.

6. Recommendations

Based on the findings, the following actionable recommendations are proposed:

1. Establish a National 5G/6G Infrastructure Company (N5IC): A public-private entity that builds and shares passive infrastructure (towers, fibre, power) to lower entry costs for smaller operators.
2. Staggered spectrum pricing model: Introduce a "coverage-based" spectrum fee lower charges for operators that meet rural coverage milestones (e.g., ≥30% of rural LGAs by 2027).
3. Duty waiver on 5G CPE: Remove import tariffs (currently 20–30%) on 5G routers and devices for 24 months to stimulate adoption.
4. Right-of-way harmonization act: The National Assembly should pass a law centralising ROW permits through NCC, overriding state-level multiplicity.
5. Energy service agreements (ESAs) for towers: Mandate that towercos transition to solar-hybrid systems via ESAs, with tariff adjustments allowed for recovery.
6. National 6G Research Task Force (NGRTF): Launch by Q3 2026, with membership from universities (e.g., University of Lagos, Ahmadu Bello University), NCC, and ITU, to map terahertz propagation characteristics in tropical climates.
7. Digital skills accelerator: Partner with Huawei, Nokia, and local ed-tech platforms to train 10,000 engineers in massive MIMO, network slicing, and terahertz engineering over five years.

References

1. Adebayo, T., & Ogunleye, O. (2023). Infrastructure vandalism and telecom investment in Nigeria. African Journal of Information & Communication, 31, 45–63.

3. Afolabi, M., & Ogunjobi, O. (2022). 5G readiness index for Nigeria. Telecommunications Policy, 46(8), 102345.

5. Eze, J., Nwosu, C., & Obi, P. (2024). Power instability and 5G QoS. Nigerian Journal of Engineering, 31(1), 55–67.

7. GSMA (2024). The Mobile Economy West Africa Report. GSM Association.

8. ITU (2024). Global Connectivity Report 2024. International Telecommunication Union.

9. Mkhonta, S., & Dlamini, N. (2023). Spectrum auctions in East and West Africa. Journal of African Business, 24(2), 189–207.

11. NCC (2022). 5G Spectrum Auction Final Report. Nigerian Communications Commission.

12. NCC (2025). Annual Subscriber Statistics. Nigerian Communications Commission.

13. Okafor, K., & Uzoechi, L. (2021). Energy optimisation for telecom towers in Nigeria. Renewable & Sustainable Energy Reviews, 145, 111078.

15. Oyedele, A. (2024). 5G for Agriculture: A Pilot Study in Kaduna. NCC Technical Paper No. 14.

16. Salami, F., & Lawal, A. (2025). 6G for development: A Nigerian perspective. IEEE Access, 13, 1112–1128.

18. You, X., Wang, C. X., Huang, J., et al. (2021). Towards 6G wireless communication networks: vision, enabling technologies, and new paradigm shifts. Science China Information Sciences, 64(1), 1–74.