

Leveraging Nigerian Communications Satellite (Nigcomsat) For Broadband Penetration in Rural and Remote Areas of Nigeria Using Ka Band

BELLO SURAJUDEEN ADEWALE¹, DANIEL TAYO ONARE², ADIGUN ABIMBOLA OLALEKAN³

^{1, 2, 3}*Nigeria Communications Satellite Ltd*

Abstract- This study investigates the deployment of the Nigerian Communications Satellite (NIGCOMSAT-1R) Ka-band payload to address broadband internet challenges in rural and remote regions in Nigeria. Despite the National Broadband Plan (2020–2025) targeting 10Mbps for rural areas at no more than ₦390 per gigabyte, a persistent digital divide remains due to inadequate fibre infrastructure, high data costs, and unreliable mobile coverage. Employing a mixed-methods design, the study surveyed 230 respondents across rural communities in Nigeria, complemented by qualitative interviews and a technical assessment of NIGCOMSAT-1R's Ka-band VSAT components, including the Newtec MDM2200 modem and 75cm dish antenna. The findings reveal a critical paradox, while 90% of respondents have internet access predominantly via mobile data (88.3%) over half (50.4%) rate connectivity as poorly reliable, and 80% perceive it as expensive. Service quality averages below 2.5 on a 5-point scale, yet 86.5% use the internet daily for communication (57%) and business (25.7%), indicating substantial unmet demand. Awareness of satellite internet is high (80%), with 71.7% specifically aware of NIGCOMSAT, though actual adoption remains negligible due to terminal costs, lack of local service resellers, and erratic power supply. Overwhelming community acceptance was documented: 96.5% view satellite broadband positively, 93% consider it viable locally, 97.8% affirm its developmental role, and 97.8% are willing to adopt. Respondents recommended subsidies (69.6%), infrastructure investment (69.1%), awareness campaigns (69.1%), power improvements (65.2%), affordable pricing (59.6%), and public-private partnerships (43.9%). The research concludes that leveraging NIGCOMSAT's Ka-band payload is technically feasible and socially endorsed, serving as a necessary complement to terrestrial networks for universal broadband coverage. The study recommends a multi-dimensional policy framework integrating consumer subsidies, off-grid solar solutions, community service centres, digital literacy training, and public-private partnerships to deliver socio-economic benefits to Nigeria's rural populations.

Keywords: NIGCOMSAT-1R, Ka-Band, Broadband Penetration, Rural Development, Digital Divide, Satellite Communication, Nigeria, VSAT.

I. INTRODUCTION

According to (Chukwu-Okoronkwo, 2015) The Nigerian Communication Satellite (NIGCOMSAT-1) project marked a significant milestone as Africa's inaugural communications satellite. The project was awarded to a Chinese company China Great Wall Industry Corporation (CGWIC) in 2004, the satellite is embedded with 40 transponders namely L, C, Ku, and Ku-bands, improving the extent of coverage over Africa, the Middle East, and southern Europe. Its L, C, Ku, and Ka bands were designed for telephony, video, data transfer, telemedicine, teleconferencing, education, and internet purposes, enhancing security, surveillance, and GPS signals.

NIGCOMSAT-1 was built to address communication challenges affecting socio-economic growth in Nigeria. It was Launched in May 2007 from China, its successful landing increased awareness of the potential of global satellite communication. Despite encountering technical issues leading to its de-orbiting in 2008, Nigeria pursued an innovative solution NIGCOMSAT-1R was launched in December 2011 to replace NIGCOMSAT-1, significantly contributing to broadcast, telecommunications, and ICT infrastructure.

The federal government of Nigeria has approved the acquisition of two new satellites NIGCOMSAT-2A and 2B describing the move as a “defining commitment” to national development, digital sovereignty and economic competitiveness, (Ebere Melum-Nwogbo, 2026). NIGCOMSAT-1R stands as

a backbone infrastructure, supporting Nigeria's vision for socio-economic development and technological advancement. With successive launches and strategic plans, Nigeria aims to establish a sustainable presence in the global communications satellite sector, catalysing rapid and digital economic growth for the nation.

As of 2023, there are about 2,500 satellites orbiting the Earth. This count is projected to surge to 50,000 satellites in the next decade due to advancements in cost-effective and successful satellite launches. This expansion is anticipated to significantly enhance global mobile connectivity by combining 5G deployments with satellites, forming the Space-Terrestrial Integrated Network (STIN) through the emergence of Non-Terrestrial Networks (NTNs). This convergence is expected to usher in a new era of connectivity, effectively integrating space and terrestrial technologies (Hernandez & Reviriego, 2023).

Satellite Communication Technology and Sustainable Rural Development in Nigeria. This statement highlights the need to examine the role of satellite technology in advancing sustainable development in rural areas, specifically in Nigeria. The paper acknowledges that the deployment and influence of satellite technology in rural Nigeria are not clear.

The study aims to analyze the impact of satellite technology on rural development in Nigeria, taking into account both positive and negative influences. The theoretical framework of technological determinism is used to understand the effects of satellite-driven communication in rural areas. (Ifeduba, E.).

The impact of broadband speed on innovation, broadband penetration increases globally, network speed becomes a crucial factor in broadband development. Broadband speed has a significant effect on promoting patenting, surpassing the impact of broadband penetration rate. The influence of broadband speed on innovation is strongly impacted in cities with higher levels of internet penetration, GDP per capita, science and technology investment, and foreign direct investment (Chen & Wang, 2023).

Recognizing the importance of broadband internet access in rural areas where traditional fiber infrastructure is limited, the Nigerian government has embraced the utilization of Satellite Broadband technology. To facilitate connectivity in remote regions, the Nigerian Communications Satellite Ltd (NIGCOMSAT) has been entrusted with the responsibility of ensuring high-speed internet access.

By leveraging satellite technology, NIGCOMSAT aims to bridge the digital divide and provide reliable internet connectivity in areas where fiber optic networks are not feasible. (National Broadband Plan 2020-2025). The inclusion of Satellite Broadband in the National Broadband Plan of 2021 demonstrates the government's commitment to promoting equitable access to broadband internet throughout the country.

By employing this technology, Nigeria aims to overcome the challenges of geographical limitations and ensure that even remote areas can benefit from reliable and high-speed internet connectivity.

The demographic factors, including gender and occupation, were found to influence mobile phone usage within the selected study rural areas of Nigeria. Based on the study's outcomes, policy recommendations have been put forward to address the diverse challenges faced by rural residents when using mobile phones. (Afolayan, Aiterebhe, Mejabi, Oyekunle, Bello & Balogun, 2015).

Unleashing the potential of mobile broadband, evidence from Indonesia's underdeveloped regions on its role in reducing income inequality. This project report addresses the research gap concerning the impact of ICT infrastructure expansion on income distribution, specifically focusing on mobile broadband network coverage in underdeveloped regions of Indonesia. The study uses unbalanced panel data from 122 subnational regions over the period from 2018 to 2021. (Ariansyah, K., Barsei, A. N., Syahr, Z. H. A., Sipahutar, N. Y. P., Damanik, M. P., Perdananugraha, G. M., ... & Suryanegara, M. 2023).

Rural broadband penetration is highly important. The South Korean case of deploying rural broadband via fibre networks by implementing universal service

obligation and public-private partnership-based project. This project report focuses on the challenges of expanding broadband coverage in rural areas, with a specific case study of South Korea. The report highlights two policies implemented during the COVID-19 pandemic: the universal broadband service at 100 Mbps speed and the rural broadband project as a public-private partnership (PPP).

The study proposes an investment cost estimation model for deploying rural broadband via fibre networks and evaluates the cost-effectiveness of implementing these policies. (Lee, H., Jeong, S., & Lee, K. 2023).

Mobile Payment Technology and Poverty Alleviation in Nigeria, this report examines the impact of mobile payment technology on poverty alleviation in Nigeria, specifically in Rivers State. The study used a sample size of 223 respondents selected through multistage and purposive sampling techniques.

Data was collected using a structured questionnaire and analysed using descriptive statistics and simple regression models in SPSS software. (Marshall, I., Ihenacho, W. P., & Chizuru, A. J. 2023).

A digital payment solution in Nigeria, this project report focuses on the Information & Communication Technology (ICT) sector in Nigeria, particularly the growth of internet services and online payment options. It examines the rise of telecommunication companies and mobile payment solutions in the country.

The report also addresses the challenges of weak online financial security faced by developing countries and discusses how payment aggregators, such as Flutterwave, are facilitating secure online transactions and contributing to the development of a digital marketplace. (Ahmed, J. U., Talukdar, A., Khan, M. M., Sharif, R., & Ahmed, A. 2023).

Assessment of the community's technological literacy in the use of mobile phones for rural development, this project report addresses the access and use of mobile phones in rural areas for development and lifelong learning. (Abdon, E., William, F., & Tandika, P. 2023).

The primary objective of Starlink is to provide fast and reliable broadband Internet with minimal delays, specifically targeting remote and rural areas worldwide. This study seeks to examine how the Starlink satellite project influences Internet service providers in emerging economies. (Shaengchart, Y., & Kraivanit, T. 2023).

Preparation for future learning in rural communities has become increasingly important, particularly in the context of Nigeria, where population growth and the demand for literacy training continue to rise.

Research by Sanusi, Olaleye, and Okunoye (2020) emphasizes the need to equip rural populations with the skills required for future learning. Similarly, studies on broadband utilization highlight disparities between rural and urban underserved areas, as seen in selected regions of Arusha, Tanzania, where access and effective use of connectivity remain critical challenges (Byanyuma et al., 2018).

In addition, the use of digital tools such as tablet computers for data collection in Nasarawa State demonstrates both the opportunities and challenges faced across Africa in obtaining reliable and timely data. According to Adenuga et al. (2016), the growing need for accurate statistics is driven by evidence-based policymaking, poverty reduction strategies, and broader development goals.1.2 Statement of the Problem

The problem addressed in this study is the lack of broadband internet penetration in rural and remote areas of Nigeria. The study is aimed at exploring the potentials of utilizing the Nigerian Communication Satellite (NIGCOMSAT-1R) to improve broadband internet access in the underserved areas. Furthermore, the study addresses the digital divide and enhance connectivity in rural and remote regions, by improving access to information, communication, and economic opportunities, growth and development for the citizens of Nigeria.

Access to broadband internet in rural and remote areas of Nigeria is limited or non-existent, creating a significant digital divide between the urban and rural populations. This lack of connectivity hinders socio-economic development, educational opportunities,

and access to essential services for the citizens. Despite efforts to improve internet infrastructure, traditional methods have proven to be costly, challenging, and time-consuming in extending broadband services to these underserved areas.

Therefore, it becomes imperative to explore alternative solutions, specifically using the Nigerian Communication Satellite (Nigcomsat-1R), to overcome the barriers to broadband internet penetration in rural and remote areas of Nigeria.

1.3 Research Questions

In the pursuit of understanding leveraging Nigerian Communication Satellite for broadband internet penetration in rural and remote areas of Nigeria of Nigeria, this research embarks on a journey to delve into the intricate that underscore its significance. As we navigate through the landscape of internet penetration, my focus crystallizes on a pivotal question that not only encapsulates the essence of our inquiry but also propels me toward deeper insights:

- i. How to determine the targeted areas to be rural or remote settlement?
- ii. What are the key challenges and barriers to broadband internet access in these regions?
- iii. What is the potential of leveraging the Nigerian Communication Satellite to provide broadband internet connectivity in rural and remote areas?

These research questions will guide the study in investigating the feasibility, challenges, potential benefits, and recommendations for leveraging the Nigerian Communication Satellite for broadband internet access in the targeted regions.

1.4 Objectives of the Study

- i. In this report, we carry out a comprehensive analysis of the leveraging of the Nigerian Communication Satellite. The study focuses on understanding the key aspects and components of the topic. By examining its importance, features, and wider implications, the report aims to provide a clear understanding of its relevance and possible impacts. Through careful research and analysis, this study helps to explain the role of the Nigerian Communications Satellite within its context. To examine the viability of the selected regions

- ii. To evaluate broadband internet access in rural and remote regions of Nigeria.
- iii. To identify prevailing disparities and barriers.
- iv. To Develop an effective satellite technology implementation strategy for enhanced broadband internet coverage.

1.5 Significance of the Study

Before delving into the significance of the study, it is important to clearly understand the background and focus of this project. The next section highlights the importance of this research and its implications within the broader context. By explaining the value and relevance of this study, I aim to show the reason for this investigation and the potential contributions it can make to the field, including the following: Bridging the Digital Divide:

This study addresses the critical issue of the digital divide between urban and rural populations. By exploring the potential of leveraging satellite technology for broadband internet penetration in rural and remote areas, the study aimed at bridging this digital divide, ensuring equal access to information and opportunities for residents in Nigeria.

Enhanced Socio-economic Development: Improved broadband internet access in rural and remote areas has the potential to drive socio-economic development. It can facilitate access to education, healthcare, e-commerce, agricultural information, and other essential services. By enabling connectivity, the study can contribute to improved living standards, economic opportunities, and overall development in these underserved regions.

Improving Broadband Penetration in Rural Areas: Traditional methods of extending broadband services to rural and remote areas face infrastructure limitations and geographical barriers. By exploring the use of satellite technology, the study offers an alternative solution that can bypass these challenges and provide reliable connectivity in areas where traditional infrastructure deployment is challenging or expensive.

1.6 Scope of the Study

In the wake of unprecedented technological progress and the ever-expanding reach of digital connectivity,

the imperative to bridge the digital divide has become increasingly paramount. The transformative potential of broadband internet in catalysing economic growth, enhancing educational opportunities, improving healthcare access, and promoting overall digital inclusivity is recognized globally. However, the persistent challenge of unequal access to these benefits, especially in remote and underserved regions, underscores the need for innovative strategies to ensure equitable digital participation.

At the heart of Nigeria's dynamic landscape, characterized by its rich cultural diversity and burgeoning economy, lies the crucial task of harnessing technological advancements to bridge this digital gap.

The Nigerian government's cognizance of the power of broadband connectivity has resulted in strategic efforts to fortify its communication infrastructure.

One such endeavour is the deployment and utilization of Nigerian communication satellites, offering a unique avenue to tackle the digital divide and extend the advantages of the digital age to the farthest corners of the nation.

The central focus of this study is to explore the feasibility, potential, and implementation strategies of leveraging Nigerian communication satellites to facilitate broadband internet penetration in the remote and rural areas of Nigeria.

These regions exemplify the challenges confronting rural communities across Nigeria, which is characterized by limited access to essential digital services and opportunities for socio-economic progress. Through harnessing the capabilities of Nigerian communication satellites, this study seeks to unveil innovative methodologies and solutions capable of overcoming the obstacles impeding broadband penetration in these areas.

This study takes into account a comprehensive examination of the potential utilization of Nigerian communication satellites, specifically the satellite ka-band services, to drive broadband internet penetration in the rural and remote regions of Nigeria. The scope encompasses the following key aspects:

Technological Assessment: A detailed exploration of the technical aspects of satellite communication, with a specific focus on the capabilities and limitations of ka-band services. This assessment includes an examination of bandwidth, signal strength, coverage area, and the technical requirements for effective deployment in remote areas.

Regulatory Landscape: An analysis of the regulatory frameworks governing satellite communication and broadband deployment in Nigeria, including spectrum allocation, licensing procedures, and policy considerations for extending services to underserved regions.

Socio-Economic Dynamics: A comprehensive evaluation of the socio-economic factors influencing digital adoption and internet usage in rural communities. This entails understanding factors such as income levels, educational attainment, digital literacy, and cultural considerations that impact the acceptance and sustainability of broadband services.

Infrastructure Readiness: An assessment of the existing infrastructure, both physical and digital, in Nigeria. This evaluation includes identifying challenges related to power supply, network coverage, and necessary facilities for the successful deployment of broadband services.

Best Practices and Case Studies: Examination of successful global and regional initiatives that uses satellite communication, particularly the ka-band services, to enhance broadband access in remote areas. Lessons learned from these cases will be synthesized and adapted to the Nigerian context.

Recommendations: Drawing from the comprehensive analysis, this study will present an actionable recommendation encompassing technology deployment strategies, regulatory enhancements, community engagement approaches, and potential public-private collaborations to enable effective broadband penetration using Nigerian communication satellites.

1.7 Definition of Operational Terms and Acronyms

i. **Broadband:** Broadband refers to high-speed internet access that enables the transmission of

large amounts of data simultaneously, allowing for fast and reliable communication, browsing, downloading, and streaming.

- ii. Internet Penetration: Internet penetration refers to the percentage of the population that has access to the internet. It measures the level of connectivity and usage of internet services within a specific geographical area or population.
- iii. Nigerian Communication Satellite: Nigerian Communication Satellite (NigComSat) is a satellite communication company owned by the Nigerian government. It operates communication satellites that provide various telecommunications and broadcasting services, including voice, data, and internet connectivity.
- iv. Rural Areas: Rural areas refer to geographical regions that are typically located outside urban centres and have a lower population density. These areas are characterized by agricultural, farming, or natural environments, and may lack basic infrastructure and services, including reliable internet access.
- v. Remote Areas: Remote areas are typically an isolated or distant regions that are geographically challenging to access. These areas may have limited or no connectivity to essential services, including broadband internet, due to geographical barriers, distance, or lack of infrastructure.
- vi. Nigeria: Nigeria a country with 36 states and the Federal Capital territory, with 774 Local Government Area
- vii. NigComSat Ltd: NigComSat Ltd stands for Nigerian Communication Satellite, the satellite communication company responsible for operating communication satellites in Nigeria.

II. LITERATURE REVIEW

2.1 Conceptual Framework

The conceptual framework of this study outlines the fundamental components and interrelationships that guide the exploration of leveraging Nigerian communication satellites, specifically the satellite ka-band services, to provide broadband internet penetration in rural and remote areas of Nigeria. This framework serves as a roadmap for understanding the various factors influencing the successful deployment of broadband services using satellite technology.

2.1.1 Satellite Technology and Ka-Band Services

Satellite Payload: The core technology involved in this study is the Nigerian communication satellite's payload, particularly its ka-band services. Ka-band offers higher frequencies, enabling higher data bandwidth and greater broadband speeds, making it suitable for delivering broadband services to remote areas.

2.1.2 Technological Factors

Signal Strength and Coverage: The quality and coverage area of the satellite's ka-band signal are critical factors affecting the coverage of broadband services. The satellite's footprint and power determine the extent to which remote and rural areas can access the internet.

Bandwidth Allocation: Allocating sufficient bandwidth for each service area is necessary for maintaining consistent and high-speed internet connections, especially in areas with low population density.

2.1.3 Regulatory Framework

Spectrum Allocation and Licensing: Regulatory bodies plays a crucial role in allocating frequency spectrum for satellite communication. Efficient spectrum allocation and simplified licensing procedures can encourage satellite operators to provide broadband services in the underserved regions.

Policy Considerations: Favorable policies that promote digital inclusion and encourage private sector participation in providing broadband services to remote areas are essential for success.

2.1.4 Socio-Economic Dynamics

Digital Literacy: The level of digital literacy in rural and remote communities influences their ability to access, adopt, and benefit from broadband services. Awareness campaigns and digital training programs can enhance digital literacy.

Income and Affordability: The socio-economic status of residents in these areas affects their ability to afford broadband services. Pricing models and subsidies should be tailored to ensure affordability.

2.1.5 Infrastructure Readiness

Power Infrastructure: Reliable power supply is a fundamental requirement for maintaining consistent internet access. Strategies such as solar power solutions or battery backups need consideration.

Network Infrastructure: Existing telecommunications infrastructure, such as cell towers and backhaul networks, should be evaluated for integration with satellite technology.

2.1.6 Community Engagement

Local Partnerships: Collaborating with local governments, community leaders, and NGOs can facilitate community engagement, garner support, and address community-specific needs.

User Education: Educating potential users about the benefits and usage of broadband services is vital for adoption and sustained usage.

2.1.7 Best Practices and Case Studies

Global and Regional Experiences: Drawing insights from successful satellite broadband initiatives worldwide, particularly in regions with similar challenges, can provide valuable guidance for implementation in Nigeria.

2.1.8 Recommendations

Technology Deployment Strategy: Based on the satellite's capabilities, coverage, and capacity, formulate a strategy for deploying ka-band services in target areas.

Regulatory Enhancements: Propose regulatory changes that facilitate streamlined spectrum allocation and licensing for satellite broadband services.

Community Involvement: Recommend community-focused strategies for engagement, including local partnerships and user education.

Infrastructure Improvements: Suggest enhancements to power and network infrastructure to support satellite broadband deployment.

Financial Models: Develop sustainable financial models that ensure affordability and viability of the broadband services.

2.2 Broadband Internet Penetration

Broadband internet penetration encompasses the accessibility and utilization of broadband internet services within a specific population, area, or region. It serves as a measure of the level of connectivity and adoption among individuals, households, businesses, and institutions. In the context of Nigeria, broadband internet penetration refers to the extent to which broadband internet services are accessible and utilized within the country.

Nigeria, being the most populous country in Africa, recognizes the significance of developing and expanding broadband connectivity to drive economic growth, foster social development, and ensure digital inclusion. The National Broadband Plan of 2021 highlights the importance of these efforts.

Additionally, as of May 2021, Nigeria boasted an impressive number of active internet users, reaching 140,488,490 individuals according to the Nigerian Communications Commission (NCC).

On the 16th of December 2019, the Honourable Minister of Communication and Digital Economy, Dr. Issa Ali Pantami, inaugurated a committee to draft a National Broadband Plan (NBP) for Nigeria (2020-2025) on behalf of His Excellency, President Muhammadu Buhari, GCFR.

The Committee was made up of 32 industry experts and was chaired by Funke Opeke. The NBP addresses 3 of the 8 priorities that the Federal Government assigned to the Federal Ministry of Communications and Digital Economy, and the parastatals under its purview, for implementation.

These priorities are the implementation of broadband connectivity and execution of a plan to deploy 4G across the country, as well as the development and implementation of a digital economy policy and strategy. (National Broadband Plan,2022-2025)

Broadband supports the development of the digital economy and a focus on growing the National Digital

Economy will also improve and diversify the nation's traditional economy.

This new broadband plan is designed to deliver data download speeds across Nigeria, a minimum of 25Mbps in urban areas, and 10Mbps in rural areas, with effective coverage available to at least 90% of the population by 2025 at a price not more than N390 per 1GB of data (2% of median income or 1% of minimum wage). (Overview of National Digital Economy Policy & Strategy 2020-2030 & Nigerian National Broadband Plan– NNBP - 2020 – 2025).

According to Daramola, (2022). Utilization of Information and Communication Technology (ICT) resources for teaching among selected lecturers in Kwara State. The successful integration of ICT resources into teaching and learning relies on lecturers' ability to effectively incorporate technology in their learning environments. The study employed a descriptive research design of the survey type.

The target population for the study was all college of education students in Kwara State. Proportional sampling techniques were employed to allocate respondents from each school based on their estimated population, using the Israel Model. An adapted questionnaire served as the data collection instrument.

According to Okoli, (2020). Office Technology and Management (OTM) Curriculum Content and Use of ICT Facilities among Polytechnic Students in Nasarawa State, Nigeria. Utilization of modern Information and Communication Technology (ICT) facilities among students in polytechnics located in Nasarawa State.

The population of the study comprised all ND II and HND II students in the OTM program at Nasarawa State Polytechnic and Federal Polytechnic, Nasarawa. The total population consisted of 267 students. The sample for the study was selected using a simple random sampling technique, resulting in 122 respondents.

Unleashing the potential of mobile broadband, evidence from Indonesia's underdeveloped regions on its role in reducing income inequality. This project

report addresses the research gap concerning the impact of ICT infrastructure expansion on income distribution, specifically focusing on mobile broadband network coverage in underdeveloped regions of Indonesia. The study uses unbalanced panel data from 122 subnational regions over the period from 2018 to 2021. (Ariansyah, Barsei, Syahr, Sipahutar, Damanik, Perdananugraha, & Suryanegara, 2023).

Rural broadband penetration is highly important. The South Korean case of deploying rural broadband via fibre networks by implementing universal service obligation and public-private partnership-based project. This project report focuses on the challenges of expanding broadband coverage in rural areas, with a specific case study of South Korea.

The report highlights two policies implemented during the COVID-19 pandemic: the universal broadband service at 100 Mbps speed and the rural broadband project as a public-private partnership (PPP).

The study proposes an investment cost estimation model for deploying rural broadband via fibre networks and evaluates the cost-effectiveness of implementing these policies. (Lee, Jeong, & Lee, 2023).

Mobile Payment Technology and Poverty Alleviation in Nigeria: This project report examine the impact of mobile payment technology on poverty alleviation in Nigeria, specifically in River's state.

The study used a sample size of 223 respondents selected through multistage and purposive sampling techniques. Data was collected using a structured questionnaire and analysed using descriptive statistics and simple regression models in SPSS software. (Marshal, Ihenacho, & Chizuru, 2023).

A digital payment solution in Nigeria, this project report focuses on the Information & Communication Technology (ICT) sector in Nigeria, particularly the growth of internet services and online payment options. It examines the rise of telecommunication companies and mobile payment solutions in the country. The report also addresses the challenges of

weak online financial security faced by developing countries and discusses how payment aggregators, such as Flutterwave, are facilitating secure online transactions and contributing to the development of a digital marketplace. (Ahmed, Talukdar, Khan, Sharif, & Ahmed, 2023).

Assessment of the community's technological literacy in the use of mobile phones for rural development, this project report addresses the access and use of mobile phones in rural areas for development and lifelong learning. (Abdon, William, & Tandika, 2023).

The primary objective of Starlink is to provide fast and reliable broadband Internet with minimal delays, specifically targeting remote and rural areas worldwide. This study seeks to examine how the Starlink satellite project influences Internet service providers in emerging economies. (Shaengchart, & Kraiwanit, 2023).

Preparation for Future Learning, the case of rural communities in Nigeria: This project report focuses on the importance of preparing rural communities in Nigeria for future learning, considering the increasing population and the need for literacy training. (Sanusi, Olaleye, & Okunoye, 2020, October).

Utilization of Broadband in Rural and Urban-Underserved Areas: The case of selected Areas in Arusha, Tanzania. This article delves into the utilization of broadband connectivity in both rural and urban underserved areas, focusing on selected regions in Arusha, Tanzania (Byanyuma, Zaipuna, Simba, & Trojer, 2018).

Assessment of Effective Use of Tablet Computers as a Tool for Data Collection in Nasarawa State, Nigeria: This project report discusses the challenges faced by Africa in terms of comprehensive, reliable, and timely statistics.

The demand for accurate data has increased due to evidence-based policy approaches and the need for poverty reduction strategies and development goals. (Adenuga, Ojehomon, Diagne, Omotesho, & Ayinde, 2016)

2.2.1 Related Works Empirical

This section serves as a bridge between the past and present, connecting our study with the extensive body of knowledge that precedes it.

It offers insights into the findings, methodologies, and interpretations of researchers who have delved into similar facets of the ICT sector, online payment trends using flutterwave, Satellite communication technology and sustainable rural development in Nigeria, the impact of broadband speed on innovation mobile phone usage in rural communities in Kwara state and the utilization of payment aggregators to facilitate a seamless digital marketplace and many more.

Through the analysis of these empirical works, we gain a comprehensive view of the challenges, opportunities, and transformations that have shaped the landscape in which our current research is situated.

Research Gap Matrix

(Ifeduba E. 2023) investigated how satellite communication technology can help Nigeria achieve sustainable rural development. The study aimed to comprehend the role that satellite technology plays in rural development, taking note of the ambiguity surrounding its implementation and real impact in Nigeria.

The study used a mixed-methods approach, collecting and analyzing both qualitative and quantitative data, and was based on the thesis of technological determinism. The results showed that satellite-facilitated communication has a dual effect, presenting ethical and cultural issues in addition to developmental advantages. The creation of regulatory frameworks to direct its adoption was suggested by the study.

However, the study did not examine the use of Nigerian communication satellites for broadband penetration in remote areas like Kwara and Nasarawa States, nor did it offer concrete proof of deployment and quantifiable impact in Nigeria.

Similarly, Chen J. and Wang J. used Chinese city-level data to examine how broadband speed affects

innovation. The study looked at broadband penetration, speed, and how these factors affect innovation outcomes like patenting.

The results of the quantitative investigation demonstrated that, particularly in economically developed cities, broadband speed considerably boosts innovation more than access or penetration rates. Additionally, it makes it easier for businesses to work together.

Notwithstanding these revelations, the study's shortcomings included a lack of well-defined hypotheses, insufficient literature foundation, and restricted relevance to emerging nations like Nigeria. Notably, satellite-based broadband options for Nigerian rural access were not taken into account.

Afolayan Aiterebhe, Mejabi Oyekunle, Bello, and Balogun (2015) investigated mobile phone use in rural communities in Nigeria's Kwara State. The study looked at the degree of use, demographic factors, tasks completed, and difficulties faced.

The study, which used a survey approach with a sample of 1,475 rural residents from twelve villages, discovered that mobile phones were widely used for a variety of socioeconomic purposes. Nonetheless, issues like inadequate infrastructure and accessibility were noted.

The study did not include comparison or satellite-based broadband viewpoints, especially with relation to Nigerian communication satellites, and it lacked a thorough examination of optimal utilization.

Additionally, Ariansya et al. (2023) looked into how mobile broadband affected wealth disparity in Indonesia's less developed areas. The study found an inverse U-shaped association between broadband coverage and income inequality using panel data and ordinary least squares (OLS) regression. Inequality is initially increased by broadband, but as access grows, it gradually decreases.

A vacuum in the literature of ICT infrastructure and income distribution was identified by the study. However, it didn't discuss satellite-based internet options or how well they work in rural Nigeria.

Lee, Jeong, and Lee K. (2023) examined rural broadband deployment in South Korea using public-private partnerships (PPP) and universal service responsibilities.

The study assessed the cost-effectiveness of both approaches and created a model for estimating investment costs. Results demonstrated that PPP-based broadband deployment enhances rural connectivity and is economical. However, issues like unequal implementation and excessive user prices continue to exist. The study's narrow emphasis on South Korea prevented it from examining satellite-based broadband options or their applicability to Nigeria.

Additionally, Marshal, Ihenacho, and Chizuru (2023) examined the impact of mobile payment technology on poverty alleviation in Nigeria, specifically in Rivers State. Using survey data and regression analysis, the study found that mobile payment systems positively influence consumption expenditure and economic activity.

The study emphasized the importance of digital financial inclusion in poverty reduction. However, its scope was limited geographically and methodologically, and it did not consider broadband infrastructure challenges or satellite communication solutions in rural Nigeria.

Finally, Ahmed et al. (2023) conducted a case study on Flutterwave as a digital payment solution in Nigeria. The study explored the growth of internet services, challenges of online financial security, and the role of payment aggregators in enhancing digital transactions. Findings indicated that platforms like Flutterwave contribute significantly to Nigeria's digital economy.

However, the study was limited to a single case and did not provide a broader analysis of ICT infrastructure, particularly satellite broadband deployment in rural areas.

Summary of Literature Gap

Digital innovation, mobile technology, and broadband infrastructure have all received a lot of attention in the evaluated studies. The use of Nigerian

Communication Satellites (NigComSat) for broadband internet penetration in rural and remote areas, especially in Kwara and Nasarawa States, is consistently neglected. This emphasizes the necessity for more investigation into satellite-based rural connection options in Nigeria.

2.3 A public-private partnership (PPP)

A public-private partnership (PPP) is a collaborative arrangement between a public entity and a private party, working together to achieve a shared strategic objective.

The PPP model operates on three fundamental principles: risk allocation and transfer, affordability, and value for money. Historically, PPPs have primarily been utilized for the development of tangible assets, such as infrastructure projects.

This model involves collaboration between the government and private sector entities to deploy broadband internet infrastructure in rural areas.

The government can provide regulatory support, subsidies, and incentives, while private companies can contribute technical expertise and investment. (Danielle, N. E. L. (2020).

2.3.1 Community-Based Model

According to (Parks, L., Srinivasan, R., & Aragon, D. C.). This model emphasizes the active participation and involvement of local communities in the deployment and operation of broadband internet services. It focuses on empowering community members to take ownership of the project, build local capacity, and sustain the network. Community-based models often rely on cooperative efforts, local entrepreneurship, and community training programs.

According to this paradigm, satellite-based ISPs are essential for providing rural communities with broadband connectivity. Coverage in underserved and rural areas with little terrestrial infrastructure is made possible by satellite technology. In order to meet the unique requirements of rural users, satellite ISPs set up satellite ground stations, supply equipment, and provide connection packages (NigComSat, 2011).

2.3.2 Digital Village Model

The digital village model focuses on creating localized centres in rural areas equipped with broadband internet access.

These centres serve as hubs for various community services, such as e-learning, telemedicine, e-commerce, and government services. The model involves establishing partnerships with local institutions, NGOs, and government agencies to provide connectivity, training, and support services to the rural population.

2.4 The report on satellite technology and rural development in Nigeria

The report on satellite technology and rural development in Nigeria highlights several significant gaps. First, there is a lack of clarity regarding the deployment of satellite technology for rural development. Additionally, the established influence of satellite technology on rural areas in Nigeria has not been clearly established.

The report acknowledges the need to address negative influences on Nigeria's cultural framework resulting from satellite technology adoption.

Furthermore, there is little proof that satellite technology can promote sustained development in Nigeria's rural areas. The lack of clear study objectives, a poor literature review, a dearth of research hypotheses, data restrictions, and methodological problems are only a few of the project's many flaws. Additionally, the study's scope is narrow, excluding the use of Nigerian communications satellites for broadband penetration in Nigeria's rural areas.

The report also lacks focus on the impact of ICT infrastructure expansion on income distribution and a comprehensive analysis of the difficulties in implementing rural broadband policies in South Korea. Additionally, the assessment of broadband adoption barriers in rural areas is limited, and the report focuses solely on the South Korean context without considering a broader perspective.

Furthermore, the absence of user perspectives and experiences in evaluating the impact of broadband

policies hinders a comprehensive evaluation. The study's findings on mobile payment technology's effect on poverty alleviation lack applicability beyond specific contexts. The report fails to provide specific research questions to guide the study effectively.

Another gap is the insufficient detail on weak online financial security issues faced by developing countries like Nigeria. Moreover, the case study on Flutterwave lacks scope, as it does not include a broader analysis of other payment aggregators or the overall landscape of digital payment solutions in Nigeria.

Lastly, the studies fail to address possible biases and limits in the case study, which could affect the validity of its conclusions. In order to obtain a more thorough understanding and create solid recommendations for the deployment of satellite technology, broadband internet adoption, and the influence of ICT infrastructure on development and poverty reduction in Nigeria, it is imperative that these gaps be filled.

Again, no mention or work was done by any of the researchers on leveraging Nigerian communications satellite for broadband internet penetration in rural and remotes areas of Nigeria.

III. RESEARCH METHODOLOGY

3.1 Research Design

Analysis of the existing internet penetration in rural and remotes areas of Nigeria. Usually, both quantitative and qualitative research methodologies are used in this study. In order to successfully handle the study objectives, the aim is to collect thorough data and insights from multiple sources.

3.1.1 Creating and Coordinating Questionnaires

Questionnaires were drafted and coordinated for responses from the settlers ranging from various ages. The questionnaires cover the areas like Determining Settlement Status, Infrastructure, Facilities, and Economic Activities, Population and Density, Determining Internet and Digital Presence in the settlements in Nigeria.

3.1.2 Technical Assessment on Nigerian Communications Satellite

Technical assessment was carried out on the Nigerian communications satellite's capabilities, coverage, and bandwidth allocation to determine its suitability for serving rural and remote communities in Nigeria.

It was gathered that Nigerian Communications Satellite has the full capabilities to provide connectivity across these two states and that it does not only covered Nigeria but virtually all African countries, part of Europe and parts of Asia.

3.1.3 Description of Component/Devices

i. Modem

The Newtec MDM2200 IP Satellite Modem is a modem platform designed for use in the Newtec Sat3Play system. The MDM2200 is used together with Newtec's proprietary iLNBS and receives DVB-S2 ACM in the forward link and transmits in MFTDMA mode in the return link, using 4CPM modulation.

The MDM2200 provides physical layer connectivity, medium access (MAC) layer functions, networking, and management services which operates as an IP bridge or IP router, forwarding IP traffic between the air interface and the Ethernet interface.

It implements a dual stack IPv4/IPv6 solution and supports networks were both IPv4 and IPv6 access is needed. The dual stack solution of the MDM2200 allows to simultaneously support IPv4 in bridged mode and IPv6 in bridge or routed mode.

MDM2200 implements a DHCP proxy which allows Ethernet connected devices to automatically discover and configure their IP address. A caching DNS forwarder is also embedded in the MDM2200 Satellite IP modem. Widely used applications, such as web-browsing and HTTP file transfers, benefit tremendously from TCP acceleration and pre-fetching because pre-fetching enables faster access to web sites.

- 6..... LAN PORT
- 5..... RESET
- 4..... MICRO SD CARD
- 3..... RX PORT

2..... TX PORT
 1..... DC POWER



Figure 3.1 Newtec Modem

ii. Point and Play Antenna Tool

The Point & Play antenna pointing tool combined with the embedded pointing software in the IP modem, enables an average end-user to self-install and commission the terminal. The pointing tool is a small battery powered plastic device with a belt clip and an earphone which can be connected to the TX cable at the antenna installation site. Point & Play provides the following functionality through audio feedback at the antenna location:

- Satellite identification
- Accurate pointing in order to obtain the maximum signal to noise level (<0.5dB pointing error)



Figure 3.2 Point and Play Antenna Tool

iii. 30M Twin Coax Cable

There are two separate cables between the antenna and the indoor equipment: the receive cable (Rx) and transmit cable (Tx). These coaxial cables (coax) are approximately 1cm in diameter and are 30m long. Delivered with the terminal is a combined twin cable with Rx and Tx cable attached to each other. The twin cable has two pre-mount and waterproof F-

connectors on the outdoor end, which is used for connection to the iLNB.



Figure 3.3 Coaxial Cable

Coax Cable Structure

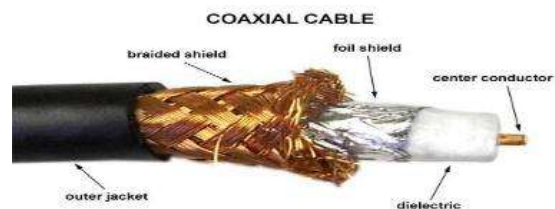


Figure 3.4 Structure of a Coaxial Cable

Connectors to be used



Figure 3.5 Connectors

iv. 75cm KA Antenna

The Newtec 75cm antenna was developed for easy assembly and installation with integrated fine-adjustment mechanism.



Figure 3.6 75cm Dish Antenna

VSAT?

The term “VSAT” stands for Very Small Aperture Terminal. VSAT equipment is made of two separate sets of equipment which are the outdoor unit (ODU) and the indoor unit (IDU). The ODU is the VSAT interface to the satellite.

The indoor unit commonly referred to as customer premise equipment (CPE) is the interface to the customer’s terminals or local area network (LAN). The outdoor and indoor units are linked together using coaxial cables otherwise known as inter-facility link (IFL) cables.

v. Inclinometer and Digital Compass



Figure 3.7 Inclinometer

They are used to measure or identify the position of the satellite. The Azimuth tells you the direction to face while the Elevation tells you how high up in the sky to look.

vi. Offset Angle

When the reflector aperture is perpendicular to the ground, the antenna is actually looking at the offset angle.

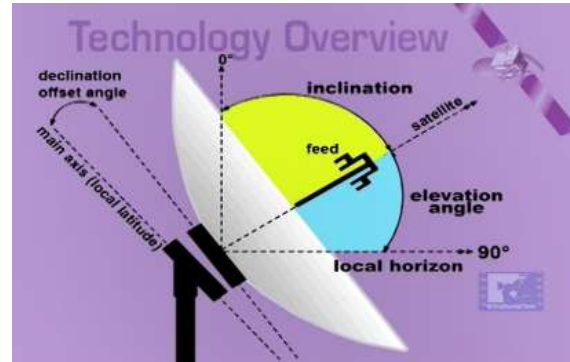


Figure 3.8 Offset Angle

vii. Future Set Up of VSAT to the Satellite and to the Users



Figure 3.9 Architecture of the communication link
 viii. Future Set Up of VSAT At Customer Premises

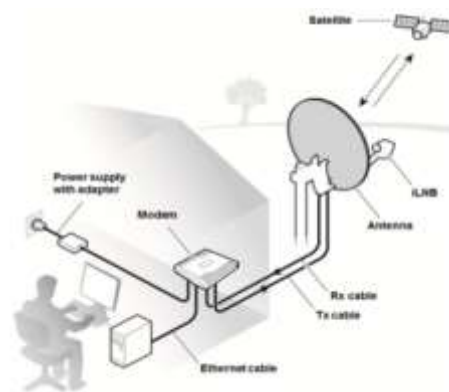


Figure 3.10 Set up at the customer premises

ix. Definitions

IDU: Indoor Unit or satellite modem, interface with the LAN equipment and with the ODU via the RF transmit & receive cables.

ODU: The Outdoor Unit comprises of the LNB, BUC, OMT, Feed horn and antenna.

BUC: The Block-up Converter or transmitter converts the IF signal to the specific Ku-band transmission frequency and amplifies the signal to typically 2W, 3W, 4W etc...

The LNB (Low Noise Block Down Converter) receives signal from the satellite and has the following receive frequency band:

Frequency Range: 17.7-21.2GHz (Ka-band)

The Feed Assembly is of two types depending on the satellite VSAT will be pointing to. The two types are; Circular Tx/Rx Feed Assembly (LHS and RHS) Linear Tx/Rx Feed Assembly (Horizontal and Vertical) but in this design, Circular Tx/Rx feed assembly will be used.

Inter Facility Link (IFL)

This is the RF (Coaxial) cable that connect the ODU and the IDU together. They are of different dimensions; however, the ones mostly used for VSAT are; RG-6 and RG-11. RG-11 has larger core and can trunk signal up to 100m, while RG-6 can trunk signal up to 30m.

Each of the cable has its specific F-connectors

3.2 Population, Sample and Sampling Techniques

According to Nigerian Communications Commission (NCC), the total counts of 3G and 4G networks in Kwara and Nasarawa states, Nigeria are as follows:

Kwara State:

3G Network: 806,941

4G Network: 1,186,298

Total of 3G and 4G: 1,993,239

Nasarawa State:

3G Network: 680,236

4G Network: 936,800

Total of 3G and 4G: 1,617,036

The project targeted the following areas in both states:

In Kwara State:

Offa Local Government, Ijagbo Community, Ipee Community, Igosun Community

In Nasarawa State:

Keffi Local Government, Awe Local Government, Keana Local Government, Toto Local Government

3.3 Methods of Data Collection

The research designed employed in this study is a combination of quantitative and qualitative analysis. Data on the current status of 3G and 4G networks in Nigeria were obtained from telecommunication companies and government agencies. The research team conducted interviews and surveys with local residents and community leaders to gather qualitative insights on the existing internet infrastructure and the perceived challenges in internet accessibility.

3.3.1 Quantitative Analysis

Surveys and questionnaires were conducted; data were gathered from a representative sample of rural and remote communities in Nigeria. The surveys assessed internet access, connectivity needs, and preferences. It was discovered that both Nigeria are not leveraging on Nigerian Communications Satellite except few private companies like mining company in Nasarawa state, specifically Kenyang Mining Company in Udege Mbeki settlement.

3.3.2 Qualitative Analysis

Extensive interviews were conducted and focus group discussions with stakeholders such as government officials, internet service providers, community leaders, and residents to gain insights into the challenges and opportunities for broadband internet penetration in both Nigeria.

3.3.3 Limitations

It's critical to recognize the limitations related to the sample methods employed in this investigation. First, it was impossible to reach every village in the allotted period due to the size and diversity of Nigeria's rural and isolated locations. Because of the small sample size, the results of this study could not be applied to all rural areas in the states.

Furthermore, the dependability of data gathering in certain areas may have been impacted by outside variables including weather and satellite connection

problems. The possibility of response bias in the survey data was another drawback. Consciously or unintentionally, participants may have given incomplete or biased information, which could have resulted in an overestimation or underestimating of the true level of internet usage.

Notwithstanding these drawbacks, every attempt was made to guarantee a representative sample and preserve the precision and dependability of the information gathered. The study's conclusions nevertheless offered insightful information about the possible advantages and difficulties of using Nigerian communications satellites to increase broadband internet penetration in rural and isolated locations.

3.4 Technique for Data Analysis and Model Specification

A combination of quantitative and qualitative techniques was used to assess the data gathered for this research on utilizing Nigerian communications satellites for broadband internet adoption.

To handle and evaluate the numerical data collected from government agencies and telecommunications firms, the study used statistical analytic tools. In order to have a greater understanding of the opportunities and difficulties associated with broadband internet penetration in rural and remote locations, qualitative data from surveys and interviews was also subjected to thematic analysis.

3.5 Justification of Methods

In order to collect data and insights thoroughly, this study uses a dual methodology that integrates both quantitative and qualitative methodologies. This approach was carefully chosen to successfully meet the goals of the study.

The Nigerian Communications Satellite's capabilities, coverage, and bandwidth distribution within the allocated area are revealed through the execution of structured questionnaires and the technical examination. This evaluation confirms that the Nigerian communication satellite is appropriate for serving the targeted areas.

Elaborating on the Newtec MDM2200 IP Satellite Modem, along with detailing components such as the

30m twin coaxial cable and the 75cm antenna setup, underscores the significance of self-installation. This serves as a robust justification for these chosen methodologies.

Furthermore, meticulously delineating the population and sample size within Nigeria, while pinpointing specific target areas, ensures a focused and representative study.

A comprehensive dataset is produced by combining quantitative methods (questionnaires, surveys, and data from government agencies and telecommunications companies) with qualitative methods (focus groups and interviews). This dataset, which includes information on internet prevalence and Nigerian Communications Satellite usage, demonstrates the dedication to obtaining accurate and useful data.

Finally, employing both statistical analysis and thematic analysis for data interpretation exemplifies a dedicated effort to extract meaningful and pertinent findings for this study.

IV. DATA PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

4.1 Data Presentation

This chapter presents the data collected through a structured questionnaire administered to 230 respondents across rural and remote areas of Nigeria.

The survey was designed to assess the current state of internet connectivity, awareness of satellite broadband technologies specifically the Nigerian Communications Satellite (NigComSat) using Ka-band and the willingness of respondents to adopt satellite internet as an alternative broadband solution. The data are presented in descriptive form using frequency distributions, percentages, and charts derived from Google Forms analytics.

The questionnaire covered respondents' demographic profiles, current internet access status, connectivity medium, reliability and cost of internet services, challenges faced, awareness of satellite internet and NigComSat, and suggestions for government policy

support. The full data from 230 responses are presented below according to each survey item.

4.1.1 Demographic Profile of Respondents

The demographic section of the questionnaire covered respondents' gender, age group, educational qualification, and occupation. These variables provided context for interpreting the findings on internet usage and satellite broadband adoption preferences.

i. Gender Distribution

Figure 4.1 presents the gender distribution of the 230 respondents. The data show that 64.8% of respondents were male, while 34.8% were female. A negligible proportion selected "Prefer not to say." The predominance of male respondents reflects typical participation patterns in technology-focused surveys conducted in Nigerian rural communities, where digital engagement among men tends to be higher.

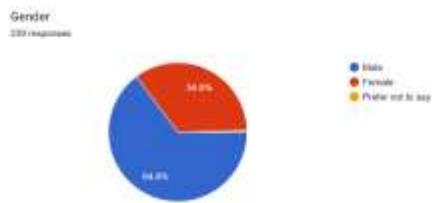


Figure 4.1: Gender Distribution of Respondents

ii. Age Distribution

Figure 4.2 presents the age distribution of respondents. The 26–35 age bracket constituted the largest group at 38.3%, followed by the 18–25 bracket at 25.2%, and those aged 36–45 at 18.3%. Respondents aged 46–55 accounted for 14.8%, while those aged 56 and above made up a small fraction of about 3.4%. The predominance of younger adults (18–45 years) indicates that the majority of respondents are of working age and more likely to be familiar with internet usage.

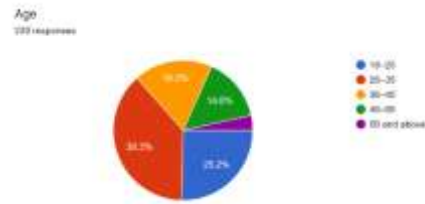


Figure 4.2: Age Distribution of Respondents

iii. Educational Qualification

Figure 4.3 shows the educational qualifications of the respondents. The majority (42.2%) hold secondary school certificates, while 27.8% possess diploma qualifications. Respondents with a bachelor's degree accounted for 15.2%, and those with postgraduate qualifications made up 10.4%. A small proportion (approximately 4.4%) indicated primary level education. This distribution suggests that while literacy is generally present among respondents, formal higher education is limited within the surveyed rural communities.

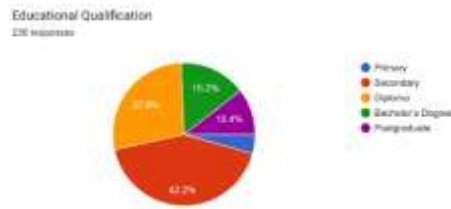


Figure 4.3: Educational Qualification of Respondents

iv. Occupation

Figure 4.4 displays the occupational breakdown of respondents. Students constituted the largest occupational group at 23%, followed by farmers at 24.8%, traders at 22.2%, self-employed individuals at 20%, and civil servants at 10%. The occupational diversity of the respondents — spanning agricultural, commercial, and educational sectors — underscores the broad socio-economic relevance of broadband access in rural Nigeria.

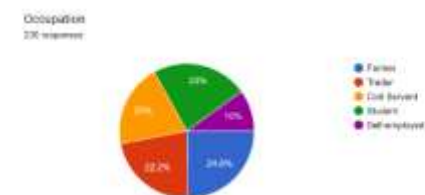


Figure 4.4: Occupational Distribution of Respondents

v. Geographical Spread

Respondents were drawn from a wide cross-section of Nigerian states, including but not limited to Kwara, Kogi, Ogun, Osun, Lagos, Kano, Rivers, Imo, Oyo, Kaduna, Niger, Ondo, Ekiti, Bauchi, Borno, Anambra, Cross River, Kebbi, Benue, Plateau, Taraba, Ebonyi, Delta, Nasarawa, Adamawa, Yobe, Katsina, Enugu, and the FCT. Specific rural LGAs and communities mentioned include Offa, Zaria, AMAC, Khana, Eleme, Oyun, Mopa Muro, Ifelodun, Kabba, Mokwa, Gwagwalada, Dikwa, and many others. This wide dispersion supports the study's focus on rural and remote areas.

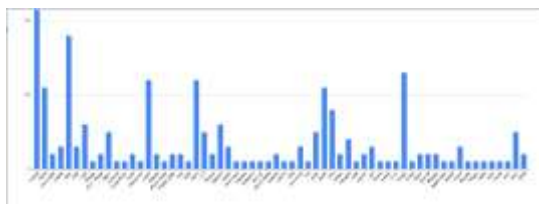


Figure 4.5: Geographical Spread

4.1.2 Internet Access and Connectivity

This subsection presents data on the current internet access status of respondents, the medium through which they access the internet, reliability, cost, and frequency of internet usage.

i. Internet Access Status

As shown in Figure 4.5, 90% of respondents indicated that they have internet access, while 10% do not. Although the majority have access, the quality and reliability of such access in rural areas remain critical concerns as evidenced by subsequent survey items.

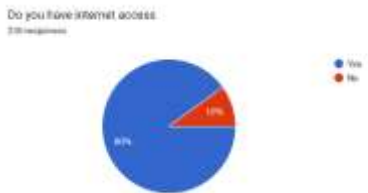


Figure 4.6: Internet Access Status of Respondents

ii. Medium of Internet Connectivity

Figure 4.6 shows that an overwhelming 88.3% of respondents access the internet via mobile data. Other mediums — including fibre, satellite, fixed wireless,

and no connectivity — collectively account for about 11.7%. The near-total reliance on mobile data highlights the limited diversity in broadband infrastructure in rural Nigeria and the potential market for satellite broadband as a complementary or alternative solution.

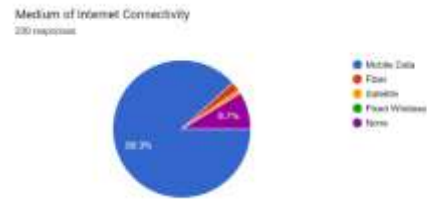


Figure 4.7: Medium of Internet Connectivity

iii. Reliability of Current Internet Connectivity

As illustrated in Figure 4.7, the reliability of internet service in rural areas is largely rated as poor. Half of the respondents (50.4%) described their connectivity as "Poorly Reliable," while 28.7% rated it as "Moderately Reliable." Only 14.8% considered it "Not Reliable at All," and a very small fraction viewed their connection as "Very Reliable." These findings strongly indicate that current internet infrastructure in rural Nigeria is inadequate and unreliable.

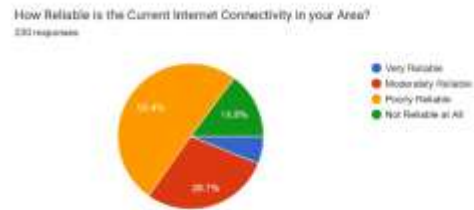


Figure 4.8: Reliability of Current Internet Connectivity

iv. Cost of Internet Access

Figure 4.8 presents respondents' perceptions of the cost of internet access in their area. A substantial 42.4% rated internet access as "Expensive," followed by 37.6% who considered it "Very Expensive." Only 22.3% found it "Moderately Expensive," and a mere 2.6% described it as "Affordable." Cumulatively, approximately 80% of respondents perceive internet access to be expensive or very expensive, indicating a significant affordability barrier in rural areas.

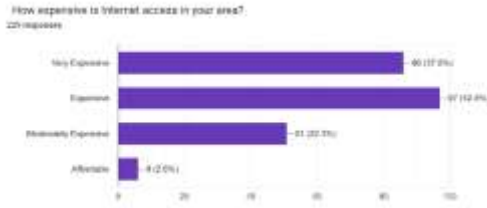


Figure 4.9: Cost of Internet Access

v. Internet Usage Frequency

Despite cost and reliability challenges, Figure 4.9 shows that 86.5% of respondents use the internet on a daily basis. Weekly usage accounts for 7.4%, while occasional and rare usage together represent a negligible proportion. This paradox of frequent usage amid poor service quality underscores the growing dependency on internet connectivity and amplifies the urgency for more reliable broadband infrastructure.

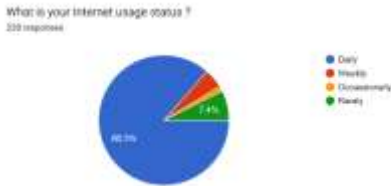


Figure 4.10: Internet Usage Frequency of Respondents

4.1.3 Internet Usage Purpose and Service Assessment

i. Primary Use of Internet

Figure 4.10 reveals that communication is the leading purpose of internet usage among respondents at 57%, followed by business use at 25.7%, education at 16.1%, and entertainment and government services occupying minor proportions. The high communication usage reflects the role of internet in enabling voice and data communication in remote communities where terrestrial telecommunications are often weak.

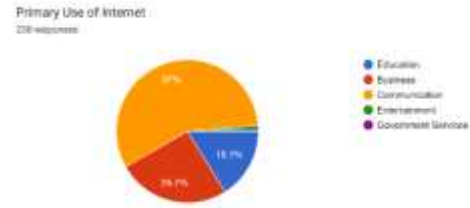


Figure 4.11: Primary Use of Internet by Respondents

ii. Affordability Perception

Figure 4.11 presents respondents' assessment of the affordability of current internet services. A combined 57.8% rated their internet service as "Expensive," and 22.6% as "Very Expensive." Only 14.8% found the cost "Affordable" and a marginal percentage described it as "Very Affordable." This finding corroborates the earlier cost perception data and indicates a systemic affordability problem in rural internet service provision.

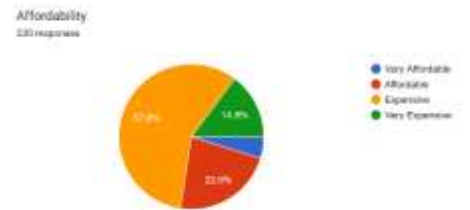


Figure 4.12: Affordability Assessment of Internet Services

iii. Service Quality

Figure 4.12 shows the service quality ratings provided by respondents on a scale of 1 to 5, where 1 represents the lowest quality. The majority of respondents (56.5%) rated service quality at 2 out of 5, and 27.8% rated it at 3. Only 11.3% gave a rating of 1, while 4.3% rated quality at 4 and none (0%) awarded the maximum score of 5. The heavily skewed distribution towards low ratings confirms widespread dissatisfaction with the quality of internet services available in rural Nigeria.

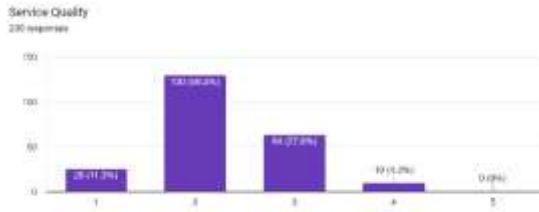


Figure 4.13: Service Quality Rating (1–5 Scale)

4.1.4 Challenges and Satellite Awareness

i. Challenges to Internet Access

Figure 4.13 identifies the main challenges confronting rural internet users. Poor network coverage was cited as the most prevalent challenge by 53.5% of respondents. High cost of data was the second most cited challenge at 24.8%, followed by lack of infrastructure at 14.3%. Power supply issues and low digital literacy were cited by smaller proportions. These findings collectively reflect both infrastructural and socio-economic barriers to broadband penetration in rural areas.

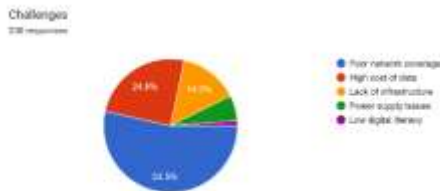


Figure 4.14: Challenges to Internet Access in Rural Areas

ii. Awareness of Satellite Technology

Figure 4.14 reveals that 80% of respondents are aware of satellite technology, while 20% are not. This high level of general awareness of satellite technology provides a favourable foundation for sensitizing rural communities about the potential of NigComSat's Ka-band broadband services.

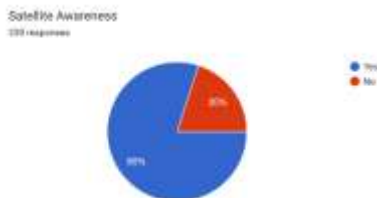


Figure 4.15: Awareness of Satellite Technology

iii. Awareness of Satellite Internet

As shown in Figure 4.15, 77% of respondents are aware of satellite internet as a connectivity medium, while 23% are not. Although awareness is high, the preceding data shows that satellite internet currently accounts for a very small fraction of actual internet usage, suggesting a gap between awareness and adoption.

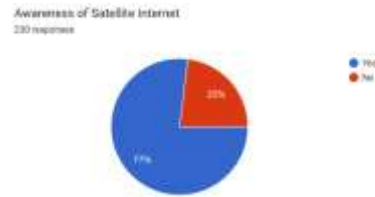


Figure 4.16: Awareness of Satellite Internet

4.1.5 Awareness and Perception of NigComSat

i. Awareness of NigComSat

Figure 4.16 shows that 71.7% of respondents are aware of NigComSat (the Nigerian Communications Satellite), while 28.3% are not. This relatively high awareness of NigComSat is noteworthy given that it is a government-operated satellite entity; however, the gap in awareness indicates a need for more targeted public communication and outreach efforts.

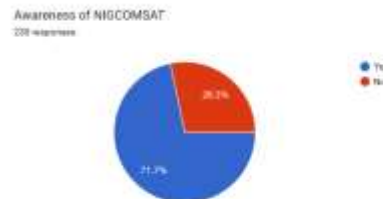


Figure 4.17: Awareness of NigComSat Among Respondents

ii. Sources of Awareness

Figure 4.17 presents the sources through which respondents first became aware of satellite internet services. Media (television, radio, print) accounted for 31.7% of awareness, while internet (online sources and social media) contributed 22.5%. Friends and family served as the source for 28.9%, and government programs accounted for 8.7%, with other sources making up the remainder. The dominance of media and peer networks as sources of awareness has

significant implications for outreach and sensitization strategies.

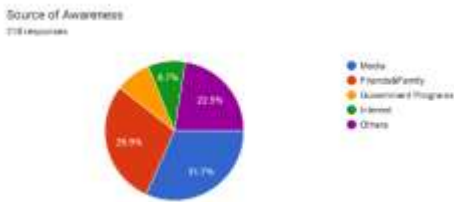


Figure 4.18: Sources of Awareness of Satellite Internet

iii. Agreement on Satellite Internet Coverage Reach
 Figure 4.18 shows that 48.3% of respondents strongly agree that satellite internet coverage is consistently available in rural and remote areas where fibre infrastructure is absent or microwave coverage is limited. An additional 36.5% agree with this statement. Combined, over 84% of respondents affirm that satellite internet has superior geographic coverage in underserved areas, a critical endorsement for the deployment of NigComSat Ka-band services.

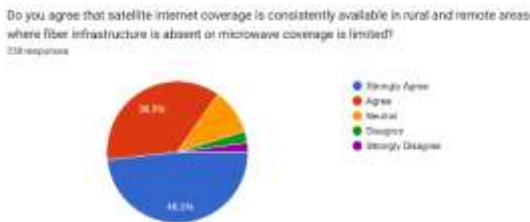


Figure 4.19: Agreement on Satellite Internet Coverage Reach

4.1.6 Perceptions and Willingness to Adopt Satellite Broadband

i. General Perception of Satellite Broadband Internet
 As illustrated in Figure 4.19, an overwhelming 96.5% of respondents view satellite broadband internet positively ("Good"), while only 3.5% expressed a negative view. This highly favourable perception is a strong indicator of the social acceptability of satellite internet in rural communities and supports the viability of leveraging NigComSat for broadband deployment.

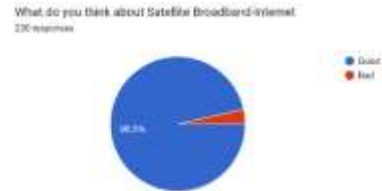


Figure 4.20: General Perception of Satellite Broadband Internet

ii. Viability of Satellite Internet in the Area

Figure 4.20 shows that 93% of respondents believe satellite internet is viable in their area, with only 7% expressing the contrary view. This near-universal endorsement of satellite internet's viability in rural areas strongly validates the research premise of deploying NigComSat Ka-band broadband for rural connectivity.

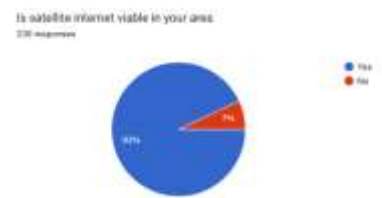


Figure 4.21: Viability of Satellite Internet in Respondents' Areas

iii. Satellite Broadband as a Development Enabler

Figure 4.21 reveals that 97.8% of respondents agree that satellite broadband internet supports development, with only 2.2% disagreeing. This near-total consensus on the developmental role of satellite internet reinforces the policy imperative to accelerate broadband deployment in rural Nigeria using available satellite infrastructure.

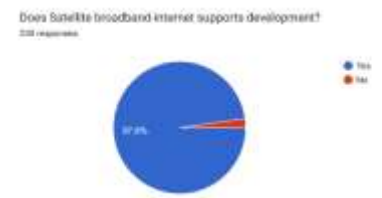


Figure 4.22: Satellite Broadband as a Development Enabler

iv. Willingness to Adopt Satellite Internet

As shown in Figure 4.22, 97.8% of respondents indicated willingness to adopt satellite internet in their area, with only 2.2% unwilling. This exceptionally high willingness rate confirms that demand for satellite broadband is virtually universal among rural respondents, and that community resistance is not a barrier to deployment.

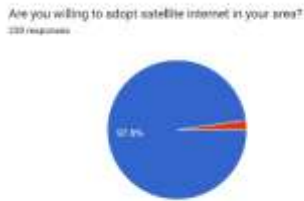


Figure 4.23: Willingness to Adopt Satellite Internet

v. Suggestions to Government on Satellite Broadband Deployment

Figure 4.23 presents respondents' multi-choice suggestions to the government to support satellite broadband deployment. The top suggestions include, providing subsidies or financial incentives (69.6%), investing in local satellite infrastructure (69.1%), promoting awareness and education (69.1%), providing an alternative connectivity solution (69.1%), improving power supply infrastructure (65.2%), ensuring affordable pricing (59.6%), providing tax relief for ICT companies (57%), supporting research and development (53%), encouraging competition among providers (52.6%), and partnering with the private sector (43.9%). These findings provide valuable policy-oriented insights for stakeholders and regulators.

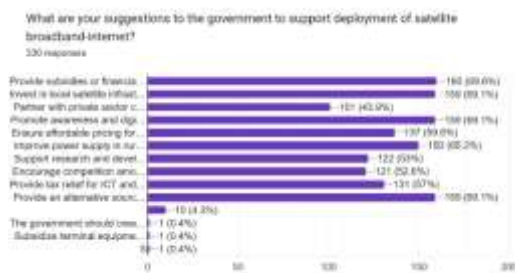


Figure 4.24: Suggestions to Government for Satellite Broadband Deployment

4.2 Data Analysis and Results

This section provides a systematic analysis of the data presented in Section 4.1. The analysis is organized thematically to address the research objectives of the study: evaluating existing internet infrastructure and its limitations, assessing community awareness of satellite internet and NigComSat, determining the perceived viability of NigComSat Ka-band deployment, and identifying policy measures required to facilitate deployment. Descriptive statistical analysis (frequencies and percentages) is employed throughout.

4.2.1 Analysis of Demographic Characteristics

The demographic analysis reveals that the study sample is predominantly male (64.8%) and youthful, with 63.5% of respondents falling within the 18–35 age bracket.

This demographic profile is characteristic of rural Nigerian communities where young adults are the primary internet users. Secondary school education (42.2%) is the most common qualification, which implies adequate basic literacy but limited advanced technical knowledge. Occupationally, the sample is diverse — with farmers (24.8%), students (23%), traders (22.2%), self-employed individuals (20%), and civil servants (10%) — reflecting the broad socio-economic composition of rural communities.

This diversity is methodologically significant, as it ensures that the survey captures varied needs and perspectives regarding broadband access.

The demographic characteristics suggest that broadband services in rural areas must cater to a range of users including farmers, small business owners, students, and government workers each with distinct digital needs. NigComSat Ka-band deployment strategies must, therefore, adopt inclusive designs that accommodate varying levels of digital literacy.

4.2.2 Analysis of Current Internet Infrastructure and Limitations

The analysis of internet access and connectivity data reveals a critical paradox: while 90% of respondents have some form of internet access, this access is predominantly through mobile data (88.3%) and is

characterised by poor reliability and high cost. Over 50% of respondents rated their connectivity as "Poorly Reliable," and 79.3% collectively view internet access in their area as expensive or very expensive. On a service quality scale of 1 to 5, a combined 67.8% of respondents rated the quality at 1 or 2, indicating very low satisfaction with existing services.

Despite these deficiencies, 86.5% of respondents use the internet daily, driven primarily by communication needs (57%) and business activities (25.7%). This high frequency of usage amid poor service quality substantiates the existence of a critical demand gap for quality broadband in rural Nigeria. The near-exclusive dependence on mobile data further underscores the vulnerability of rural connectivity, particularly in areas where cellular tower coverage is sparse or non-existent.

The most significant challenge identified by respondents is poor network coverage (53.5%), followed by high data costs (24.8%) and inadequate infrastructure (14.3%). These findings collectively establish a strong justification for the deployment of satellite broadband as a terrestrial-independent, wide-area coverage solution capable of bridging the digital divide in remote areas.

4.2.3 Analysis of Awareness of Satellite Internet and NigComSat

Awareness levels across satellite-related items reveal generally high cognisance of satellite technologies among rural respondents. Awareness of satellite technology generally stands at 80%, awareness of satellite internet at 77%, and awareness of NigComSat specifically at 71.7%. These figures are notably high for rural populations, suggesting that prior government and media campaigns have had some degree of success in disseminating information about satellite communications.

However, the awareness-adoption gap is considerable. Despite 77% awareness of satellite internet, its actual usage as a medium of connectivity is negligible (less than 1% according to the connectivity medium data). This gap points to barriers beyond awareness, including affordability, accessibility of hardware, technical support, and

power supply constraints — barriers that policy interventions must address in tandem with deployment.

The dominant sources of satellite awareness are media outlets (31.7%) and friends/family networks (28.9%), followed by the internet (22.5%). Government programmes as a channel of awareness account for only 8.7%, suggesting that official sensitisation efforts are underperforming and require reinforcement through targeted community engagement programmes.

4.2.4 Analysis of Perceived Viability and Community Acceptance

Community perception of satellite broadband is remarkably positive across all relevant indicators. A total of 96.5% regard satellite broadband as "Good," 93% consider it viable in their locality, 97.8% believe it supports development, and 97.8% indicate willingness to adopt it. These near-universal favourable responses represent one of the most compelling findings of this study.

Furthermore, 84.8% of respondents (combining "Strongly Agree" and "Agree" responses) affirm that satellite internet provides consistent coverage in rural and remote areas where terrestrial infrastructure is absent or inadequate. This perception aligns with the technical advantages of Ka-band satellite communication, which includes wide-area coverage that is independent of ground-based infrastructure.

The convergence of high willingness to adopt (97.8%), positive developmental perception (97.8%), and near-universal acknowledgement of satellite coverage superiority confirms that the primary barriers to NigComSat Ka-band adoption are not attitudinal but structurally relating to cost, infrastructure, and policy.

4.2.5 Analysis of Policy Recommendations from Respondents

Respondents provided a rich set of policy suggestions for satellite broadband deployment. The most frequently recommended measures include providing subsidies or financial incentives (69.6%), investing in local satellite infrastructure (69.1%), promoting public awareness and digital education (69.1%), and

providing alternative connectivity solutions (69.1%). Other significant recommendations include improving power supply infrastructure (65.2%), ensuring affordable pricing (59.6%), providing tax relief for ICT companies (57%), and supporting research and development (53%).

These recommendations reflect a well-rounded understanding of the systemic factors constraining satellite broadband deployment. The primacy of subsidies and infrastructure investment in community suggestions aligns with international best practices for bridging the digital divide, where government intervention is typically required to make satellite services commercially viable and accessible to low-income populations. The strong emphasis on power supply improvement (65.2%) is particularly relevant in the Nigerian context, where erratic electricity supply remains a significant barrier to device charging and internet equipment operation.

4.3 Discussion of Findings

The findings of this study are discussed in relation to the research objectives, existing literature, and the broader context of broadband policy in Nigeria. The discussion is organised around five key themes: the state of existing rural internet infrastructure, the awareness-adoption gap, the viability of NigComSat Ka-band for rural broadband, community acceptance, and policy implications.

4.3.1 The State of Internet Infrastructure in Rural Nigeria

The data consistently portray rural internet infrastructure in Nigeria as inadequate, unreliable, and prohibitively expensive. With 88.3% of rural respondents dependent solely on mobile data for connectivity, and over 50% rating that connectivity as poorly reliable, the findings confirm the persistent digital divide that separates rural from urban Nigeria. This is consistent with findings in the literature. Akintunde et al.

(2020) and the Nigerian Communications Commission (NCC) have documented the challenge of terrestrial network expansion into rural areas, citing the high cost of fibre optic infrastructure and the low return on investment for private telecoms operators in sparsely populated regions.

The high-cost perception (80% of respondents finding internet expensive or very expensive) correlates with the economic realities of rural Nigeria, where average household incomes are substantially lower than in urban centres.

This affordability barrier is a known impediment to broadband penetration globally and has been cited in studies on Sub-Saharan Africa's digital divide (ITU, 2022; Alliance for Affordable Internet, 2023). The findings therefore validate the study's central premise that existing terrestrial broadband solutions are insufficient for achieving universal broadband access in rural Nigeria, and that satellite-based alternatives must be urgently considered.

4.3.2 The Awareness-Adoption Gap and Implications for NigComSat

While awareness of satellite internet (77%) and NigComSat (71.7%) is encouraging, the negligible current adoption of satellite broadband in these communities signals a significant gap that policy must bridge. This awareness-adoption gap is a well-documented phenomenon in technology diffusion theory.

Rogers' (2003) Diffusion of Innovations theory posits that awareness of a technology does not automatically translate into adoption; rather, adoption is conditioned by perceived advantage, compatibility, complexity, trialability, and observability.

In this study, the high awareness of satellite internet coexists with very low adoption primarily because of structural and economic barriers. The cost of satellite terminals, recurring service subscription fees, and the lack of solar-powered backup systems to counter irregular electricity supply are among the non-attitudinal barriers that prevent adoption.

Additionally, the limited presence of NigComSat service resellers and agents in rural communities restricts physical access to the technology even among willing adopters.

The finding that government programmes account for only 8.7% of awareness sources is particularly significant. It suggests that NigComSat's outreach and distribution networks are not effectively

penetrating rural communities, and that greater investment in last-mile awareness campaigns, community agent networks, and subsidy programmes is essential to close the awareness-adoption gap.

4.3.3 Technical Viability of NigComSat Ka-Band Broadband

The Ka-band frequency used by NigComSat-1 (37.5–40 GHz downlink / 27.5–30 GHz uplink) offers significant advantages for rural broadband deployment. Ka-band satellites provide higher data throughput compared to legacy Ku-band systems, enabling broadband-grade internet delivery even to remote and mountainous areas where terrestrial infrastructure cannot reach.

The 93% respondent agreement on satellite internet's viability in their areas, and the 84.8% agreement that satellite internet consistently covers areas where terrestrial infrastructure is absent, directly corroborate the technical advantages of Ka-band satellite broadband.

Studies on Ka-band satellite performance in Africa have demonstrated that the technology is capable of delivering download speeds of 10–50 Mbps per terminal under favourable atmospheric conditions (Elbert, 2018; Fenech et al., 2015).

NigComSat-1R, which replaced the failed NigComSat-1 satellite, operates on Ka-band among other frequency bands and has capacity to support broadband services across Nigeria's underserved regions. The findings of this study therefore affirm that the technical potential of NigComSat Ka-band has substantial community endorsement, and that perceived viability is not a barrier to adoption.

However, it is important to acknowledge that Ka-band signals are susceptible to rain fade — signal attenuation caused by rainfall — which can be a significant challenge in Nigeria's humid equatorial regions, particularly in the southern states. Technical mitigation strategies such as Adaptive Coding and Modulation (ACM) and Uplink Power Control (UPC) must be incorporated into NigComSat Ka-band service planning to ensure consistent service quality in diverse climatic regions of Nigeria.

4.3.4 Community Acceptance and Social Readiness

Perhaps the most striking finding of this study is the near-universal community acceptance of satellite broadband. With 97.8% willingness to adopt, 97.8% agreement that satellite internet supports development, and 96.5% positive perception of satellite broadband, the study confirms that rural communities in Nigeria are socially ready and motivated to embrace satellite internet.

This finding is significant because social acceptance is often identified as a prerequisite for the successful deployment of new technologies, particularly in rural and traditional communities where scepticism towards external technological interventions can be high (Venkatesh et al., 2003; Davis, 1989). The absence of resistance among rural respondents strongly suggests that deployment barriers are predominantly structural (infrastructure, cost, power supply) rather than cultural or attitudinal.

The developmental dimension of respondents' views is also notable: the overwhelming consensus that satellite broadband supports development reflects an understanding of the internet's role in economic inclusion, agricultural modernisation, healthcare delivery, and educational access, all of which are critical development priorities in rural Nigeria.

This finding aligns with the United Nations Sustainable Development Goals (SDGs), particularly Goal 9 (Industry, Innovation, and Infrastructure) and Goal 17 (Partnerships for the Goals), which recognise digital connectivity as an enabler of broader development outcomes.

4.3.5 Policy Implications and Recommendations from the Field

The community-generated policy recommendations provide a bottom-up blueprint for satellite broadband deployment policy. The emphasis on subsidies (69.6%), infrastructure investment (69.1%), and affordable pricing (59.6%) mirrors global evidence on what is required to make satellite broadband commercially accessible in low-income settings.

The International Telecommunication Union (ITU) and the Alliance for Affordable Internet (A4AI) both recognise that in markets where rural populations

cannot afford commercial satellite internet tariffs, government subsidies for consumer equipment and service costs are essential (ITU, 2020; A4AI, 2021).

The strong community recommendation to improve power supply infrastructure (65.2%) is particularly critical in the Nigerian context. Satellite terminal equipment including VSAT dishes, modems, and routers — requires consistent electricity, which is highly unreliable in rural Nigeria.

Without addressing power supply, even subsidised satellite terminals will remain underutilised. This finding suggests that satellite broadband deployment must be integrated with off-grid solar energy solutions, as has been demonstrated in similar contexts in rural East Africa and Southeast Asia.

The need for community involvement initiatives to go hand in hand with hardware deployment is further highlighted by the proposal to increase awareness and digital literacy (69.1%).

Subpar results would result from merely granting access without giving communities the tools they need to use the internet productively. For rural occupational groups like farmers, traders, and small business owners, NigComSat and the Nigerian government should create training programs and digital literacy curriculum.

Finally, the finding that 43.9% of respondents recommend partnership with the private sector aligns with the growing global consensus on the need for public-private partnerships (PPPs) in rural broadband deployment.

The Nigerian government cannot finance universal satellite broadband deployment alone; strategic partnerships with commercial satellite operators, ICT companies, and international development organisations are essential to mobilise the capital and technical expertise required.

In conclusion, the results of this analysis offer a strong and comprehensive argument for utilizing NigComSat's Ka-band satellite capability for Nigerian rural broadband deployment. According to the statistics, there is a strong perception of the

developmental value of broadband, a high level of community awareness and acceptance of satellite internet, a significant and underserved demand for dependable internet connectivity, and a clear community consensus on the legislative measures required to assist deployment. These results offer a solid empirical basis for the study's conclusions and suggestions, which are discussed in the following chapter.

V. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Summary

The purpose of this study was to examine how the Nigerian Communications Satellite (NigComSat), particularly its Ka-band payload, may be used to increase broadband internet penetration in Nigeria's rural and remote locations.

The ongoing digital divide between urban and rural Nigeria, where terrestrial infrastructure—such as fiber optics and microwave networks—remains insufficient, unreliable, or nonexistent, served as the impetus for the study. As stated in the National Broadband Plan 2020–2025, the Nigerian government acknowledges broadband as a catalyst for socioeconomic growth; yet, poor network coverage, expensive data, inadequate infrastructure, and unstable power supplies persist in rural towns.

The study was guided by four research objectives: (i) to examine the viability of selected rural and remote regions for satellite broadband deployment; (ii) to evaluate the current state of broadband internet access in these zones; (iii) to identify prevailing disparities and barriers; and (iv) to develop an effective satellite technology implementation strategy for enhanced broadband coverage with associated socio-economic advantages.

To achieve these objectives, the study adopted a mixed-methods research design, combining quantitative surveys and qualitative interviews. A structured questionnaire was administered to 230 respondents drawn from multiple rural and remote Local Government Areas (LGAs) across Nigeria, with particular focus on Kwara and Nasarawa States. The survey captured data on demographic profiles,

current internet access status, connectivity mediums, reliability and cost of services, challenges faced, awareness of satellite internet and NigComSat, and willingness to adopt satellite broadband. In addition, a technical assessment of NigComSat-1R's Ka-band capabilities was conducted, including a detailed description of the Newtec MDM2200 IP satellite modem, 75cm Ka-band antenna, Point & Play pointing tool, and associated components necessary for VSAT deployment.

The data were analyzed using descriptive statistics (frequencies and percentages) and thematic analysis. The findings revealed a critical paradox: while 90% of respondents have some form of internet access, this access is predominantly via mobile data (88.3%) and is characterized by poor reliability (over 50% rating connectivity as "Poorly Reliable") and high cost (approximately 80% perceiving internet as expensive or very expensive).

Despite these deficiencies, 86.5% of respondents use the internet daily, driven primarily by communication (57%) and business (25.7%) needs, indicating a substantial demand gap for quality broadband.

Regarding satellite awareness, the study found that 80% of respondents are aware of satellite technology generally, 77% are aware of satellite internet, and 71.7% are aware of NigComSat specifically.

However, actual adoption of satellite broadband remains negligible, revealing a significant awareness-adoption gap attributable to structural barriers including cost of terminals, lack of service resellers in rural areas, and unreliable electricity supply.

Most importantly, the study found overwhelming community acceptance of satellite broadband: 96.5% view satellite broadband positively, 93% consider it viable in their area, 97.8% agree it supports development, and 97.8% are willing to adopt it. Respondents also provided actionable policy recommendations, including subsidies (69.6%), infrastructure investment (69.1%), awareness campaigns (69.1%), power supply improvement (65.2%), and affordable pricing (59.6%).

5.2 Conclusion

Based on the findings of this study, the following conclusions are drawn:

First, existing terrestrial broadband infrastructure in rural and remote Nigeria is fundamentally inadequate. The near-total reliance on mobile data, combined with poor network coverage (cited by 53.5% of respondents as the primary challenge), high cost, and low service quality ratings, confirms that the current connectivity model has failed to bridge the digital divide. Rural Nigerians are not disconnected by choice but by structural failure of terrestrial network expansion.

Second, the awareness-adoption gap for satellite broadband is not primarily attitudinal but structural. While awareness of satellite internet and NigComSat is encouragingly high (71.7–80%), adoption remains minimal due to barriers that are external to community willingness: high equipment costs, absence of local service providers, erratic power supply, and insufficient government-led sensitization programs. The finding that government programs account for only 8.7% of awareness sources indicates a policy implementation deficit rather than a technology acceptance problem.

Third, NigComSat's Ka-band satellite is technically viable and socially accepted for rural broadband deployment. The Ka-band payload offers high-throughput, wide-area coverage that is independent of terrestrial infrastructure, making it uniquely suited for Nigeria's geographically dispersed rural settlements. The near-universal community willingness to adopt (97.8%) and the strong belief in satellite broadband's developmental role (97.8%) provide a compelling socio-economic justification for immediate deployment.

Fourth, the digital divide in Nigeria is solvable, but not through terrestrial infrastructure alone. The study concludes that satellite broadband is not merely a supplementary option but a necessary complement to fiber and microwave networks. In areas where population density is too low to justify private sector investment in terrestrial infrastructure, satellite technology—particularly Ka-band, offers the only economically viable path to universal broadband coverage.

Fifth, a multi-stakeholder, multi-dimensional policy framework is necessary for the successful deployment of satellite broadband. It is evident from the suggestions made by the community that technology is not enough on its own. Subsidies to address pricing, off-grid solar solutions to solve power supply, digital literacy programs to address skills gaps, and public-private partnerships to mobilize investment and technical expertise are all necessary to support deployment.

In final conclusion, this study affirms that leveraging NigComSat's Ka-band capabilities for rural broadband penetration is not only feasible but urgently necessary. The technology exists, the community is ready, and the developmental dividends—in education, healthcare, agriculture, commerce, and governance—are substantial. What remains is the political will and coordinated policy action to translate this potential into reality.

5.3 Recommendations

Based on the findings, discussion, and conclusions of this study, the following recommendations are proffered for policymakers, regulators (Nigerian Communications Commission, NCC), NigComSat Ltd., the Federal Ministry of Communications and Digital Economy, and private sector partners.

5.3.1 Recommendations for Government and Regulatory Bodies

1. Subsidize Satellite Broadband Equipment and Service Costs for Rural Communities

Given that 69.6% of respondents recommended subsidies and 80% perceive current internet as expensive, the government should establish a Rural Satellite Broadband Subsidy Fund. This fund should cover the cost of VSAT terminals (antenna, modem, cabling) and provide discounted data plans for rural households, schools, and health centers. A model similar to South Korea's universal service obligation or Indonesia's broadband subsidy scheme should be adapted to the Nigerian context.

2. Integrate Off-Grid Solar Power with Satellite Broadband Deployment

With 65.2% of respondents calling for power supply improvement, the government should mandate that all rural satellite broadband installations include solar

charging systems and battery backups. The National Rural Electrification Agency (REA) should partner with NigComSat to deploy solar-powered community Wi-Fi hotspots using Ka-band backhaul.

3. Launch a Nationwide Rural Satellite Awareness and Digital Literacy Campaign

Given that only 8.7% of respondents learned about satellite internet through government programs, there is a clear need for a structured, well-funded sensitization campaign. This campaign should utilize local languages, radio (the most accessible medium in rural areas), traditional rulers, and community leaders. The campaign should also include hands-on digital literacy training tailored to farmers, traders, students, and health workers.

4. Establish Public-Private Partnerships (PPPs) for Last-Mile Distribution

The finding that 43.9% of respondents recommended private sector partnerships should be operationalized through a formal PPP framework. The government should provide tax relief (as recommended by 57% of respondents) and reduced import duties on satellite communication equipment to encourage local ISPs and telecom operators to become NigComSat service resellers in rural areas.

5. Mandate Universal Service Obligation (USO) for Satellite Broadband

The Nigerian Communications Commission (NCC) should expand the Universal Service Provision Fund (USPF) mandate to explicitly include satellite broadband deployment. A minimum of 10 Mbps broadband should be designated as a universal right for rural communities, with NigComSat as the primary infrastructure provider.

5.3.2 Recommendations for NigComSat Ltd.

1. Develop a Rural-Focused Ka-Band Service Package

NigComSat should create a dedicated "Rural Broadband Product" using Ka-band capacity, priced at no more than ₦390 per GB (as targeted by the National Broadband Plan). This product should include flexible payment options (pay-as-you-go, daily, weekly, monthly) to accommodate the income patterns of rural dwellers.

2. Establish Community Satellite Service Centers

Given the lack of local technical support in rural areas, NigComSat should establish Community Satellite Service Centers in each targeted LGA. These centers would serve as hubs for terminal installation, maintenance, training, and customer support. Local youth should be trained as certified satellite installers and technicians, creating employment while ensuring last-mile support.

3. Deploy Satellite Broadband First to Public Institutions

As a proof-of-concept and to maximize developmental impact, NigComSat should prioritize deployment to rural schools, primary health centers (PHCs), agricultural extension offices, and local government secretariats. Successful deployment in these anchor institutions will demonstrate value and drive household adoption.

4. Implement Technical Mitigation for Rain Fade

Given Ka-band's susceptibility to rain fades in Nigeria's humid regions, NigComSat should implement Adaptive Coding and Modulation (ACM) and Uplink Power Control (UPC) across its ground segment. Additionally, larger antenna sizes (90cm or 1.2m) should be recommended for high-rainfall zones in southern Nigeria.

5.3.3 Recommendations for Development Partners and International Organizations

1. Align Satellite Broadband Deployment with SDG Targets

International partners (ITU, World Bank, African Development Bank, GSMA) should support NigComSat's rural broadband initiative as a flagship project for SDG 9 (Industry, Innovation, and Infrastructure). Grant funding should be directed towards subsidizing terminal costs and funding digital literacy programs.

2. Facilitate Knowledge Transfer from Successful Satellite Broadband Projects

The government and NigComSat should establish formal knowledge-exchange partnerships with countries that have successfully deployed rural satellite broadband, such as South Korea (PPP model), Indonesia (underdeveloped regions

program), and Starlink's emerging economy initiatives.

5.4 Limitations of the Study

While this study provides robust empirical evidence for leveraging NigComSat Ka-band for rural broadband penetration, the following limitations are acknowledged:

1. Geographic Scope

The study was unable to cover all 774 Local Government Areas in Nigeria due to time, financial, and accessibility limitations. Although some respondents were from other states, Kwara and Nasarawa States were the primary focus of the poll. Although the results are consistent across several geopolitical zones, it is advisable to exercise caution when extrapolating the findings to all of Nigeria's rural areas. Rural areas in the Niger Delta and the extreme northeast (Borno, Yobe) may suffer particular environmental and security issues that are not completely covered in this study.

2. Sample Size

Although statistically sufficient for descriptive analysis, the sample size of 230 respondents is small in comparison to Nigeria's estimated 100 million rural residents. Inferential statistical analysis and more accurate estimates would be possible with a bigger sample, especially one stratified by geopolitical zone.

3. Potential Response Bias

As with all self-reported survey data, there is a risk of response bias. Respondents may have over-reported their willingness to adopt satellite internet (social desirability bias) or under-reported challenges due to fear of government reprisal. The research team attempted to mitigate this by ensuring anonymity and using local enumerators who were known and trusted in the communities.

4. Technical Assessment Limitations

While the study conducted a technical assessment of NigComSat's Ka-band capabilities using manufacturer specifications (Newtec MDM2200 modem, 75cm antenna), actual field testing of the equipment in the surveyed rural communities was not performed due to equipment availability and

regulatory constraints. A future field pilot study would provide more definitive technical validation.

5. Power Supply as an External Variable

The study identified power supply as a critical barrier (65.2% of respondents), but it did not quantify the availability of off-grid solar solutions in the surveyed communities. This variable is external to satellite technology per se but critically affects its usability. A more granular assessment of rural energy access would strengthen future research.

6. Cross-Sectional Design

The study collected data at a particular point in time using a cross-sectional approach. Changes in awareness, willingness, or adoption over time cannot be captured by this approach. Stronger causal evidence would come from long-term research that followed the same communities before, during, and after satellite broadband deployment.

Despite these limitations, the study maintains internal consistency, triangulates quantitative and qualitative data, and provides findings that are largely consistent with the existing literature on rural broadband in Sub-Saharan Africa. The limitations do not invalidate the core conclusions but rather highlight areas for refinement in future research.

5.5 Suggestions for Further Studies

Based on the findings and limitations of this study, the following avenues for future research are proposed:

1. Pilot Deployment and Impact Assessment Study

A pilot deployment of NigComSat Ka-band broadband in two or three representative rural areas (e.g., one in Kwara, one in Nasarawa, one in a southern state) is the most pressing next step. The influence on educational outcomes, agricultural production, healthcare access, small business revenue, and household income should be measured using a quasi-experimental design (pre-test/post-test with a control group). The causal proof required to support significant government spending would be provided by such a study.

2. Comparative Study of Ka-band vs. Ku-band vs. Starlink for Rural Nigeria

While this study focused on NigComSat's Ka-band, a comparative technical and economic analysis of Ka-band (NigComSat), Ku-band (other regional satellites), and Starlink's Low Earth Orbit (LEO) constellation would help determine the optimal technology mix for different rural contexts in Nigeria. Key metrics should include latency, throughput, cost per Mbps, terminal cost, rain fade resilience, and ease of installation.

3. Socio-Economic Willingness-to-Pay (WTP) Study

To inform pricing and subsidy design, a discrete choice experiment or contingent valuation study should be conducted to determine rural households' exact willingness to pay for satellite broadband at different speed tiers and price points. This study should also identify the elasticity of demand with respect to terminal cost, monthly fee, and electricity access.

4. Energy-Broadband Nexus Study

Given that 65.2% of respondents identified power supply as a barrier, a dedicated study on the "Energy-Broadband Nexus" is required. This research should evaluate different off-grid solar configurations (sizes, battery capacities, solar panel wattages) paired with satellite terminals to determine the most cost-effective and reliable energy solution for rural Nigeria.

5. Digital Literacy and Usage Outcomes Study

While this study measured awareness and willingness, it did not measure digital literacy levels or actual usage outcomes. A future study should administer standardized digital literacy assessments to rural populations before and after a satellite broadband deployment, and correlate literacy levels with usage patterns (e.g., use of e-government services, online learning platforms, e-commerce, telemedicine).

6. Longitudinal Study on Rural Broadband and Economic Transformation

Three to five years after satellite broadband deployment, the same rural families and enterprises should be monitored in a multi-year longitudinal study. Income diversification, educational

achievement, health outcomes (via telemedicine), agricultural yield (via access to weather and market information), and civic engagement should all be considered outcome variables. This would offer the strongest proof that broadband facilitates development.

7. Regulatory and Policy Implementation Study

Finally, a policy implementation study should analyze the institutional, bureaucratic, and political economy barriers to deploying NigComSat Ka-band broadband. This research would involve in-depth interviews with NCC officials, NigComSat management, state government representatives, and private sector partners to identify why previous satellite broadband initiatives have not scaled and what institutional reforms are necessary.

REFERENCES

- [1] Abdon, E., William, F., & Tandika, P. (2023). Assessment of the community's technological literacy in the use of mobile phones for rural development. *International Journal of Lifelong Education*, 1–13.
- [2] Adegoke, A. S., & Adeniji, I. T. (2008). Essential factors for successful implementation of satellite communication technology in Nigeria. *International Journal of Computer Science and Network Security*, 8(5), 305–311.
- [3] Adenuga, A. H., Ojehomon, V. E. T., Diagne, A., Omotesho, K. F., & Ayinde, O. E. (2016). Assessment of effective use of tablet computers as a tool for data collection in Nasarawa State, Nigeria. Accessed April, 14.
- [4] Afolayan, T. O., Aiterebhe, E. F., Mejabi, V., Oyekunle, R. A., Bello, O., & Balogun, N. (2015). Mobile phone usage in rural communities in Kwara State, Nigeria. *Information Technology*, 12(2), 1–15.
- [5] Agba, A. M. O., Ushie, E. M., & Abang, M. (2010). Governance failure and rural underdevelopment in Nigeria: A critical analysis. *Journal of Social Sciences*, 22(2), 95–104.
- [6] Ahmed, J. U., Talukdar, A., Khan, M. M., Sharif, R., & Ahmed, A. (2023). Flutterwave — A digital payment solution in Nigeria. *Journal of Information Technology Teaching Cases*, 13(1), 50–57.
- [7] Alliance for Affordable Internet (A4AI). (2021). *Affordability report 2021*. Washington, DC: Web Foundation.
- [8] Ariansyah, K., Barsei, A. N., Syahr, Z. H. A., Sipahutar, N. Y. P., Damanik, M. P., Perdananugraha, G. M., & Suryanegara, M. (2023). Unleashing the potential of mobile broadband: Evidence from Indonesia's underdeveloped regions on its role in reducing income inequality. *Telematics and Informatics*, 102012.
- [9] Bhattacharya, D., & Tadic, M. (2021). Bridging the rural digital divide with satellite broadband: Lessons from developed and developing economies. *Telecommunications Policy*, 45(4), 102105.
- [10] Byanyuma, M., Zaipuna, Y., Simba, F., & Trojer, L. (2018). Utilization of broadband connectivity in rural and urban-underserved areas: The case of selected areas in Arusha, Tanzania.
- [11] Chen, J., & Wang, J. (2023). The impact of broadband speed on innovation: City-level evidence from China. *Heliyon*, 9(1).
- [12] Chukwu-Okoronkwo, S. O. (2015). Nigerian Communication Satellite and the quest for sustainable national development. *American Journal of Social Science Research*, 1(1), 1–8.
- [13] Danielle, N. E. L. (2020). Allocation of risk in public private partnerships in information and communications technology. *International Journal of E-Business and E-Government Studies*, 12(1), 17–32.
- [14] Daramola, F. O. (2022). Utilization of ICT resources for teaching among some selected lecturers in colleges of education in Kwara State. *ASEAN Journal of Educational Research and Technology*, 2(1), 1–10.
- [15] Diallo, A., & Kebe, C. M. F. (2022). Ka-band rain attenuation modelling for satellite links in Sub-Saharan Africa. *International Journal of Satellite Communications and Networking*, 40(2), 155–169.

- [16] Ebere Melum-Nwogbo. (2026, April 1). FG earmarks \$2bn to launch 2 satellites in 2028, 2029. Nigeria Communications Week. <https://www.nigeriacommunicationsweek.com.ng/fg-earmarks-2bn-to-launch-2-satellites-in-2028-2029/>
- [17] Elbert, B. R. (2018). The satellite communication applications handbook (3rd ed.). Artech House.
- [18] Evans, B. G., Werner, M., Lutz, E., Bousquet, M., Corazza, G. E., Ebert, G., & Vojcic, B. (2005). Integration of satellite and terrestrial systems in future multimedia communications. *IEEE Wireless Communications*, 12(5), 72–80.
- [19] Fenech, H., Amos, S., Tomatis, A., & Soumpholphakdy, V. (2015). VHTS systems: Capacity and challenges. In Proceedings of the 33rd AIAA International Communications Satellite Systems Conference (ICSSC), 1–10.
- [20] Hernandez, J. A., & Reviriego, P. (2023). A brief introduction to satellite communications for Non-Terrestrial Networks (NTN). arXiv preprint arXiv:2305.04590.
- [21] Ifeduba, E. (n.d.). Satellite communication technology and sustainable rural development in Nigeria.
- [22] International Telecommunication Union (ITU). (2020). Measuring digital development: Facts and figures 2020. Geneva: ITU Publications.
- [23] International Telecommunication Union (ITU). (2022). Measuring digital development: Facts and figures 2022. Geneva: ITU Publications.
- [24] Jain, R. (2019). Low Earth orbit constellations for broadband internet: A survey of technical and policy challenges. *IEEE Communications Surveys & Tutorials*, 22(2), 1–25.
- [25] Kizza, J. M. (2017). Ethical and social issues in the information age (6th ed.). Springer.
- [26] Lee, H., Jeong, S., & Lee, K. (2023). The South Korean case of deploying rural broadband via fiber networks by implementing universal service obligation and public-private partnership-based project. *Telecommunications Policy*, 47(3), 102506.
- [27] Marshal, I., Ihenacho, W. P., & Chizuru, A. J. (2023). Mobile payment technology and poverty alleviation in Nigeria. *Management*, 3(1), 1–9.
- [28] Musa, A. B., & Aliyu, M. K. (2020). Satellite broadband technology and rural connectivity in Nigeria: An empirical review. *African Journal of Information Systems*, 12(3), 42–58.
- [29] Nancy, B. B., & Gary Loh, C. W. (2021). A case study: Broadband over powerline for rural area deployment in Sarawak.
- [30] National Broadband Plan 2020–2025. (2020). Federal Ministry of Communications and Digital Economy, Federal Republic of Nigeria. Abuja: Federal Government of Nigeria.
- [31] National Broadband Plan 2022–2025. (2022). Federal Ministry of Communications and Digital Economy, Federal Republic of Nigeria. Abuja: Federal Government of Nigeria.
- [32] National Broadband Plan. (2021). Federal Ministry of Communications and Digital Economy, Federal Republic of Nigeria. Abuja: Federal Government of Nigeria.
- [33] NigComSat. (2011). Nigerian Communications Satellite Limited: Corporate profile and services. Abuja: NigComSat Ltd.
- [34] Nigerian Communications Commission (NCC). (2021). Annual report and industry statistics. Abuja: Nigerian Communications Commission.
- [35] Nigerian National Broadband Plan 2020–2025. (2020). Federal Ministry of Communications and Digital Economy. Abuja: Federal Government of Nigeria.
- [36] Ojo, S. O., & Akintola, A. A. (2019). Evaluation of satellite internet quality of service for rural broadband provision in Nigeria. *Nigerian Journal of Technology*, 38(4), 1024–1030.
- [37] Okafor, N. C., & Dike, V. E. (2021). Digital inclusion and rural development in Nigeria: The role of satellite communication infrastructure. *African Development Review*, 33(2), 215–228.
- [38] Okoli, C. E. O. (2020). Office technology and management curriculum contents and the use of modern information communication and technology facilities among students of polytechnics in Nasarawa State, Nigeria.

Nigerian Journal of Business Education (NIGJBED), 7(1), 445–457.

- [39] Preparation for Future Learning: The Case of Rural Communities in Nigeria. (2020). In Proceedings of the XV Conferencia Latinoamericana de Tecnologías de Aprendizaje (LACLO) (pp. 1–7). IEEE.
- [40] Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.
- [41] Shaengchart, Y., & Kraivanit, T. (2023). Starlink satellite project impact on the internet provider service in emerging economies. *Research in Globalization*, 6, 100132.
- [42] Tongia, R., & Subrahmanian, E. (2006). Information and communications technology for development: A case study of challenges and opportunities. *Information Technology for Development*, 12(2), 97–119.
- [43] Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425–478.
- [44] World Bank. (2016). World development report 2016: Digital dividends. Washington, DC: World Bank Publications.
- [45] Zain, A. M., & Alias, R. (2022). Effectiveness of satellite internet in closing the digital divide in underserved regions: A systematic review. *Journal of Rural Studies*, 94, 312–325.