International Journal of Research in Advanced Engineering and Technology
www.allengineeringjournal.in
ISSN: 2455-0876
Received: 21-08-2025, Accepted: 20-09-2025, Published: 06-10-2025
Volume 11, Issue 2, 2025, Page No. 9-13

Optic Fiber deployment and maintenance for efficient performance in high density population: A survey of selected ICT firms Lagos metropolis, Nigeria

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Abstract
The increasing demand for reliable broadband services in high-density urban areas has made fibre optic deployment a critical component of digital infrastructure. This study examined fibre optic deployment and maintenance practices among selected ICT firms in Lagos Metropolis, Nigeria, with a focus on challenges, strategies, and performance implications. A purposive random sampling method was used to select 30 respondents drawn from three ICT firms, comprising operators, site managers, and technicians. Data were collected through structured questionnaires and analyzed using descriptive statistics and thematic interpretation. Findings revealed that fibre deployment is predominantly carried out through direct burying (66.7%), while aerial suspension accounts for 33.3%. Major challenges included technical manpower shortages and cost-related issues (each 33.3%), as well as security concerns (20%) and right-of-way barriers (6.7%). Corrective and preventive maintenance strategies dominated (83.3%), with limited use of innovative methods such as drone surveillance (3.3%). The study concludes that while progress has been made in deployment, fibre performance in Lagos remains constrained by infrastructural, technical, and security challenges. The research recommends strengthening workforce capacity through targeted training, adopting predictive maintenance technologies, and improving security and policy frameworks for right-of-way management. These measures will enhance service reliability, reduce downtime, and support Nigeria's broader digital transformation agenda.

Keywords: Deployment, high density population, ict firms, lagos metropolis, maintenance, optic fibre, performance

Introduction

The rapid expansion of internet-based services has made high-capacity, low-latency broadband infrastructure a strategic priority for cities with dense populations. Optical fibre is the backbone technology for modern broadband, offering high bandwidth, low attenuation, and long-term scalability (International Telecommunication Union [ITU], 2024) [12]. In Lagos Metropolis, Nigeria's largest city and commercial hub, demand for reliable broadband continues to surge due to increasing ICT adoption, digital businesses, remote work, and streaming services. National statistics indicate steady growth in land-based fibre deployment, with metropolitan rollouts concentrated in major cities such as Lagos and Abuja (Nigerian Communications Commission [NCC], 2023; National Broadband Plan, 2020) [18, 19, 21].

Despite this progress, high-density urban environments such as Lagos present unique challenges to fibre deployment and maintenance. These include congested rights-of-way, coordination difficulties with utility providers, vandalism and theft, restricted access in residential estates, and a shortage of skilled splicing and maintenance personnel. Without effective planning and robust maintenance regimes, these issues can degrade network performance, increase operational costs, and reduce service reliability (ITU, 1996; Ogunwale, 2018) [23, 24].

The growing demand for high-speed broadband in Lagos underscores the need for resilient optical fibre infrastructure. However, many ICT firms continue to face service disruptions, high maintenance costs, and challenges in sustaining quality of service despite national broadband targets and increasing investments (National Broadband Plan, 2020; Federal Ministry of Communications, Innovation and Digital Economy [FMCIDE], 2024) [7, 18, 19]. These inefficiencies directly affect digital businesses, online education, financial services, and e-government platforms, where uninterrupted connectivity is essential.

Existing research has largely emphasized broadband penetration levels and national infrastructure growth trends (Statista, 2023; TechCabal, 2025) [28, 29]. Yet, few empirical studies have examined firm-level deployment strategies and maintenance practices in Lagos Metropolis. This gap in the literature makes it difficult to fully understand the operational challenges ICT firms face in high-density urban contexts. Addressing this gap is vital, as without targeted insights, achieving efficiency in fibre performance and realizing Nigeria's digital transformation agenda will remain elusive.

This study, therefore, investigates optical fibre deployment and maintenance practices adopted by selected ICT firms in Lagos Metropolis, with the aim of evaluating how these practices influence network performance in high-density locations.

Significance of the Study

This study is significant for several reasons. First, it provides ICT firms with practical insights into how deployment and maintenance strategies affect fibre network performance in high-density locations. By identifying common challenges such as vandalism, poor monitoring, and delays in repairs, the research can guide firms in strengthening preventive and corrective maintenance practices (ITU, 2024).

Second, the study benefits policymakers and regulators by supplying empirical evidence that can inform fibre-related policies, rights-of-way negotiations, and the enforcement of maintenance standards (NCC, 2023). This contributes to achieving the objectives of Nigeria's National Broadband Plan, which emphasizes efficient infrastructure deployment in urban areas (National Broadband Plan, 2020) [18, 19].

Third, the research has societal significance. Improved fibre deployment and maintenance directly enhance broadband reliability for end-users in Lagos. This supports economic growth, digital inclusivity, and the ability of individuals and businesses to fully participate in the digital economy (FMCIDE, 2024; Statista, 2023) [7, 28].

Finally, from an academic perspective, the study contributes to the limited body of literature on fibre deployment and performance management in African megacities. It bridges the gap between high-level infrastructure reports and ground-level operational practices, thereby offering a framework for future studies in ICT infrastructure management.

Research Methodology

Study Area

Lagos Metropolitan Area is a state in the southwestern geopolitical zone of Nigeria. The smallest in area of Nigeria's 36 states, Lagos State is arguably the most economically important state of the country and containing the nation's largest urban area. It is a major financial centre and the third largest economy in Africa. Lagos State is bounded on the north and east by Ogun State. In the west it shares boundaries with the Republic of Benin. Behind its southern borders lies the Atlantic Ocean. 22% of its 3,577 km^2 are lagoons and creeks (This Day, 2012; Metro Lagos, 2015; Lagos State Government 2015) [16, 17, 31].

Research Design

This study adopts a mixed-methods design combining descriptive and exploratory approaches to capture both deployment practices and system evaluation metrics. This approach aligns with established infrastructure research methods (Creswell & Creswell, 2018; NCC, 2023) [4].

Population and Sample

The study employed a purposive random sampling technique to ensure the selection of respondents with relevant expertise in fibre optic deployment and maintenance. A total of 30 valid questionnaires were administered to respondents drawn from three ICT firms: Chert Technologies, Main One, and Rack Centre. Ten questionnaires were distributed to each firm, targeting operators, site managers, and technicians whose professional roles provided direct experience with fibre deployment and management.

Purposive sampling was considered appropriate because it enables the researcher to focus on knowledge-rich participants who can provide in-depth insights into the subject matter (Etikan *et al*., 2016) [5]. This approach ensured that the collected data reflected both technical and operational perspectives necessary for evaluating deployment and maintenance practices.

Data Collection Methods

Interviews: Semi-structured interviews with technical leads and field engineers to document deployment and maintenance workflows (Gill *et al*., 2008) [8].

Questionnaires: Structured questionnaires for site managers and operations staff to gather data on fault rates, Mean Time to Repair (MTTR), and monitoring practices (Kothari, 2004) [15].

Document analysis: Review of NCC reports, company manuals, and broadband policy documents (NCC, 2023; National Broadband Plan, 2020) [18, 19].

Observations: On-site inspections and simple performance checks (Ogunwale, 2018) [23, 24].

Data Analysis

Qualitative data were thematically coded (Braun & Clarke, 2006) [3]. Quantitative data were summarized using descriptive statistics (Creswell & Creswell, 2018) [4].

Ethical Considerations

Permission and informed consent were obtained from all participating firms and individuals (Resnik, 2018) [27]. Sensitive operational metrics were anonymized and presented only in aggregate unless explicit permission for attribution was given. Data were stored securely and used only for this academic research. The study respected non-disclosure constraints when firms asked that certain proprietary operational details not be published.

Limitations

The purposive nature of sampling and limited sample size constrains broad generalizability. Site access and corporate confidentiality limited the depth of metric capture. Nevertheless, the mixed-method approach provides credible insights into practical deployment and maintenance patterns in Lagos's high-density areas.

Results and discussion

Demographic characteristics of the respondent

Table 1 presents the demographic characteristics of respondents. Findings revealed that 80% of participants were male, while only 20% were female. This indicates a male-dominated workforce in fibre optic deployment and maintenance, which aligns with broader studies on gender distribution in technical ICT roles (International Labour Organization [ILO], 2021) [10].

In terms of education and career specialization, 50% of respondents possessed National Diploma (ND) or professional fibre optic certifications, 33.3% had Higher National Diploma (HND) or Bachelor's degrees, while 16.7% held postgraduate qualifications. This reflects the growing reliance on mid-level technical certifications as the main qualification for optic fibre installation (Akanle & Akinyemi, 2020) [2].

Age distribution showed that the majority (66.7%) were between 20–35 years, with only 33.3% above 35 years. The dominance of younger respondents suggests that fibre deployment tasks, which are labor-intensive and physically demanding, are more appealing to younger professionals (Ndukwe, 2019) [20].

Monthly income distribution indicated that 80% earned between ₦50,000–₦100,000, while 20% earned above ₦100,000. This reflects the relatively modest remuneration for technical staff despite the increasing demand for broadband services (NCC, 2023).

Table 1: Demographic characteristics of the Respondents

Variables	Frequency	Percentage (%)
1. Gender		
Male	24	80
Female	06	20
Total	**30**	**100**
2. **Education/ Career Specialization**		
ND/Fiber Optic Certifications	15	50.00
HND/BSc	10	33.33
MSc and above	05	16.67
Total	**30**	**100.00**
3. Age		
20-35	20	66.67
35 and above	10	33.33
Total	**30**	**100.00**
4. Income/month		
50,000-100,000	24	80.00
100,000 and above	06	20.00
Total	**30**	**100.00**

Field survey, 2023

Optic Fibre Installation pattern

As shown in Table 2, the dominant installation technique within Lagos Metropolis was direct burying (66.7%), followed by aerial suspension (33.3%). Direct burying remains the preferred option in high-density areas because it provides greater physical protection and minimizes service interruptions caused by weather or accidental damage (ITU, 2024). However, aerial suspension is still used where terrain or infrastructure constraints make underground deployment cost-prohibitive (Ogunwale, 2018) [23, 24].

Table 2: Fibre Optic Installation pattern

Variables		Frequency	Percentage (%)
Installation pattern			
i.	Direct burying	20	66.67
ii.	Aerial suspension	10	33.33
Total		30	100.00

Field survey, 2023

Optic Fibre Deployment challenges

Table 3 highlights the major challenges encountered in fibre optic deployment. Technical manpower shortages and cost-related issues (each 33.3%) emerged as the most pressing challenges. These findings corroborate earlier studies that identified high capital expenditure and lack of skilled technicians as bottlenecks in Nigeria's fibre rollout (National Broadband Plan, 2020; Adeniran, 2021) [1, 18, 19].

Right-of-Way (RoW) issues (6.7%) and installation barriers such as difficult terrain (6.7%) were also reported. These issues reflect ongoing policy and urban planning barriers in Lagos, where fibre deployment often requires negotiation with multiple government agencies and estate managers (NCC, 2023). Additionally, 20% of respondents reported security concerns, including vandalism, theft, and threats to personnel. Such risks increase operational costs and prolong Mean Time to Repair (MTTR), affecting service reliability (FMCIDE, 2024) [7].

Table 3: Optic Fibre Deployment challenges

Variables		Frequency	Percentage (%)
Optic Fiber Deployment challenges			
i.	Manpower (Technical)	10	33.33
ii.	Cost (distance and amplifier facilities)	10	33.33
iii.	Installation barriers (difficult terrain)	02	06.67
iv.	Right of Way issues	02	06.67
v.	Security (Personnel & Facilities)	06	20.00
Total		**30**	**100.00**

Field survey, 2023

Maintenance strategies for efficient performance of Optic Fibre

Table 4 presents maintenance strategies used to sustain efficient fibre performance. Preventive and corrective maintenance dominated at 83.3%, reflecting a reactive maintenance culture within many Nigerian ICT firms. This suggests that while corrective actions restore service after failures, limited emphasis is placed on predictive strategies that could reduce MTTR and improve overall resilience (Pressman & Maxim, 2020) [25].

Other strategies included surveillance drones and satellite monitoring (3.3%) and patrolling by security agencies (13.3%). The use of drones remains minimal, despite their potential in reducing surveillance costs and enabling real-time fault detection (ITU, 2024). Security patrols, though somewhat effective, may not fully mitigate vandalism in high-density areas without integrated technological solutions.

Table 4: Maintenance strategies for efficient performance of Optic Fibre

Variables	Frequency	Percentage (%)
Maintenance strategies for efficient performance of Optic Fiber		
Preventive & Corrective Maintenance	25	83.34
Surveillance drone and Satellite	01	03.33
Patrolling by security Agency	04	13.33
Total	30	100.00

Field survey, 2023

Discussion of the findings

The results indicate that while Lagos Metropolis is making progress in fibre deployment, challenges persist in technical manpower, cost of deployment, and infrastructure security. The reliance on direct burying reflects global best practices in metropolitan fibre deployment (TeleGeography, 2022) [30], but sustainability requires balancing costs with advanced monitoring solutions.

The dominance of corrective maintenance also highlights a need for a paradigm shift toward preventive and predictive approaches. Global evidence suggests that predictive maintenance strategies, leveraging artificial intelligence and remote monitoring, significantly reduce downtime and improve fibre longevity (Wirtz & Zeithaml, 2018) [32].

Overall, the findings underscore that addressing deployment barriers, investing in workforce training, and integrating advanced monitoring technologies are essential for enhancing fibre optic network efficiency in Lagos' high-density urban environment.

Conclusion

This study has shown that fibre optic deployment and maintenance in Lagos Metropolis are shaped by both technical and infrastructural realities of a high-density urban environment. Deployment is largely achieved through direct burying methods due to their durability, yet firms face persistent challenges including high costs, limited skilled manpower, and security threats. Maintenance practices remain primarily corrective, which prolongs downtime and impacts service reliability. Overall, the findings suggest that the effectiveness of fibre optic networks in Lagos depends on addressing workforce limitations, adopting more advanced monitoring technologies, and implementing robust infrastructure protection measures.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Expand technical training and certification programs to address shortages of skilled fibre optic personnel.
2. Adopt predictive and technology-driven maintenance strategies such as AI-based monitoring and drone surveillance to reduce downtime.
3. Strengthen security measures through partnerships with government agencies and deployment of protective infrastructure.
4. Streamline right-of-way policies and inter-agency coordination to reduce delays and costs in fibre deployment.
5. Encourage ICT firms to invest in sustainable, scalable fibre infrastructure that can meet growing demand in high-density urban areas.

References

1. Adeniran A. Infrastructure financing and broadband deployment in Nigeria. Journal of African Policy Studies,2021:27(2):55–73.
2. Akanle O, Akinyemi A. Skills, youth employment and digital infrastructure in Nigeria. African Journal of Science Technology Innovation and Development,2020:12(7):811–820. https://doi.org/10.1080/20421338.2020.1729481
3. Braun V, Clarke V. Using thematic analysis in psychology. Qualitative Research in Psychology,2006:3(2):77–101. https://doi.org/10.1191/1478088706qp063oa
4. Creswell JW, Creswell JD. Research design: Qualitative, quantitative, and mixed methods approaches. Thousand Oaks, CA: Sage Publications, 2018.
5. Etikan I, Musa SA, Alkassim RS. Comparison of convenience sampling and purposive sampling. American Journal of Theoretical and Applied Statistics,2016:5(1):1–4. https://doi.org/10.11648/j.ajtas.20160501.11
6. Federal Ministry of Communications Innovation and Digital Economy FMCIDE. Digital economy annual report. Abuja: FMCIDE Publications, 2024.
7. FMCIDE / Industry white paper. Broadband access for all: Deepening Nigeria's national backbone and middle-mile infrastructure. FMCIDE White Paper, 2024. Retrieved from https://nban.gov.ng/wp-content/uploads/2025/02/FMCIDE-White-Paper-broadband-access-for-all-deepening-nigerias-national-backbone-and-middle-mile-infrastructure-january-2024.pdf
8. Gill P, Stewart K, Treasure E, Chadwick B. Methods of data collection in qualitative research Interviews and focus groups. British Dental Journal,2008:204(6):291–295. https://doi.org/10.1038/bdj.2008.192
9. Guardian Nigeria technology coverage. Why fibre-to-the-home remains concentrated in Nigerian cities. The Guardian Nigeria, 2025. https://guardian.ng/technology/why-fibre-to-the-home-remains-concentrated-in-cities/
10. International Labour Organization ILO. Digital economy and gender gaps in ICT work. Geneva: ILO, 2021.
11. International Telecommunication Union ITU. Handbook on optical fibre cables. Geneva: ITU, 1996.
12. International Telecommunication Union ITU. Broadband infrastructure guidelines. Geneva: ITU, 2024.
13. International Telecommunication Union. Optical fibre cable network maintenance ITU-T Recommendation L.25, 1996. https://www.itu.int/rec/T-REC-L.25
14. International Telecommunication Union. Guide on the use of ITU-T L-series recommendations related to optical technologies for outside plant LSTP-GLSR, 07/2024, 2024. https://www.itu.int/epublications
15. Kothari CR. Research methodology: Methods and techniques. 2nd ed. New Age International, 2004.
16. Lagos State Government. Population-Lagos State. Lagos State Government, 2015.
17. Metro Lagos. Metro Lagos Nigeria. Local Government Areas. City Population, 2015.
18. National Broadband Plan. 2020–2025 National Broadband Plan: Unlocking Nigeria's digital economy. Abuja: Federal Government of Nigeria, 2020.
19. National Broadband Plan. Nigerian National Broadband Plan 2020–2025 NCC / Federal Government of Nigeria, 2020. Retrieved from https://digitalrightslawyers.org/wp-content/uploads/2021/01/Nigerian_National_Broadband_Plan_2020-2025.pdf
20. Ndukwe E. Broadband and the Nigerian economy: Challenges and prospects. Telecommunications Policy Review,2019:43(4):220–234.
21. Nigerian Communications Commission [NCC]. Industry statistics report 2022. Abuja: NCC, 2023.
22. Nigerian Communications Commission. Year-end performance report: Subscriber / network data annual report, 2022. (NCC). https://www.ncc.gov.ng/sites/default/files/2024-11/Documents/2022%20YEAR%20END%20PERFORMANCE%20REPORT.pdf,2023
23. Ogunwale A. Fibre optic infrastructure in Nigeria: Challenges and opportunities. Journal of Information Technology and Development,2018:14(2):102–115.
24. Ogunwale S, Author(s). Analysis and implementation of Fibre-to-the-Home FTTH network: Case study — Peace Estate, Lagos State, Nigeria conference paper / thesis. ResearchGate, 2018. https://www.researchgate.net/publication/327418251_Analysis_and_Implementation_of_Fiber_to_the_Home_Network_Using_Peace_Estate_Lagos_State_Nigeria_as_a_Case_Study

25. Pressman R, Maxim B. Software engineering: A practitioner's approach 9th ed. New York: McGraw-Hill, 2020.
26. ResearchGate / Literature review. State of fiber optic networks for internet broadband penetration in Nigeria: A review, 2018. https://www.researchgate.net/publication/322698504_State_of_Fiber_Optic_Networks_for_Internet_Broadband_Penetration_in_Nigeria-A_Review
27. Resnik DB. The ethics of research with human subjects: Protecting people, advancing science, promoting trust. Springer, 2018. https://doi.org/10.1007/978-3-319-68756-8.
28. Statista. Broadband internet penetration in Nigeria, 2023. https://www.statista.com
29. TechCabal / Business reporting on fibre projects. Nigeria's $2b fibre project offers lifeline for internet providers. TechCabal, 2025. https://techcabal.com/2025/08/12/nigerias-2b-fibre-project-offers-lifeline-for-internet-providers/
30. TeleGeography. Global bandwidth research service. Washington, DC: TeleGeography, 2022.
31. This Day. Eko 2012: Building Branding through Sports, Articles. This Day. Lagos, Nigeria, 2012.
32. Wirtz J, Zeithaml VA. Cost-effective service excellence. Journal of the Academy of Marketing Science,2018:46(1):59–80. https://doi.org/10.1007/s11747-017-0560-7