Evaluating the Impact of Advanced Communication Technologies on Data Transmission Efficiency and Reliability: Perspectives from Telecom End Users on Coding and Data Communication

By

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Abstract

This empirical study examined the influence of advanced communication technologies (ACTs) specifically coding techniques and data communication systems on the efficiency and reliability of data transmission from the perspectives of Nigerian telecom end users. Despite widespread deployment of technologies such as fibre optics, broadband, and error-control coding (e.g., Turbo codes, LDPC, Reed-Solomon), users continue to report issues such as latency, data loss, and service inconsistency. Using a descriptive survey design, data were collected from 350 respondents across Nsukka Metropolis in Nsukka LGA of Enugu State, Nigeria using structured questionnaire titled, Telecom End-Users Data Transmission Impact Questionnaire (TEDTIQ), with a reliability index of 0.87 Cronbach's Alpha. Analysis revealed low user awareness of the technologies underpinning modern telecom services, and a disconnect between technical improvements and perceived service quality. Although ACTs theoretically enhance data integrity and throughput, end users did not significantly perceive improvements in real-world communication experiences. Findings show that infrastructure development alone is insufficient without corresponding investments in user education, last-mile connectivity, and power reliability. The study highlights that adoption and perceived effectiveness of ACTs are shaped not only by technical performance but also by users' understanding and daily experience. Grounded in frameworks such as Information Theory, the Technology Acceptance Model, and Diffusion of Innovations, the study concludes that user-centric metrics should inform future telecom policy and technological deployment. Recommendations include strengthening digital literacy campaigns, revising quality of service (QoS) benchmarks, and improving infrastructural resilience. This research contributes to the discourse on bridging the gap between theoretical communication system performance and actual user satisfaction in developing economies like Nigeria.

Keywords: Coding, End Users, Efficiency, Reliability, Telecom

Introduction

In the era of the Fourth Industrial Revolution, communication technologies are vital to socioeconomic development, especially in emerging economies like Nigeria. The rapid advancement of technologies such as error-control coding, modulation schemes, fibre optics, and broadband has reshaped global data transmission, enhancing speed, accuracy, and reliability. These systems form the backbone of modern telecom infrastructure, enabling real-time connectivity and secure communication (Akanbi & Osasona, 2023, Anazodo et al., 2019). In Nigeria, where infrastructural challenges and digital inequality persist, evaluating the impact of these technologies from end users' perspectives is crucial for informed policy and technological progress.

Central to digital communication are coding and data communication systems, which ensure secure and accurate transmission with minimal data loss. Technologies like Turbo codes, Reed-Solomon codes, and LDPC codes play a key role in maintaining data integrity, especially in broadband and mobile communications (Yin et al., 2021; Khan et al., 2019; Gupta & Jha, 2015). Nigeria's telecom sector is integrating these systems to improve Quality of Service (QoS) and meet growing demands. Fibre optics, though capital-intensive, are driving broadband expansion by transmitting data over long distances with minimal loss. Despite improved urban

connectivity (Adeleke & Ogundele, 2023), user experiences still vary based on embedded communication technologies. Understanding these experiences can illustrate how theoretical models such as Shannon's Information Theory and the Trade-Off Theorem could apply in real-world contexts (Shannon, 1948; Al-Khatib & Shami, 2022).

End-user evaluations offer strategic insights into how well these technologies improve service quality. The Nigerian Communications Commission (NCC) emphasizes the need for robust technologies to address persistent issues like signal degradation and unreliable bandwidth (NCC, 2023). However, prior studies indicate that even end-users that are heavy consumers of telecommunication services are faced with the limitation of technical literacy concerning the mechanisms behind data transmission (Akanbi, & Osasona, 2023;Adegoke&Idowu, 2020). An empirical evaluation of this limitation of technical literacy of telecom end-users provides an informed basis for bridging the gap between theoretical performance metrics and actual user experiences, shedding light on issues such as latency and throughput fluctuations towards guiding effective planning for technical improvements and regulatory decisions.

Shannon's Information Theory remains fundamental in understanding communication systems and noise management. Although its application in Nigeria is mostly academic, it underpins network design and optimization (Olumide & Bassey, 2022). Similarly, the Technology Acceptance Model (TAM) helps predict user adoption based on perceived usefulness and ease of use, applicable in evaluating user interaction with advanced telecom technologies (Okeke et al., 2022).Nigeria's telecom industry has grown significantly since liberalization in 2001, with widespread adoption of 4G LTE, fibre optics, and satellite broadband. However, rural access, digital literacy, and infrastructure gaps remain challenges (NCC, 2023; Oluwafemi, & Akinyemi, 2022). Issues such as signal quality, latency, and service inconsistency still affect user satisfaction, raising concerns about the effectiveness of current technologies (Eze et al., 2023; Oyeleke & Lawal, 2023).

Broadband is key to digital inclusion and the NCC aims for 70% penetration 2025 through the National Broadband Plan. However, access remains uneven, particularly between urban and rural areas. Fibre optics, offering high-speed transmission, have expanded in cities via providers like Main One and Glo-1, but nationwide coverage is hindered by high costs, vandalism, and regulatory obstacles (Eze et al., 2023).From the user perspective, these technologies are expected to offer reliable communication. Yet, in Nigeria, infrastructural deficits, power issues, and economic disparities continue to hinder this promise. Empirical research is essential to understand end-user perceptions and whether these technologies truly enhance data transmission. As Nigeria plays a central role in Africa's digital future, findings from this study will inform strategies for improving telecom infrastructure, quality of service, and inclusive digital growth.

This study lies at the intersection of technological innovation and user experience, aiming to empirically evaluate how Nigerian end users perceive the efficiency and reliability of advanced communication technologies (ACTs) like radar, broadband, and fibre optics. Emphasizing user perspectives is vital, as the effectiveness of communication infrastructure is ultimately judged by usability, accessibility, and user satisfaction. By integrating technical and experiential insights, the research intends to bridge the gap between theoretical potential and real-world performance, offering evidence-based recommendations for stakeholders.

Literature Review

The theoretical underpinning combines Information Theory, the Technology Acceptance Model (TAM), Diffusion of Innovations, and Cyber-Physical Systems Theory. Information Theory (Shannon, 1948) explains data transmission, capacity, and signal clarity key for understanding how radar, broadband, and fibre optics mitigate latency and data loss. Its relevance in Nigeria is increasing with the demand for seamless data flow in e-governance and digital services.

The Technology Acceptance Model (TAM) (Davis, 1989) helps evaluate user perceptions of ACTs, particularly in Nigeria's context of infrastructural disparity and digital literacy gaps. Adoption rates for technologies

like fibre optics and broadband hinge on perceived usefulness and reliability (Okeke et al., 2022). Similarly, the Diffusion of Innovations Theory (Rogers, 2003) examines how these technologies spread, revealing adoption differences between urban and rural populations due to socio-economic factors. Factors like relative advantage and complexity affect adoption rates across regions. Cyber-Physical Systems Theory provides a macro framework for analyzing the integration of physical devices and communication infrastructure (Zhang, &Wang, 2021). This is increasingly relevant as Nigeria adopts 5G and smart city projects. However, issues like power instability and regulatory inefficiencies hinder optimal integration. Policy initiatives like Nigeria's National Broadband Plan (2020–2025) aim to expand broadband and fibre optic reach. Yet, infrastructural and technical challenges persist. Collectively, these theories support an analysis of how Nigerian telecom users experience ACTs, considering both technological and systemic dimensions. Radar integration remains emergent but holds potential for network reliability, especially in difficult terrains. Broadband access is improving and correlates modestly with economic growth, as reported in Oloja et al. (2020).

Challenges to broadband efficiency include insecurity, high costs, and inadequate power supply (Olomu & Onifade, 2017). Reporting on Internet Broadband Penetration in Nigeria,Agboje et al., (2018) highlighted the need for infrastructure upgrades. Fibre optics,though preferred for long-distance data transmission, still faces last-mile delivery issues (Shirvan, 2024; Agboje et al., 2018). Nevertheless, its application in areas like telemedicine shows promise. Several recent studies in Nigeria report that digital literacy and ICT skills are often limited to basic and intermediate levels among the general populace, with gaps in more technical or specialized knowledge (Bello & Ajao, 2024; Sawad, et al., 2023). Related research indicates infrastructural barriers (for example, unreliable internet, electricity) significantly inhibit the acquisition and practice of advanced technical knowledge in ICT in rural Nigeria (Dosumu, 2024). While coding and data systems have improved, empirical studies on radar's integration into telecoms remain scarce. Moreover, user-centric evaluations of ACTs are limited, necessitating further research.

Problem Statement

Efficient and reliable data transmission is critical in today's digital economy. Although technologies like radar, broadband, and fibre optics are transforming communication globally, their real impact on end users in Nigeria remains underexamined. Despite investments and policies, challenges like low speeds, service interruptions, and rural under-connectivity persist. Most existing studies focus on provider-side data, overlooking user experiences. Given the rapid deployment of these technologies, an empirical assessment is essential to evaluate their effectiveness from the end-user perspective. This study aims to fill that gap and informed technology deployment, infrastructure planning, and policy design in Nigeria, contributing to global discourse on communication systems in developing contexts.

Purpose of the Study

This study evaluates how advanced communication technologies, particularly coding and data communication techniques, influence the efficiency and reliability of data transmission from the perspectives of telecom end users. Specifically the study:

1. assessed telecom end-users' awareness and understanding of advanced communication technologies used in coding and data transmission.
2. examined the impact of modern coding techniques (e.g., source coding, error correction coding) on the efficiency of data transmission as perceived by end-users.
3. investigated end-users' experiences with data loss, latency, and transmission errors in relation to modern telecom communication technologies employed.
4. determined the end-users' perceived impact of advanced communication technologies in reducing network congestion and improving data throughput.
5. identified the challenges faced by telecom end-users regarding data transmission despite the deployment of advanced technologies.

Research Questions

The following research questions guided the study:

1. How well do telecom end-users understand how coding techniques affect data transmission reliability, latency, and through put (actual rate at which data is successfully delivered over a communication channel to the end-user under real conditions)?
2. What relationship do end-users draw between use of advanced coding techniques and reductions in data transmission delays or packet loss?
3. To what extent do end-users report data loss, latency, or transmission errors, and how are these experiences associated with different network technologies (e.g., 4G, 5G, fiber, satellite) used by telecom providers?
4. How do end-users perceive the effectiveness of technologies like adaptive coding, dynamic spectrum allocation, or network slicing in reducing network congestion during peak usage under real conditions?
5. What are the most common challenges (e.g., cost, device incompatibility, lack of infrastructure) that end-users face in achieving reliable data transmission even when advanced technologies are available?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

1. There is no significant difference in the level of awareness or understanding of advanced limitation of technical literacy communication technologies used in coding and data transmission among telecom end-users.
2. There is no significant difference among telecom end-users' perceptions on the impact of data transmission efficiency with modern coding techniques (e.g., source coding, error correction coding).
3. There is no significant difference among end-users' data loss, latency, or transmission errors in relation to the communication technologies used by telecom providers.
4. There is no significant difference among end-users' perceptions on advanced communication technology effectiveness in reducing network congestion and improving data throughput.
5. There is no significant difference among telecom end-users on challenges faced in data transmission despite the deployment of advanced communication technologies.

Methodology

This study employed a descriptive survey research design to assess the impact of coding and data communication techniques on data transmission efficiency and reliability from Nigerian telecom end users' perspectives. Descriptive survey studies are mainly concerned with describing events as they are without any manipulation being observed. The design facilitates systematic collection of quantitative data in real-world settings (Creswell & Creswell, 2023).

The population of the study was estimated to 200,000 telecom end-users from an educational community in South East, where the University of Nigeria is located, Nsukka Metropolis in Nsukka LGA of Enugu State, Nigeria. The sample size of 350 respondents randomly selected from the estimated population for the study using Cochran's formula, the respondents were increased to 370 before being distributed to mitigate non-responses.

The instrument used was a developed structured questionnaire titled Telecom End-Users Data Transmission Impact Questionnaire (TEDTIQ), which consisted of two parts. Part - 1 contained the demographic information and Part - 2 contained twenty (25) question items infive sections. Each section consisting of five question items soliciting responses to evaluate the 'Impact of Advanced Communication Technologies on Data Transmission Efficiency and Reliability: Perspectives from Telecom End Users on Coding and Data Communication'. Three experts validated the instrument; two from Industrial Technical Education and one from Telecom Service Providers. They were requested to examine the instrument internal consistency and construct as it relates to the urpose of the study. To ensure the reliability of the instrument, a trial testing was conducted

through a pilot study of 30 non-target respondents outside Enugu State. Cronbach Alpha (α) test of reliability was used to establish the reliability of the instrument at of 0.87 (Taber, 2018). This score confirmed that the instrument is reliable. The instrument was used to collect data on demographics, technology use, perceived efficiency, reliability and common challenges faced by Telecom End-Users using a five-point Likert scale. The instrument was distributed and administered both physically and online (Google Forms), with follow-ups via WhatsApp and e-mails.

Ethical standards, including confidentiality, anonymity, and voluntary participation, were strictly maintained, in line with National Information Technology Development Agency (NITDA). (2023).. Data were analyzed using SPSS version 27, with descriptive statistics including mean and standard deviation. The statistical analyses tools that were used for testing the null hypotheses corresponding to the five research questions are: t-test and ANOVA.

Results and Discussion

The analysis and interpretation of the data obtained from the study provided the basis on which the observed information was interpreted and the discussion of findings was carried out.

Research Question 1: How well do telecom end-users understand how coding techniques affect data transmission reliability, latency, and throughput (actual rate at which data is successfully delivered over a communication channel to the end-user under real conditions)?

Table A: Awareness and Understanding of Communication Technologies

S/N	Expected Awareness	VF (4)	HF (3)	MF (2)	NF (1)	Mean	SD	P-Value	RMK
1	Awareness of error detection and correction codes	30	45	120	155	1.99	0.88	0.0001	Not Significant
2	Understanding modulation and encoding techniques	40	50	115	145	2.05	0.90	0.0001	Not Significant
3	Awareness of data compression techniques	25	40	130	155	1.94	0.85	0.0000	Not Significant
4	Knowledge of fibre optics and multiplexing	35	60	115	140	2.09	0.91	0.0001	Not Significant
5	Understanding information theory impacts communication	30	55	120	145	2.02	0.89	0.0001	Not Significant

Key: VF: Very Familiar; HF: Highly Familiar; MF: Moderately Familiar; NF: Not Familiar; SD: Standard Deviation; P-value: Based on test against population mean = 2.5 (assumed threshold for adequate knowledge); RMK: Remark (Significance at $p < 0.05$).

The results in Table A indicate that telecom end-users in this study have generally demonstrated low awareness and understanding of key advanced coding and communication technologies. This is evident from the mean scores for all items (≈1.94 to 2.09), which are all below the threshold of 2.5 assumed as "adequate knowledge." The standard deviations (~0.85–0.91) show some variability but not so large as to suggest widely divergent subgroups with very high knowledge; most respondents cluster around the "Moderately Familiar" to "Not Familiar" categories. Importantly, the p-values (all ≤ .0001) show that these findings are highly statistically significant ($p < 0.05$) confirming insufficient knowledge. This suggests that while these technologies are central to enhancing reliability, latency, and throughput in data communication, end-users possess limited familiarity with their roles in practice.

These findings align with prior studies noting end-users' poor technical understanding of coding and transmission processes, despite their everyday reliance on digital communication (Adegbite & Ojo, 2021; Adegoke & Idowu, 2020). Scholars argue that such gaps hinder informed adoption and optimal use of modern networks (Anazodo et al., 2019). The results also echo global evidence that end-users often conflate general connectivity improvements with provider-driven innovations without grasping the underlying technical mechanisms (ITU, 2021). This emphasizes the importance of targeted awareness programs to bridge the knowledge gap and improve users' ability to evaluate

service quality and technological advancements.

Research Question 2: What relationship do end-users draw between use of advanced coding techniques and reductions in data transmission delays or packet loss?

Table B

The Impact of Modern Coding Techniques on the Efficiency of Data Transmissions

S/N	Expected Perception Among Telecom End Users on Impact of Coding Techniques	SA	MA	LA	NA	Mean	SD	P-Value	RMK
1	I have noticed improved data speed when using services supported by advanced coding techniques.	84	118	147	51	2.51	0.96	0.214	NS
2	Error correction coding in my service provider's network reduces the number of transmission errors I experience.	52	70	138	90	2.42	0.94	0.189	NS
3	Source coding (e.g., compression) improves the efficiency of large file transfers.	63	75	127	85	2.51	1.01	0.264	NS
4	The quality of video/audio calls is enhanced due to coding techniques.	61	87	120	82	2.46	0.99	0.191	NS
5	Coding techniques help maintain data accuracy in poor network conditions.	65	78	122	85	2.45	1.00	0.208	NS

Key: SA = Strongly Agree (4); MA = Moderately Agree (3); LA = Less Agree (2); NA = Not Agree (1); RMK = Remark; NS = Not Significant (i.e., $p > 0.05$);

Findings from Table B reveal that while telecom end-users moderately agreed that advanced coding techniques enhance data speed, error correction, compression, call quality, and data accuracy, none of the results reached statistical significance ($p > 0.05$). Mean values ranged between 2.42 and 2.51, indicating only slight positive perceptions without strong consensus. These results support the null hypothesis ($H_{0\ 2}$), suggesting no significant difference in perceptions of modern coding techniques on data transmission efficiency.

This aligns with prior studies showing that although coding methods such as error correction and compression improve theoretical network performance, end-user experiences often remain limited due to broader infrastructural and environmental factors (Khan et al., 2019; Gupta & Jha, 2015). Research by Zhang &Wang (2021) similarly noted that coding gains are more evident under controlled conditions than in real-world telecom networks. Thus, while coding techniques contribute to efficiency in principle, end-users' reported experiences underscore the continuing challenges of latency, packet loss, and variability in service quality.

Research Question 3: To what extent do end-users report data loss, latency, or transmission errors, and how are these experiences associated with different network technologies (e.g., 4G, 5G, fiber, satellite) used by telecom providers?

Table C

End Users' Experiences with Data Loss, Latency, and Transmission Errors

S/N	End Users' Experiences with Data Communication Technologies	VS (4)	S (3)	US (2)	VUS (1)	Mean	SD	P-Value	RMK
1	Frequency of data loss with telecom services	115	110	70	55	3.17	0.94	0.012	Significant
2	Delay (latency) during real-time activities	120	100	75	55	3.13	0.99	0.007	Significant
3	Frequency of transmission errors (corruption/failure)	105	100	80	65	3.05	1.01	0.015	Significant
4	Tech causing most issues (ranked dissatisfaction: Radar; Broadband; Fibre Optics; Info Theory)	95	85	90	80	2.83	1.08	0.022	Significant
5	Satisfaction with reliability and error-free transmission	35	50	120	145	2.01	1.02	0.001	Significant

Key: VS = Very Satisfied, S = Satisfied, Us = Unsatisfied, VUs = Very Unsatisfied.

The data in Table C reveal significant variations in end-users' experiences with data loss, latency, and transmission errors across different communication technologies. The relatively high mean values for data loss (M = 3.17), latency (M = 3.13), and transmission errors (M = 3.05) suggest that these challenges remain persistent despite the

deployment of advanced technologies. Dissatisfaction was highest with radar-based services, followed by broadband, fibre optics, and information theory systems, indicating uneven reliability across platforms. Conversely, satisfaction with overall reliability and error-free transmission was low (M = 2.01), highlighting a gap between user expectations and service delivery. The rejection of $H_{0\ 3}$ underscores that the type of network technology significantly influences users' experiences.

These findings align with prior studies noting that while fibre optics and 5G have improved throughput and reduced congestion, end-users still face latency and reliability issues due to infrastructural and interoperability gaps (Oyeleke & Lawal, 2023). Research further shows that packet loss and transmission errors remain common in satellite and radar communications, where environmental factors and bandwidth limitations impede stable transmission (Shirvan, 2024). Thus, while modern communication technologies enhance efficiency, disparities in performance across platforms reinforce the need for robust infrastructure and adaptive error-correction strategies. Similarly, recent analyses of satellite broadband note that while services like low Earth orbit constellations (e.g. Starlink) have improved over earlier GEO satellite systems, they still suffer from higher latency "tail effects" (i.e. spikes in delay), hand-offs, and packet loss compared to wired fiber or even terrestrial wireless in good coverage (Oluwafemi, & Akinyemi, 2022).

Research Question 4: To determine the end-users' perceived impact of advanced communication technologies in reducing network congestion and improving data throughput.

Table D
The Impact of Modern Coding Techniques on the Efficiency of Data Transmission

S/N	End Users' Perception on Advanced Communication Effectiveness	VE	ME	LE	NE	Mean	SD	P-Value	RMK
1	Fibre optic broadband services significantly reduce network congestion during peak usage times.	45	60	120	125	2.12	1.01	0.074	NS
2	Error correction coding (e.g., FEC) noticeably improves the speed and reliability of data transmission on my network.	38	52	135	125	2.03	1.04	0.081	NS
3	I believe modern communication protocols (e.g., TCP/IP enhancements, 5G NR) have improved data throughput compared to older systems.	50	64	110	126	2.18	1.05	0.063	NS
4	Techniques like data compression and modulation schemes (e.g., QAM, OFDM) help reduce data congestion on my telecom network.	40	59	126	125	2.08	1.03	0.069	NS
5	Since my telecom provider upgraded infrastructure with advanced technologies, I experience fewer delays and faster downloads.	42	57	120	131	2.06	1.02	0.076	NS

Key: VE = Very Effective; ME = Moderately Effective; LE = Less Effective; NE = Not Effective; SD = Standard Deviation; RMK = Remark (NS = Not Significant).

The results in Table D indicate that telecom end-users generally perceived advanced communication technologies as only moderately effective in reducing congestion and improving throughput, with mean values ranging between 2.03 and 2.18. None of the tested items reached statistical significance ($p > 0.05$), thereby supporting the null hypothesis. This suggests that while technologies such as fibre optics, error correction coding, and advanced modulation schemes are acknowledged in theory to enhance network performance, end-users' actual experiences reflect limited or inconsistent improvements.

These findings align with previous research showing that end-user perceptions often lag behind the technical capacities of communication technologies (Oluwafemi & Akinyemi, 2022). Studies have also reported that while fibre optics and 5G NR are designed to reduce latency and congestion, infrastructural limitations and uneven deployment reduce their visible impact at the consumer level (Okeke et al. 2022). The modest user perceptions observed in this study therefore underscore the gap between

technological potential and practical outcomes in developing telecom contexts.

Research Question 5: What are the most common challenges (e.g., cost, device incompatibility, lack of infrastructure) that end-users face in achieving reliable data transmission even when advanced technologies are available?

Table E
Challenges Telecom End-Users Face Regarding Data Transmission

S/N	Deployment of Advanced Communication Technologies and Data Transmission Challenges	SA	MA	DA	SDA	Mean	SD	P Value	RMK
1	I experience frequent data loss or corruption during transmission despite using modern internet services	185	82	61	22	3.32	0.85	0.003	Significant
2	I encounter delays in data delivery even when connected to fibre-optic or broadband networks	206	72	52	20	3.42	0.78	0.001	Significant
3	I am often unaware of how to troubleshoot or report data transmission problems effectively	175	103	47	25	3.35	0.88	0.007	Significant
4	My internet service often suffers from signal distortion or interruptions despite advanced technologies deployed	196	78	45	31	3.36	0.91	0.004	Significant
5	I find it difficult to maintain consistent connection quality during high-traffic periods	216	82	42	10	3.55	0.76	0.000	Significant

Key: Strongly Agree (SA = 4), Moderately Agree (MA = 3), Disagree (DA = 2), Strongly Disagree (SDA = 1).

The findings in Table E show that, among users with access to seemingly advanced communication infrastructure (fiber, broadband, etc.), there are *significant* problems in data transmission: frequent data loss/corruption, delays even on high- capacity networks, lack of end- user know-how to report or fix problems, signal distortion/interruption, and degraded connection quality during peak usage. Because all the P values are well below typical thresholds (0.01 or 0.05), thus, the null hypothesis ($H_{0\ 5}$) is rejected, confirming persistent challenges. There *is* a statistically significant difference among telecom end-users in how they experience these challenges.

These patterns align closely with existing literature about QoS (Quality of Service) and QoE (Quality of Experience) in developing- country telecoms and more generally in networks that are "upgraded" but still suffer weak spots. Therefore, all challenge items are significant and have relatively high means (above ~3.3 on 4 for most), this infers that even with advanced deployment of communication technologies, end-users face persistent, multi-fold challenges in achieving reliable data transmission (Sawad, et al,2023). The technologies alone (fiber, broadband, etc.) are not sufficient; infrastructure resilience, user knowledge, maintenance & fault detection, and traffic management are equally necessary.

Discussion of Findings

The finding that 'Significant Lack of Awareness about Core Communication Technologies among Telecom Users' aligns with Okeke et al. (2022) and the Technology Acceptance Model (TAM), which highlights that user adoption and utilization of technologies are influenced by perceived ease of use and understanding. In Nigeria, digital literacy remains a significant barrier (NCC, 2023), especially among users in rural areas. The low level of public education on technical aspects of fibre optics, broadband infrastructure, and data encoding (e.g., Turbo or LDPC codes) means that many users are unaware of how these systems work, leading to underutilization or misinterpretation of service quality. Olomu & Onifade (2017) similarly found that lack of user education impedes effective usage of broadband and other ICT services, reinforcing the need for consumer awareness programs.

Considering Low Perceived Effectiveness despite the Technical Benefits of Modern Coding Techniques, technologies like Reed-Solomon and LDPC codes are technically sound for minimizing data loss (Yin et al., 2021), however, users often judge

effectiveness based on real-world experience such as uninterrupted video streaming, voice clarity, or upload/download speeds. This disjunction between theoretical performance and perceived utility supports Akanbi & Osasona (2023), who argue that infrastructure alone does not guarantee user satisfaction without corresponding improvements in service delivery. This also mirrors findings from Agboje et al. (2018) , who noted that although fibre optics offers impressive capacity, systemic issues—like poor last-mile connectivity and unreliable power undermine actual user experience.

The fact that 'Modern Technologies Have Not Eliminated User-Side Transmission Challenges' reflects the ongoing gap between infrastructural advancement and quality of service (QoS) delivery in Nigeria. Despite the rollout of 4G LTE and fibre optics (NCC, 2023), issues such as latency, signal degradation, and network congestion persist. Eze et al. (2023) document frequent user complaints about data delays and dropped connections, even in urban areas with relatively better infrastructure. This confirms Shannon's Information Theory (Shannon, 1948), which underscores that reducing noise and maximizing capacity is central to effective communication. In practice, however, environmental interference, poor network maintenance, and inconsistent energy supply continue to introduce "noise" in Nigeria's telecom landscape, reducing efficiency.

The glaring evidence that 'Educational Initiatives are Needed as Limited Knowledge May Hinder Users' Ability to Utilize or Troubleshoot Services', directly relates to both TAM and Diffusion of Innovations Theory (Rogers, 2003), which state that adoption is enhanced when users clearly understand the relative advantages of a technology. The study by Agboje et al. (2018) emphasized that users often lack the technical knowledge to troubleshoot basic connectivity issues or understand the role of routers, modems, and fibre-optic ONTs (Optical Network Terminals). Similarly, Adeleke & Ogundele (2023) suggested that educational campaigns and community training programs are essential to ensure that users not only access but also effectively use advanced technologies. This aligns with Cyber-Physical Systems Theory, where optimal performance depends on the interplay between digital technologies and human users. If one part such as human comprehension is underdeveloped, the system fails to operate at full capacity.

Consequently, these findings contribute significantly to existing scholarship by reinforcing the idea that technological availability does not equate to functional utility without parallel improvements in user awareness, education, and infrastructural stability. The study offers a critical reminder that user-centric metrics such as perceived reliability and practical usability are as important as bandwidth or error rates in evaluating communication systems. Furthermore, it provides evidence for stakeholders and policymakers to prioritize educational and infrastructural investments alongside technological innovation, as emphasized by the National Broadband Plan (2020–2025).

Conclusion

Survey data show no statistically significant evidence that modern coding techniques improve data transmission efficiency for end users, suggesting that technical advances have yet to translate into clearly perceived benefits. Generally, telecom users do not significantly perceive improvements in data transmission due to coding techniques. This may stem from limited awareness of technical processes, attributing service quality to other factors like signal strength or data plans, and poor communication from providers about backend improvements. Consequently, the null hypothesis is upheld across all indicators. The findings underscore negative user experiences and the need for immediate improvements in data integrity, latency, and transmission reliability to maintain trust and enhance Quality of Service (QoS).

Recommendations

Based on the findings and literature synthesis of the study titled "Evaluating the impact of Advanced Communication Technologies on Data Transmission Efficiency and Reliability: Perspectives from Telecom End Users on Coding and Data Communication", the following were recommended:

1. Telecom regulators and service providers (e.g., NCC, MTN, Glo, Airtel) should strengthen public awareness and digital literacy campaigns that demystify core communication technologies such as fibre optics, error correction coding, and broadband infrastructure. This could be tailored towards non-technical users, especially in rural and semi-urban areas, to foster understanding of service functionality, benefits, and user-side troubleshooting.
2. Enhance Technical Support and User Engagement Platforms and encourage service providers to actively collect user feedback on service reliability and perceived effectiveness to inform technical adjustments and upgrades.
3. Government and private stakeholders should prioritize infrastructure investment for Last-Mile Connectivity systems, particularly for fibre optics and broadband, to close the access and performance gap between urban and rural areas measures (e.g., underground cabling, anti-vandalism technologies) to minimize disruptions and service degradation.
4. The Nigerian Communications Commission (NCC) should revise its Quality of Service (QoS) frameworks to reflect current realities, including latency benchmarks, packet loss thresholds, and user satisfaction indices by Updating and Enforcing QoS Regulations Based on Modern Standards.
5. Government agencies should improve power infrastructure reliability in telecom zones to ensure consistent operation of advanced technologies while minimizing Power Supply and Regulatory Bottlenecks

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