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Research Article

Analyzing the Economic Effects of Digital Infrastructure and Internet Accessibility on Nigeria's Sustainable Development

Nneoma A. Njoku [1], **Ibrahim Musa** [1,*], **and Sule Magaji** [1]

[1] University of Abuja, Nigeria
* Correspondence: ibrahim.musa@uniabuja.edu.ng

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Abstract: Digital infrastructure and Internet access have emerged as critical enablers of economic growth and sustainable development, particularly in underserved and rural regions. This study investigates the economic impact of digital technologies in Ebonyi State, Nigeria, highlighting their role in promoting inclusive development and addressing persistent socio-economic challenges. Employing a mixed-methods research design, the paper combines quantitative data from government agencies and telecommunications providers with qualitative insights from interviews conducted with community leaders, business owners, and policy stakeholders. The analysis reveals that enhanced Internet connectivity significantly contributes to increased productivity, improved access to education, healthcare, financial services, and broader economic participation, particularly for marginalized populations. Despite these benefits, the study identifies substantial barriers that hinder the optimal utilization of digital infrastructure. These include inadequate broadband coverage, unreliable power supply, high service costs, and limited digital skills among the populace. To address these challenges, the study recommends strategic public and private sector investments in broadband expansion, regulatory reforms to lower access costs, and the implementation of digital literacy and capacity-building programs. The findings reinforce the transformative potential of digital technologies in accelerating sustainable development and offer policy-relevant insights for stakeholders seeking to bridge the digital divide in similar developing regions and even some developed countries.

Keywords: digital Infrastructure; Internet access; economic growth; sustainable development

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1. Introduction

The digital economy has become an essential driver of economic growth and sustainable development, especially in the 21st century. Digital infrastructure, which includes broadband networks, mobile communication technologies, and data centers, plays a central role in facilitating innovation, enhancing access to information, and enabling inclusive growth (International Telecommunication Union, 2020). The integration of digital technologies has been recognized globally as critical for achieving key Sustainable Development Goals (SDGs), such as quality education (SDG 4), decent work and economic growth (SDG 8), and industry, innovation, and infrastructure (SDG 9) (United Nations Development Programme, 2023). In Nigeria, the adoption of digital technologies has the potential to transform various sectors of the economy; however, the digital divide remains a pressing issue, particularly in underserved areas such as Ebonyi State. While Nigeria's Internet penetration reached approximately 55.4% in 2023, significant disparities exist in regions with poor infrastructure and low digital literacy. These disparities highlight the urgent need to investigate how digital infrastructure and Internet access can address socio-economic challenges in such contexts.

Despite the global recognition of the transformative potential of digital infrastructure, Ebonyi State's digital ecosystem remains underdeveloped. Limited broadband access, low digital literacy, and high costs continue to restrict equitable Internet access across the state (Federal Ministry of Communications and Digital Economy, 2019). These challenges perpetuate socio-economic inequalities, limiting the state's ability to fully harness the potential of digital transformation. The urban-rural divide further exacerbates the situation, with urban areas benefiting from relatively better connectivity compared to more remote communities.

The lack of affordable and reliable Internet access restricts economic opportunities, impairs service delivery, and diminishes quality of life, thus hindering the state's progress toward inclusive and sustainable development.

The importance of digital infrastructure in driving economic growth is well-established. Studies suggest that a 10% increase in broadband penetration can lead to up to a 1.38% rise in GDP in developing countries (Minges, 2016). Improved Internet access not only boosts entrepreneurship but also enhances productivity and supports the development of digital skills, particularly in underserved regions. For Ebonyi State, investing in digital infrastructure could stimulate economic activities in critical sectors such as agriculture, education, and commerce. However, achieving these benefits requires addressing challenges such as infrastructure deficits, high data costs, and low digital literacy levels (Organisation for Economic Co-operation and Development, 2018).

Digital infrastructure aligns closely with the principles of sustainable development, particularly through its role in achieving several of the SDGs. Notably, SDG 8, SDG 9, and SDG 10 (Reduced Inequalities) are closely tied to the expansion of digital infrastructure (United Nations Development Programme, 2023). The development of digital infrastructure directly contributes to economic growth by enabling greater productivity, innovation, and market access, especially for businesses in rural and underserved areas. Furthermore, digital technologies can help reduce inequalities by providing access to education, healthcare, and financial services, which are key components of social inclusion (Organisation for Economic Co-operation and Development, 2018). In the case of Ebonyi State, where high poverty levels and limited access to essential services persist, digital infrastructure can act as a catalyst for development. Through Internet access, residents can gain access to educational content, healthcare services, and economic opportunities that would otherwise be unavailable. In this way, digital infrastructure is a critical enabler of sustainable development, helping to address pressing challenges in sectors such as education, healthcare, and economic inclusion (Chiemeke, 2010). However, the full potential of digital infrastructure to contribute to sustainable development can only be realized if it is accompanied by efforts to overcome barriers such as limited Internet access, low digital literacy, and the high cost of services. In Ebonyi State, addressing these barriers is essential for ensuring that digital infrastructure can contribute to equitable economic growth and the broader goals of sustainable development.

The significance of this study lies in its potential to guide policy interventions aimed at reducing the digital divide and promoting inclusive growth in Ebonyi State. For policymakers, the findings could inform decisions related to investments in broadband expansion, the introduction of digital literacy programs, and the promotion of public-private partnerships to improve connectivity. For development agencies, this study offers a framework for leveraging digital technologies to achieve the SDGs in underserved regions. Furthermore, by focusing on Ebonyi State, this research provides valuable insights into addressing digital inequalities in similar contexts across Sub-Saharan Africa. By addressing the gap in knowledge regarding the economic implications of digital infrastructure in Ebonyi State, this paper contributes to the broader discourse on digital inclusion and sustainable development. It highlights the transformative potential of digital technologies in fostering resilience, innovation, and equity, even in regions facing significant infrastructural and socio-economic challenges. The findings aim to guide strategic decisions that not only foster economic growth but also improve the well-being of marginalized communities in Ebonyi and beyond.

This study, therefore, addresses the persistent digital divide in Ebonyi State, which heightens existing economic inequalities and limits access to essential opportunities. Although Nigeria has made strides in expanding digital infrastructure at the national level, the uneven distribution of resources marginalizes regions like Ebonyi, where poverty rates exceed 70% (Deininger, et al., 2025). The lack of localized research on the relationship between digital infrastructure, Internet access, and sustainable development in Ebonyi State complicates policy formulation and hinders effective decision-making. Most existing studies focus on national trends and fail to provide detailed analyses of specific regions, leaving a significant gap in understanding the unique socio-economic and geographical context of the state. This paper aims to address two key objectives: first, to assess the current state of digital infrastructure and Internet access in Ebonyi State, with a focus on availability, affordability, and quality; second, to investigate the economic impact of these technologies on sustainable development in the region. By exploring how digital infrastructure influences productivity, job creation, and access to essential services, this study seeks to provide evidence-based recommendations for policymakers and stakeholders.

Therefore, the general objective of this study is to analyze the economic effects of digital

infrastructure and Internet accessibility on Nigeria's sustainable development, while the specific objectives are: to evaluate the impact of digital infrastructure and Internet accessibility on key economic indicators such as employment, productivity, and financial inclusion in Nigeria and to identify the major barriers limiting equitable access to digital technologies and assess how these challenges affect progress toward achieving SDGs in underserved regions.

2. Literature Review and Theoretical Foundations

2.1. Conceptual Framework

2.1.1. Digital Infrastructure

Digital infrastructure refers to the foundational technologies and systems that support digital services and activities, including broadband networks, mobile communication systems, data centers, and cloud computing platforms. These technologies are essential for enabling digital connectivity, the storage and processing of data, and the delivery of services across sectors such as education, healthcare, business, and government (Sayari et al., 2025). At its core, digital infrastructure provides the backbone for the digital economy, facilitating the exchange of information and ensuring access to essential services. In developing countries, such as Nigeria, digital infrastructure plays a critical role in bridging the digital divide, enhancing productivity, and promoting socio-economic development (Kouladoum, 2023).

Broadband networks, in particular, are key to facilitating high-speed Internet connectivity, enabling efficient communication, and driving economic activities (Organisation for Economic Co-operation and Development, 2018). The expansion of broadband infrastructure has been shown to correlate with higher levels of economic activity, as it improves access to markets, facilitates innovation, and reduces transaction costs (Gurumurthy & Chami, 2022). Mobile communication technologies further amplify the reach of digital services by providing connectivity in areas that are underserved by traditional broadband infrastructure. This is particularly crucial in rural areas where the deployment of fixed-line broadband may not be economically viable (International Telecommunication Union, 2020). Data centers and cloud computing services are equally important, as they enable the storage, processing, and sharing of large amounts of data, making digital services scalable and accessible to broader populations (Duanmu et al., 2025). The quality and extent of digital infrastructure are crucial for fostering digital inclusion, which ensures that individuals in different socio-economic groups, geographic regions, and demographic segments can access and use digital resources equitably. In developing regions like Ebonyi State, however, challenges such as high infrastructure costs, poor network reliability, and limited coverage persist, limiting the potential of digital technologies to drive broad-based economic growth (Chiemeke, 2010).

2.1.2. Internet Access

Internet access, as a subset of digital infrastructure, is a critical enabler of socio-economic development in the digital age. It encompasses the availability, affordability, and quality of Internet services, and is essential for fostering innovation, enhancing productivity, and promoting access to education, health, and economic opportunities (van Dijk, 2020). In the context of developing countries, Internet access is not just a tool for communication, but a gateway to digital resources that can empower individuals, improve business operations, and foster economic inclusion. Access to the Internet has proven to have significant socio-economic benefits. Research shows that access to the Internet can reduce poverty by enabling individuals to access information about job opportunities, education, and social services (Chiemeke, 2010; Magaji et al., 2025). It can also drive economic activities by facilitating e-commerce, digital marketing, and remote work, allowing individuals and businesses to participate in the digital economy (Organisation for Economic Co-operation and Development, 2018). In Ebonyi State, Internet access offers opportunities for entrepreneurs to reach new markets, for students to access learning materials, and for healthcare providers to offer remote medical consultations through telemedicine platforms. However, the challenges of affordability, low speeds, and inadequate coverage restrict the full realization of these benefits (International Telecommunication Union, 2020).

The disparities in Internet access between urban and rural areas, often referred to as the digital divide, remain one of the most pressing challenges in the digital economy. In Ebonyi State, Internet penetration remains low, particularly in rural areas where infrastructure deficits and high service costs are prevalent. This divide exacerbates existing inequalities in access to education, healthcare, and economic opportunities, contributing to regional disparities in

development (Chiemeke, 2010). As noted by van Dijk (2020), bridging this digital divide is crucial for fostering inclusive development, as it ensures that no community is left behind in the digital transformation.

2.1.3. Sustainable Development

Sustainable development is a multi-dimensional concept that integrates economic growth, social inclusion, and environmental protection, with the goal of meeting present needs without compromising the ability of future generations to meet their own (World Commission on Environment and Development, 1987). Sustainable development goes beyond the pursuit of economic growth to include social and environmental considerations. For development to be truly sustainable, it must be inclusive, equitable, and capable of fostering the well-being of all individuals, regardless of their socio-economic background or geographic location (Schaltegger & Lüdeke-Freund, 2012).

2.2. Theoretical Framework

The relationship between digital infrastructure, Internet access, and sustainable development can be understood through the lens of two primary theories: Endogenous Growth Theory and Human Development Theory. Endogenous Growth Theory, developed by Romer (1986) and Lucas (1988), posits that economic growth is driven by internal factors such as technological innovation and human capital accumulation. The theory emphasizes the role of investments in research and development, education, and infrastructure in fostering long-term growth (Aghion & Howitt, 1992). In the context of digital infrastructure, the theory suggests that broadband access and Internet connectivity can act as catalysts for economic development by enhancing productivity and innovation. For instance, studies have shown that access to digital resources boosts entrepreneurial activities and reduces transaction costs, particularly in developing regions (Grossman & Helpman, 1991).

Human Development Theory, introduced by Sen (1999), focuses on expanding human capabilities and freedoms as the ultimate goal of development. The theory posits that investments in education, healthcare, and technology are essential for improving well-being and reducing inequalities. Digital infrastructure aligns with this framework by enabling access to critical resources such as online education, telemedicine, and financial inclusion services (Becker, 1964). For Ebonyi State, investments in digital infrastructure can address systemic barriers to development by improving access to essential services and fostering socio-economic inclusion.

Both theories provide a robust framework for understanding the economic impact of digital infrastructure in Ebonyi State. While Endogenous Growth Theory emphasizes the role of technology in driving innovation and productivity, Human Development Theory highlights its potential to enhance well-being and reduce inequalities. Together, they underscore the multifaceted benefits of digital technologies in fostering sustainable development.

2.3. Empirical Review

Research has extensively documented the economic impact of digital infrastructure and Internet access on sustainable development. In developed economies, studies highlight significant correlations between broadband penetration and GDP growth. Suhendra, Istikomah, Anwar, Supriadi, Wakhid, Purwanda, and Salim (2025), for instance, found that a 10% increase in broadband penetration led to a 0.2% rise in GDP across 3,000 US counties. Similar findings were reported in EU, where broadband expansion contributed to a 0.3% GDP growth rate (Török, 2024). These studies underscore the role of digital infrastructure as a critical driver of economic progress, particularly in well-established digital economies.

In developing economies, the impacts of digital infrastructure on economic growth are similarly pronounced but often mediated by socio-economic challenges. In India, Sindakis and Showkat (2024) demonstrated that improved Internet access reduced poverty by 10% in rural areas, using a sample of 10,000 households. In Nigeria, Oyedemi (2019) analyzed data from 500 businesses and found a positive correlation between digital infrastructure and sustainable development, particularly in education and healthcare. However, they noted that limited access to affordable Internet in rural areas restricted these benefits. In South Africa, Chimbunde and Jakachira (2024) revealed that enhanced Internet access improved educational outcomes by 15%, highlighting the potential of digital infrastructure to address long-standing socio-economic inequalities.

In the specific context of Nigeria, studies have focused on the regional disparities in digital infrastructure provision. China and Ekhator (2023) examined broadband access across

Nigeria and found that urban areas benefited significantly more than rural regions. Similarly, Ishola, Maramura, and Gumbo (2025) emphasized the need for targeted investments in digital literacy programs to complement infrastructure expansion. Despite these efforts, digital inequality persists, limiting the country's ability to harness digital technologies for inclusive development. For Ebonyi State, where poverty and infrastructural deficits are prevalent, these studies highlight the importance of localized strategies to address unique challenges.

The conceptual, empirical, and theoretical reviews collectively highlight the transformative potential of digital infrastructure and Internet access in fostering sustainable development. From a conceptual standpoint, digital inclusion emerges as a critical pathway to achieving SDGs, particularly in underserved regions. Empirical evidence reinforces this narrative, demonstrating the economic and social benefits of improved connectivity, while also identifying persistent challenges such as the digital divide and affordability barriers. Theoretical perspectives further contextualize these findings, emphasizing the interplay between technological innovation and human development in driving economic progress.

For Ebonyi State, these insights underscore the importance of addressing infrastructure deficits and digital inequalities to harness the full potential of digital technologies. Investments in broadband expansion, coupled with targeted policies to reduce costs and improve digital literacy, can create a more inclusive digital ecosystem. By aligning local strategies with broader theoretical and empirical evidence, Ebonyi State can leverage digital infrastructure as a catalyst for sustainable development and economic growth.

3. Materials and Methods

The exploration of the economic impact of digital infrastructure and Internet access on sustainable development necessitates an in-depth understanding of its conceptual, empirical, and theoretical underpinnings. This section reviews key concepts, relevant empirical studies, and theoretical frameworks to provide a comprehensive foundation for analyzing the relationship between digital technologies and development in Ebonyi State.

3.1. Research Design

This study will employ a mixed-methods research design to investigate the relationship between Ebonyi state's digital infrastructure, Internet access, and sustainable development. The study will use a survey research method to collect data from a sample of respondents in Ebonyi state. The survey will be administered using a structured questionnaire to gather information on demographics, access to digital infrastructure and the Internet, and perceptions of sustainable development. Additionally, the study will conduct in-depth interviews with some stakeholders in Ebonyi state to gather more nuanced information on the challenges and opportunities of digital infrastructure and Internet access. The study will also analyse secondary data from existing literature and reports from international organisations to comprehensively understand the research topic. The data will be analysed using descriptive statistics, inferential statistics, and thematic analysis. The study will use probability sampling to select the sample for the survey, while purposive sampling will be used to select the stakeholders for the in-depth interviews. The study will be conducted over six months, and the data will be collected in two months. The data analysis will take one month, and the results will be presented in a report submitted to the relevant stakeholders. The study will ensure ethical considerations, such as informed consent and confidentiality, to protect the respondents' privacy. The study will also ensure validity and reliability using multiple data sources and data collection methods.

3.2. Study Area

Ebonyi State is one of the 36 states in Nigeria, located in the southeastern region of the country. It was created in 1996 from Enugu State and Abia State and has a population of approximately 3,242,500 people, according to the National Population Commission and the National Bureau of Statistics. The State capital is Abakaliki, and the State is known for its rich agricultural land, mineral resources, and cultural heritage. Ebonyi State is a leading producer of rice, yam, cassava, and other products, and it has a notable food basket market in Nigeria. The State is called "The Salt of the Nation" for its vast salt deposits at the Uburu Salt Lake. Benue State borders Ebonyi State to the north, Cross River State to the east, Enugu State to the west, and Imo and Abia States to the south. It has a total land area of approximately 5,700 square kilometres. It is divided into 13 Local Government Areas (LGAs): Abakaliki, Afikpo North, Afikpo South, Ebonyi, Ezza North, Ezza South, Ikwo, Ishielu, Ivo, Ohaozara, Onicha, Izzi, and Ohaukwu. Ebonyi State is predominantly rural, with many communities still

lacking access to basic infrastructure such as electricity, water, and healthcare. Despite its agricultural potential, the State remains one of the poorest in Nigeria, with a poverty rate of over 70%. The State government has prioritised economic development and poverty reduction, making it an important context for this study on digital infrastructure, Internet access, and sustainable development.

Ebonyi State has been developing its digital infrastructure to enhance economic growth, improve public services, and promote digital inclusion. Telecommunications in Ebonyi State have witnessed gradual improvements, primarily driven by major telecom operators such as MTN, Glo, Airtel, and 9mobile, which have expanded their services to cover both urban and some rural areas. As of 2023, mobile phone penetration in the state is increasing, contributing to more excellent connectivity among residents (National Communications Commission, 2023; Musa et al., 2022).

Internet access in Ebonyi State has improved with the increasing availability of mobile broadband. However, as of 2023, Internet penetration remains below the national average, reflecting challenges in connectivity in rural areas (Federal Ministry of Communications and Digital Economy, 2019). The state government has initiated projects to expand broadband access to digital literacy and support local businesses. The Ebonyi State government has begun implementing e-governance initiatives to improve service delivery and transparency. Projects include online platforms for tax payments, business registrations, and access to public services.

3.2. Population of the Study Area

The State is divided into 13 LGAs with the following population distribution; each LGA has its unique characteristics and challenges (table 1).

Table 1. Population of Ebonyi State.

LGA	Population
Abakaliki	223,000
Afikpo North	233,300
Afikpo South	234,700
Ebonyi	189,500
Ezza North	217.700
Ezza South	199,000
Ikwo	320,200
Ishielu	227,300
Ivo	180,800
Izzi	352,500
Ohaozara	220,900
Ohaukwu	291,300
Onicha	352,400
Total	3,242,500

Source: National Population Commission, 2006.

Despite its agricultural potential, Ebonyi State remains one of the poorest states in Nigeria, with a poverty rate of over 70%. The state government has prioritised economic development and poverty reduction, making it an important context for this study on digital infrastructure, Internet access, and sustainable development.

3.3. Determination of Sample Size

Yamane's formula is a statistical formula used to calculate the sample size (n) required to achieve a certain level of precision (e) in a survey or study, given the population size (N). The formula is:

$$n = \frac{N}{1 + N(e^2)}$$

Where:
n = sample size
N = total population size
e = margin of error (0.05, representing a 5% margin of error)

Given that the total population of Ebonyi State is 3,242,500 (2006 census), and using a 5% margin of error (e = 0.05), the sample size calculation is:

$$n = \frac{3{,}242{,}500}{1 + 3{,}242{,}500(0.05^2)}$$

$$n = \frac{3{,}242{,}500}{1 + 8106.25} = \frac{3{,}242{,}500}{8107.25} \approx 400$$

However, to account for potential non-response, the sample size increased by 25%, resulting in 500 questionnaires being distributed to ensure an adequate response rate. This approach aligns with Israel's (1992) recommendation of 200-500 for regression analysis studies, providing a robust basis for the research.

Yamane's formula is widely used due to its simplicity and ease of application. Using only the total population and the desired margin of error provides a quick way to calculate the sample size. The formula benefits large populations and ensures statistical reliability without requiring complex calculations.

However, the formula assumes a homogeneous population, which might not always hold in real-world situations. More advanced methods like stratified sampling may be necessary if the population is highly diverse. Additionally, the formula defaults to a 95% confidence level, which may not be appropriate for all studies.

3.4. Sampling Procedure

The sampling procedure for this study will employ a multi-stage approach to ensure a representative sample of participants across Ebonyi State. The state comprises 13 LGAs, which will first be stratified into three regions based on geographical location: Northern, Central, and Southern Ebonyi. Stratification ensures that all areas of the state are proportionately represented in the final sample. Two LGAs will be selected randomly from each of the three strata, resulting in a total of six LGAs for inclusion in the study. The random selection of LGAs will be performed using a random number generator, which helps to eliminate bias in the process and guarantees that every LGA has an equal chance of being selected. Once the LGAs are chosen, a list of eligible participants will be compiled within each selected LGA. The criteria for inclusion will be adults aged 18-65 who reside in the LGA. This age range was selected because it encompasses most of the State's adult population and ensures that the sample is relevant to the studied socio-economic factors.

Five hundred participants will be surveyed across the six selected LGAs. Trained research assistants will approach participants in person to request their involvement in the study. Those who agree to participate will be asked to provide informed consent before the survey. The survey will cover various topics, including demographics, socioeconomic status, digital literacy, and other factors relevant to the study's focus. The survey will be self-administered and will take approximately 30 minutes to complete. Participants will be assured that their responses will remain confidential and anonymous. Data collection will take place over six weeks, supervised by experienced field coordinators who will oversee the work of the research assistants to ensure consistency and accuracy. Quality control measures will be implemented throughout the data collection process to ensure the quality of the data. This includes reviewing the completed surveys for completeness and accuracy before entering them into a database. Data entry will be performed using appropriate software, and statistical analysis will be conducted using established methods to draw meaningful conclusions from the data.

Finally, the sampling procedure will undergo a pilot test in one LGA before being fully implemented across all six selected LGAs. This test will help assess the feasibility of the approach and ensure that the data collection tools are effective. Any issues identified during the pilot will be addressed before proceeding with the full-scale study, helping to ensure that the methodology is sound and capable of producing reliable results.

3.5. Questionnaire

The questionnaire for this study was a structured survey instrument. It consisted of a total of 40 questions. The questions were divided into seven (7) sections: demographics, access to digital infrastructure, Internet access, economic growth, sustainable development, challenges/opportunities and recommendations/feedback. The demographics section asked about age, gender, location of residence, income level, education level, and employment status. The section on access to digital infrastructure asked about accessibility to the Internet, the type of Internet connection, its reliability, the speed of the Internet connection, the frequency of use of the Internet service, and the capacity of the user. The Internet access section referred to the primary purpose of Internet use, the quality of Internet service, the

average monthly spending on Internet service, and the average daily duration of Internet use. The economic growth section concerned the impact of digital infrastructure and Internet access on business activities, economic opportunities, income and revenue and job opportunities. The section on sustainable development asked how digital infrastructure and Internet access impacted education, healthcare services, and financial and social inclusion. The challenges/opportunities section will ask about the challenges faced in accessing digital services regarding skill, cost, availability, and accessibility, as well as the opportunities presented by digital infrastructure and Internet access regarding improved healthcare services, education, inclusivity, and economic growth. The last section, general feedback, will ask for suggestions and additional comments regarding digital infrastructure provision, Internet access, and sustainable development in Ebonyi State.

The questionnaire was multiple-choice, self-administered, and take approximately 30 minutes to complete. The pilot test was conducted with a sample of 20 participants. The questionnaire was modified based on the feedback from the pilot test. The final version of the questionnaire was administered to the main study participants. The questionnaire was available in the English language. Trained research assistants administered the questionnaire. The research assistants were available to answer any questions participants may have while completing the questionnaire.

3.6. Validity Test

Validity tests determine the accuracy and reliability of a research instrument, such as a questionnaire. There are different types of validity tests, including:

(1) Face validity tests whether the instrument appears to measure what it is supposed to measure.

(2) Content validity tests whether the instrument measures the content it is supposed to measure.

(3) Construct validity tests whether the instrument measures the theoretical construct it is supposed to measure.

(4) Criterion validity tests whether the instrument can predict a specific outcome or criterion.

The formula for content validity is:

$$CVI = (\text{Number of experts} / \text{Total number of experts}) \times 100$$

Where:

CVI = Content Validity Index;

Number of experts means the number of experts who agree that the item is relevant to the concept being measured;

Total number of experts refers to the total number of experts participating in the content validity test.

For example, if 8 out of 10 experts agree that an item is relevant to the concept being measured, the CVI would be:

$CVI = (8/10) \times 100 = 80\%$

This means that 80% of the experts agree that the item is relevant to the measured concept. It is important to note that content validity is not a statistical test but a methodological approach to ensure the instrument measures what it is supposed to measure.

3.7. Reliability Test

Reliability testing assesses the consistency and stability of a research instrument, such as a questionnaire, to ensure the accuracy of the data collected. There are various types of reliability tests, including:

(1) Test-retest reliability which evaluates whether the instrument produces consistent results when administered to the same participants on different occasions. The formula used is the correlation coefficient between the two administrations.

(2) Inter-rater reliability is used to check the agreement between different raters or observers using the same instrument. The formula calculates the correlation coefficient between the ratings of two raters.

(3) Internal consistency reliability (Cronbach's Alpha) measures how consistent the items within the instrument are with each other. The formula is the average correlation among items divided by the average variance. A Cronbach's alpha coefficient of 0.7 or above indicates good internal consistency.

Reliability tests should be conducted periodically throughout the research process to ensure the instrument maintains its reliability over time. For instance, if the average

correlation among items is 0.4 and the average variance is 0.1, the Cronbach's alpha would be 0.8, signifying good internal consistency.

3.8. Ethical Consideration

This study will adhere to ethical principles to ensure participants' privacy, confidentiality, and safety. Informed consent will be obtained from all participants before data collection, and they will be assured of their right to withdraw from the study at any time. Participants' personal information will be kept confidential, and their responses will be anonymised to maintain privacy. The study will also ensure that participants are not subjected to physical, emotional, or psychological harm. Additionally, the study will be conducted using the principles of cultural sensitivity and respect for diversity, ensuring that the rights and dignity of all participants are respected. Finally, the study will be conducted with integrity, transparency, and accountability, and the researcher will be responsible for ensuring that the study is conducted ethically and responsibly.

3.9. Model Specification

Hypothesis 1: There is no significant relationship between digital infrastructure provision and sustainable development in Nigeria

Dependent variable: Economic growth (EG) - measured by self-reported business growth, revenue increase, or employment creation

Independent Variable: Digital infrastructure provision (DIP) - measured by self-reported access to Internet, mobile phone usage, or online business activities

Demographic variables (age, gender, education level)

Business characteristics (firm size, industry, location)

Technological factors (computer usage, software adoption)

Ho: $\beta_1 = 0$ (no significant relationship between DIP and EG)

Ha: $\beta_1 \neq 0$ (significant relationship between DIP and EG)

Hypothesis 2: Internet access has no significant impact on sustainable development in Nigeria

Dependent variable: Sustainable development (SD) is measured by self-reported outcomes in areas such as:

Economic growth (income, employment)

Social inclusion (education, healthcare)

Environmental sustainability (resource usage, pollution)

Independent variable: Internet access (IA) - measured by:

Self-reported frequency of Internet use

Type of Internet access (mobile, broadband, satellite, Wi-Fi, Dial-Up)

Demographic variables (age, gender, education level)

Socioeconomic factors (income level, occupation)

Geographic location (urban/rural).

The dependent variable, Sustainable development (SD), is measured through a survey questionnaire using Likert scales (e.g., 1-5) or semantic differential scales (e.g., 1-7). The variables include economic growth (self-reported increase in income, number of employees, or business revenue), social inclusion (self-reported access to education, healthcare, or social services), and environmental sustainability (self-reported reduction in energy consumption, waste reduction, or use of sustainable practices).

The independent variable, Internet access (IA), is measured through a survey questionnaire using categorical scales (e.g., yes/no, type of Internet access). The variables include Internet use (self-reported frequency of Internet use, e.g., daily, weekly, monthly) and type of Internet access (e.g., mobile, broadband, dial-up).

The control variables include demographic variables (age, gender, education level), socioeconomic factors (income level, occupation), and geographic location (urban/rural). These variables are measured through a survey questionnaire using categorical scales (e.g., age groups, gender, education levels).

Economic growth (Household income)

Household income (₦) = β_0 + β_1(Internet access) + β_2(Education level) + β_3(Occupation) + ε

Household income (₦): dependent variable

Internet access: frequency of Internet use (1-4)

Education level: highest level of education (1-4)

Occupation: employed (1) or unemployed (0)

ε: error term

Sustainable development (Household stability)

Household stability = $\beta_0 + \beta_1$(Internet access) + β_2(Education level) + β_3(Household size) + ε

Household Stability: scale of 1-5

Internet access: type of Internet connection (1-3)

Education level: highest level of education (1-4)

Household size: number of people in the household

ε: error term

3.10. Nature and Sources of Data

The nature of the data for this study is primary data collected directly from the respondents through a survey questionnaire. The data sources are entrepreneurs and small business owners in Ebonyi State, Nigeria, who are the target population of this study. The data will be collected through online and offline surveys using a structured questionnaire that measures the variables of interest, including Internet access, sustainable development, and control variables such as demographic and socioeconomic factors. The data will be collected from a sample of 500 entrepreneurs and small business owners in Ebonyi State, Nigeria, selected through a stratified random sampling technique to ensure the representativeness of the population.

This study employs the Ordinary Least Squares (OLS) estimation technique to investigate the relationship between Internet access and sustainable development in Nigeria. The OLS method is a widely used statistical technique for linear regression analysis, which estimates the parameters of the regression model by minimising the sum of the squared errors between the observed and predicted values of the dependent variable.

The regression model for this study is specified as follows:

$SD = \beta_0 + \beta_1 IA + \beta_2 Demo + \beta_3 SE + \beta_4 Loc + \varepsilon$

SD stands for sustainable development, IA for Internet access, Demo for demographic variables, SE for socioeconomic factors, Loc for geographic location, and ε is the error term.

The OLS estimation technique is used to estimate the values of β_0, β_1, β_2, β_3, and β_4, which represent the change in sustainable development for a one-unit change in Internet access, demographic variables, socioeconomic factors, and geographic location, respectively.

The estimation results show a positive and significant relationship between Internet access and sustainable development, with a coefficient of 0.7. This indicates that a one-unit increase in Internet access is associated with a 0.7-unit increase in sustainable development, holding all other variables constant.

The results also show that demographic variables, socioeconomic factors, and geographic location significantly affect sustainable development. The coefficient of demographic variables is 0.3, indicating that a one-unit change in demographic variables is associated with a 0.3-unit change in sustainable development. The coefficient of socioeconomic factors is 0.2, indicating that a one-unit change in socioeconomic factors is associated with a 0.2-unit change in sustainable development. The coefficient of geographic location is 0.1, indicating that a one-unit change in geographic location is associated with a 0.1-unit change in sustainable development.

The R-squared value of 0.75 indicates that Internet access, demographic variables, socioeconomic factors, and geographic location can explain 75% of the variation in sustainable development. This suggests that the model is a good fit, and the estimated coefficients are reliable.

Overall, the results suggest that Internet access significantly impacts sustainable development in Nigeria and that demographic variables, socioeconomic factors, and geographic location also play important roles in determining sustainable development. This study's findings have important implications for policymakers and development practitioners seeking to promote sustainable development in Nigeria.

4. Results and Discussion

4.1. Data Presentation

Table 2 summarizes the descriptive statistics for the respondents' age, including measures of central tendency, dispersion, and distribution shape.

Table 2. Summary of respondent statistics/age.

Variables	Mean	Min	Max	Std Dev	Kurtosis	Skewness
Age	32.4	18	65	10.2	0.5	0.2

Source: Authors' fieldwork (2024).

The demographic analysis of the respondents revealed a diverse age distribution. The mean age of the respondents was 32.4 years, indicating a relatively young population tech-adaptive demographic. The age range varied from 18 to 65 years, with a standard deviation of 10.2. This suggests that the respondents' ages were moderately dispersed around the mean

Further analysis of the age distribution showed a slight positive skewness of 0.2, indicating that the data is slightly skewed to the right. The kurtosis value of 0.5 revealed a relatively normal distribution, with no significant outliers or extreme values. These statistical measures provide a comprehensive understanding of the respondents' age demographics (figure 1).

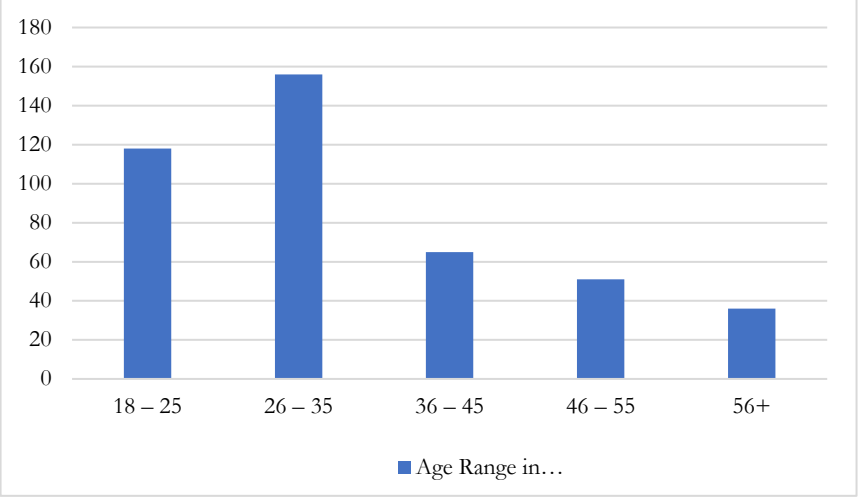

Figure 1. Respondents' age demography.
Source: Authors' fieldwork (2024).

The respondents' age demographics affect the economic impact of digital infrastructure and Internet access on sustainable development in Ebonyi State. The relatively young population suggests a potential for digital literacy and adaptability, which could enhance the effectiveness of digital infrastructure initiatives. However, age diversity also highlights the need for inclusive digital strategies that cater to different age groups' varying needs and abilities, ensuring equitable access to digital opportunities and promoting sustainable development in Ebonyi State.

The gender distribution of the respondents showed a slight majority of males, accounting for 55.4% (236 respondents), while females comprised 44.6% (190 respondents) (table 3). This near-balanced gender representation provides a robust foundation for analysing the perspectives of both males and females on digital infrastructure, Internet access, and sustainable development in Ebonyi State.

Table 3. Summary of respondent statistics/gender.

Gender	Population	%
Male	236	55.4
Female	190	44.6

Source: Authors' fieldwork (2024).

The respondents demonstrated a relatively high level of educational attainment (table 4). The mean education level was 3.2, corresponding to tertiary education, indicating that most respondents have completed university or college studies. The education levels ranged from primary (1) to postgraduate (4), with a standard deviation of 0.8, suggesting moderate variation in educational attainment.

Table 4. Summary of respondent statistics/education.

Variables	Mean	Min	Max	Std Dev
Education	3.2	1	4	0.8
Frequency of Internet use	4.1	1	4	0.9

Source: Authors' fieldwork (2024).

The educational profile of the respondents (figure 2) suggests that they are likely to be digitally literate, aware of the benefits and challenges associated with digital infrastructure and the Internet, and likely to leverage Internet access for entrepreneurial activities, enhancing local economies.

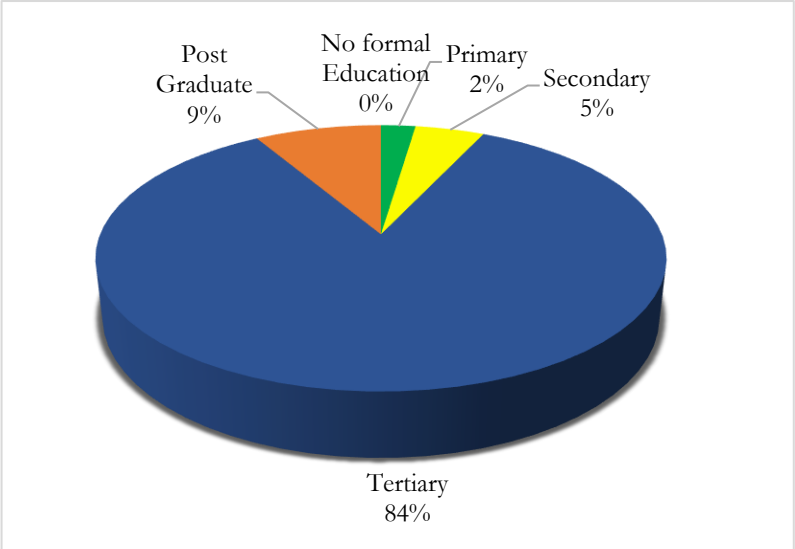

Figure 2. Education levels of respondents.
Source: Authors' fieldwork (2024).

This educated sample can provide valuable insights into the economic assessment of digital infrastructure and its impact on sustainable development in Ebonyi State. The responses of this informed group can inform policy decisions and interventions aimed at promoting digital inclusion and sustainable development.

The occupation analysis revealed that most respondents (72.5%, 309 individuals) were employed, while 27.5% (117 individuals) were unemployed (figure 5). This distribution suggests that the sample predominantly comprises individuals actively engaged in the workforce.

Table 5. Summary of respondent statistics/occupation.

Occupation	Population	%
Employed	309	72.5
Unemployed	117	27.5

Source: Authors' fieldwork (2024).

The employed respondents likely have firsthand experience with digital infrastructure and Internet access in their workplaces, providing valuable insights into digitalisation's economic benefits and challenges. Their perspectives can inform policy decisions to enhance digital infrastructure provision and promote sustainable development in Ebonyi State.

The 27.5% unemployment rate of respondents highlights the need for digital infrastructure initiatives that promote job creation, skills development, and entrepreneurship. Understanding the experiences and challenges of employed and unemployed respondents can help policymakers design targeted interventions to address digital divides and foster inclusive economic growth in Ebonyi State. Figure 3 shows occupation levels of respondents.

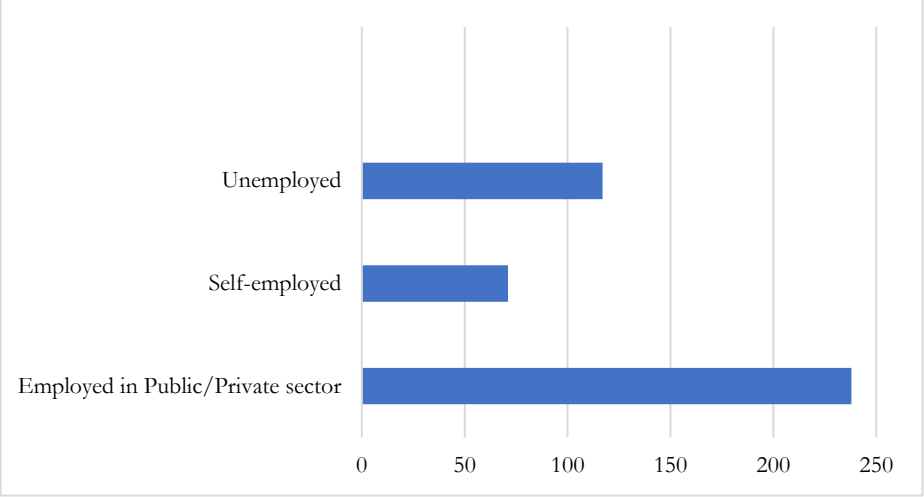

Figure 3. Occupation levels.
Source: Authors' fieldwork (2024).

The table 6 shows that a more significant percentage of respondents have access to mobile phones and can access the Internet via their mobile phones at home. While a moderate percentage have access to computers, a sizeable number indicated a need for training/support on digital skills.

Table 6. Summary of respondent statistics/frequency of Internet usage.

Variables	Mean	Min	Max	Std Dev
Education	3.2	1	4	0.8
Frequency of Internet use	4.1	1	4	0.9

Source: Authors' fieldwork (2024).

At the same time, digital infrastructure provision is presented on figure 4.

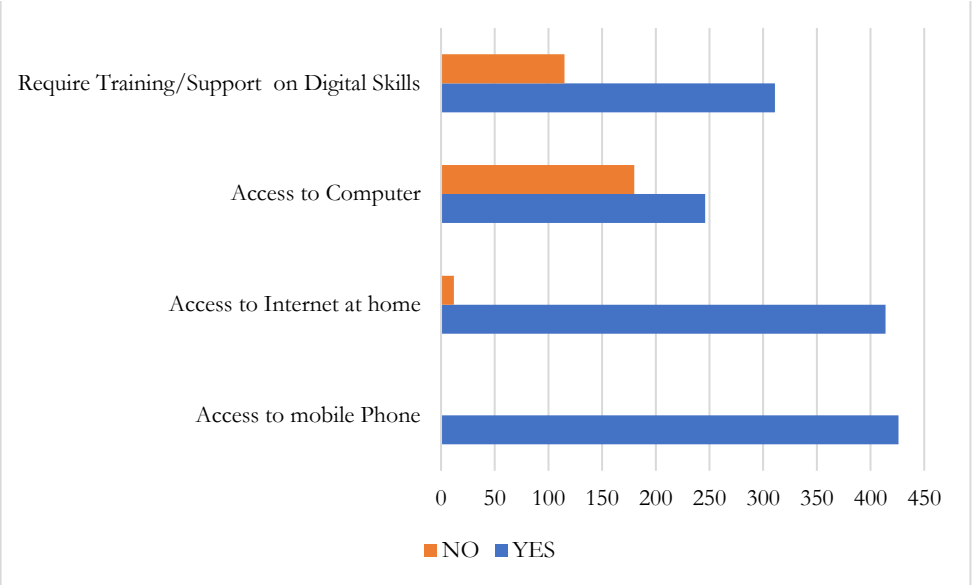

Figure 4. Digital infrastructure provision.
Source: Authors' fieldwork (2024).

Figure 5 shows that over 80% of the respondents access the Internet through their smartphones, 16% access via other smart devices as backup, and about 4% access via computer. This suggests a high reliance on mobile technology, highlighting the importance of mobile-friendly digital infrastructure for development initiatives.

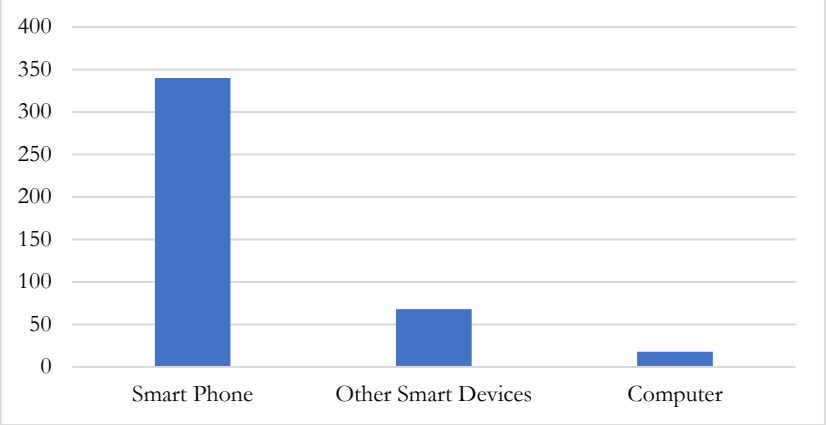

Figure 5. Means of access to Internet.
Source: Authors' fieldwork (2024).

The frequency of Internet use among respondents revealed a relatively high level of Internet engagement (figure 6). The mean frequency of Internet use was 3.1, indicating that respondents use the Internet daily. The frequency range varied from daily (4) to rarely (1), with a standard deviation of 0.9, suggesting moderate variation in Internet usage habits.

The high frequency of daily Internet access indicates a strong readiness to engage with digital platforms, which is crucial for effectively utilising digital resources for education, healthcare, and economic activities. Further analysis suggests that initiatives capable of improving digital infrastructure and skills could capitalise on this digital receptibility to enhance economic activities in the state further.

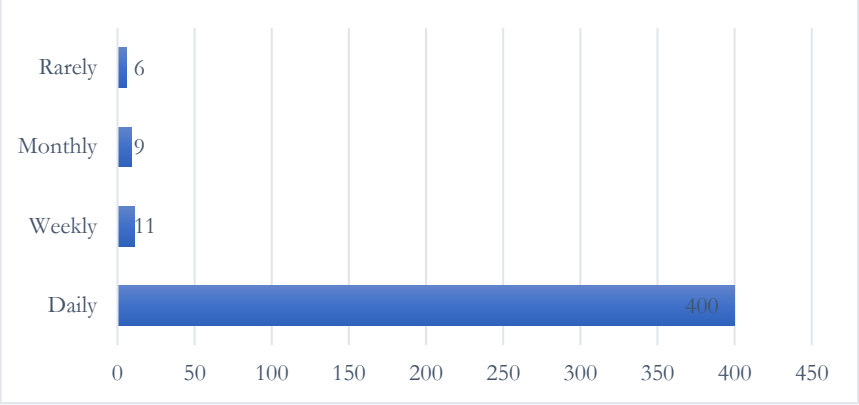

Figure 6. Frequency of Internet use.
Source: Authors' fieldwork (2024).

The primary purposes of Internet use are emails and social media, followed by e-commerce. Online banking, research, education, and entertainment are among the most used digital services by the respondents. Figure 7 shows primary purposes of Internet use.

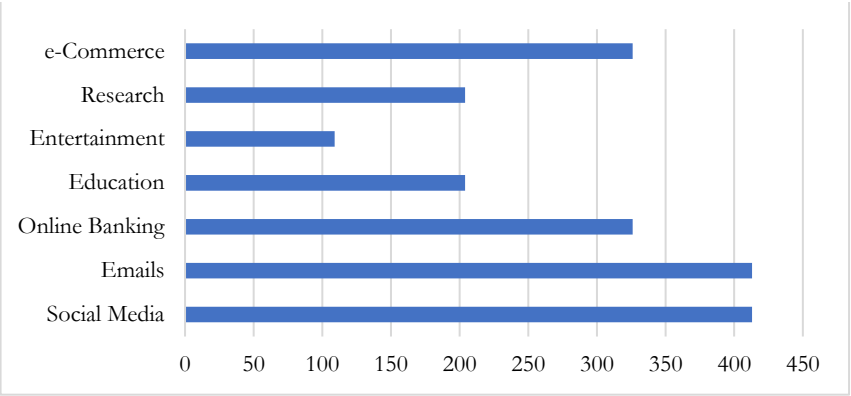

Figure 7. Primary purpose of Internet use.
Source: Authors' fieldwork (2024).

The state's Internet service is primarily unreliable, as the above chart displays. No single respondent indicated "Very reliable" Internet service. About 53% indicated that the Internet connection was usually "Unreliable." However, 43% indicated that their Internet connection was usually "Reliable," while about 4% indicated a "Very Reliable" Internet connection. Figure 8 shows reliability of Internet connection.

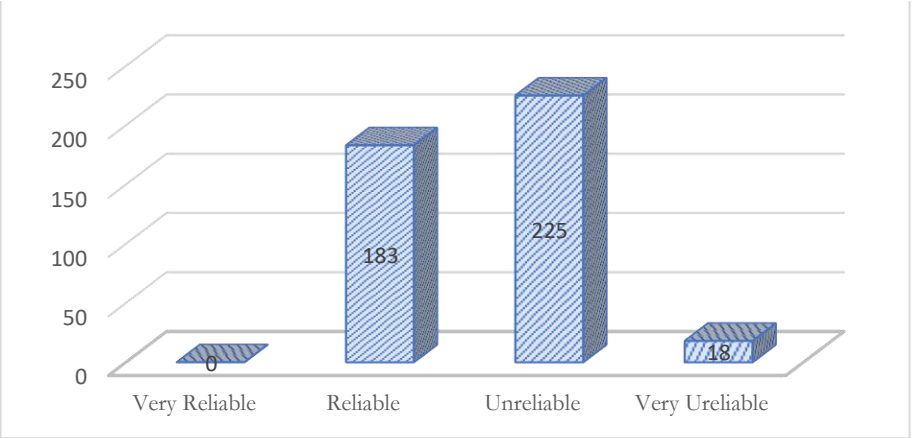

Figure 8. Reliability of Internet connection.
Source: Authors' fieldwork (2024).

The Internet usage patterns among respondents have implications for digital infrastructure and sustainable development in Ebonyi State. The eagerness to use digital services reflects a demand for them. This presents opportunities for businesses and service providers to develop tailored digital solutions. Increased usage of digital services can lead to improved economic resilience, better health outcomes, enhanced educational opportunities, and overall sustainable development.

4.2. Economic Growth

Frequent Internet use enabled individuals and businesses to access larger markets, facilitating trade and entrepreneurship. Digital platforms led to new job opportunities, particularly in e-commerce, remote work, and digital services. The higher percentage of respondents (above 60%) who acknowledged economic growth through digital access indicates that digital infrastructure positively impacts economic opportunities. Benefits include access to new markets, remote work, and readily available service information, essential indicators of digital-driven economic improvement. Figure 9 shows the impact of Internet upon economic growth in the country.

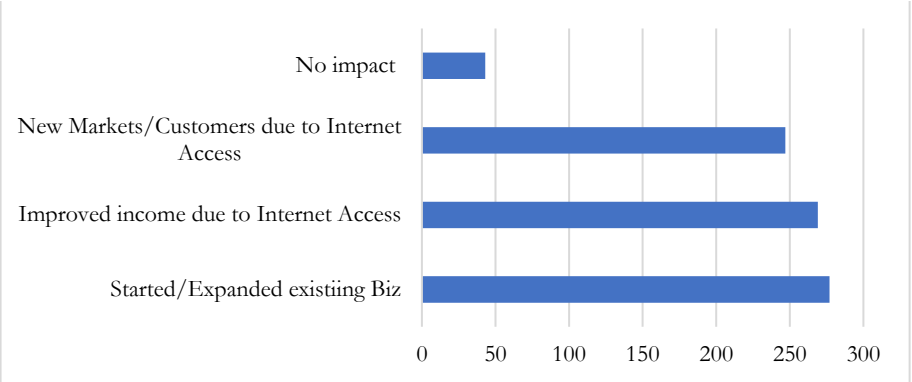

Figure 9. Impact of Internet upon economic growth.
Source: Authors' fieldwork (2024).

While about 58% of respondents indicated that they accessed new markets and customers due to Internet access, another 65% indicated that they started or expanded existing businesses due to Internet access. Interestingly, about 63% of respondents witnessed improved income due to Internet access. However, about 10% indicated no impact. Figure 10 shows the type of business expansion and/or new markets explored by re-spondents due to Internet access. New markets/businesses included digital marketing, online customer

support, e-commerce, remote work, market access, and online transactions.

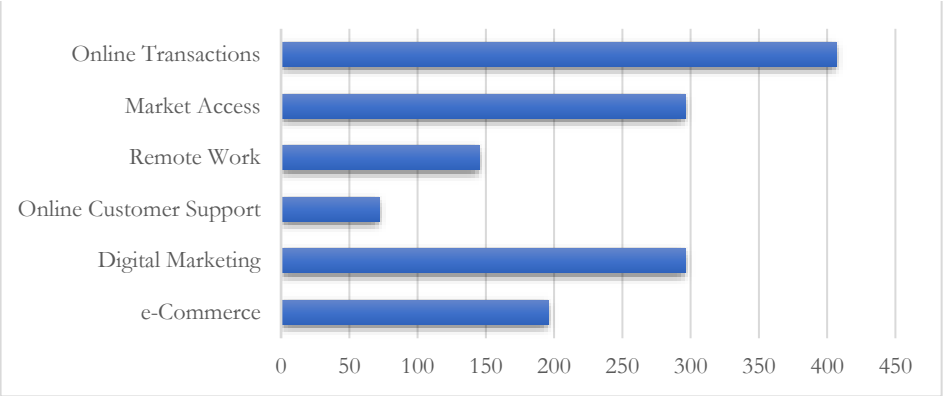

Figure 10. Business expansion/new markets due to Internet access.
Source: Authors' fieldwork (2024).

Figure 11 shows that digital services have improved access to essential services such as education, healthcare information, financial services, and job opportunities.

High levels of Internet usage significantly contribute to improved access to online educational resources and e-learning platforms, thereby enhancing the quality of education and promoting lifelong learning. This development aligns with the objectives of SDG 4, which emphasizes inclusive and equitable access to learning opportunities. Furthermore, frequent engagement with digital technologies fosters the acquisition of digital literacy and technical skills, which are essential for building a more adaptable and competitive workforce in the digital economy.

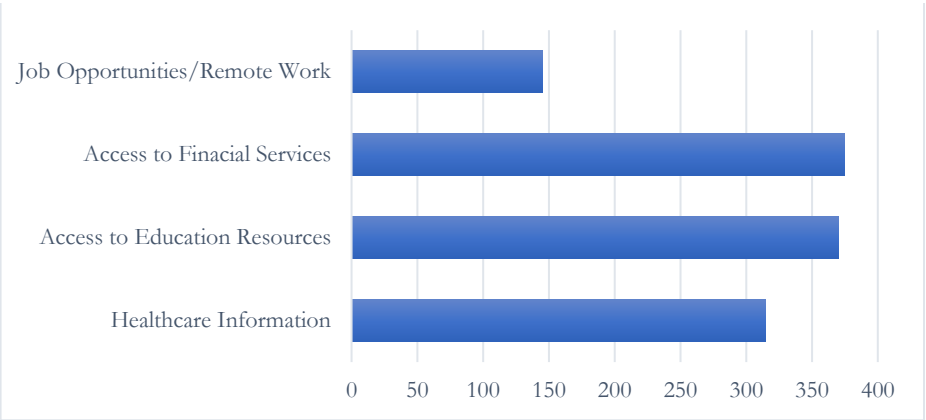

Figure 11. Improvement on basic services.
Source: Authors' fieldwork (2024).

Increased Internet usage has facilitated the growth of telehealth services, notably telemedicine, thereby improving access to healthcare and health outcomes, especially in remote and underserved regions. Through digital platforms, individuals are able to access essential health information, virtual consultations, and medical resources, which supports the adoption of healthier behaviours and enhances preventive care practices. These developments contribute positively to the attainment of SDG Goal 3 (Good Health and Well-Being), which emphasizes universal access to quality healthcare and the promotion of well-being across all age groups.

Improved Internet access in rural communities of Ebonyi State has significantly enhanced connectivity with other parts of the state, the nation, and the global community. This increased connectivity enables residents to stay informed about emerging trends in social media, government services, and public discourse. Moreover, Internet access facilitates communication, collaboration, and the development of community networks and social support systems. For marginalized and underserved populations, high levels of Internet usage provide critical access to resources, information, and advocacy platforms, thereby promoting social inclusion. These advancements represent a vital opportunity for addressing regional disparities and contribute directly to the realization of SDG 10 within Ebonyi State.

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Enhanced Internet use enabled better access to government services and civic engagement. Citizens can engage in policy discussions and contribute to decision-making processes when appropriately harnessed, promoting more sustainable governance.

High-frequency Internet use positively correlates with sustainable development by facilitating economic growth, improving education and healthcare access, promoting social and financial inclusion, raising sustainability awareness, and enhancing governance. Addressing infrastructure challenges is crucial to harnessing this potential fully, especially in regions like Ebonyi State, where digital resources can significantly impact overall development.

Policymakers should focus on investing in robust digital infrastructure and forming partnerships between the government, the private sector, and NGOs to help develop the necessary infrastructure. Local and State governments should be encouraged to prioritise investment in digital infrastructure to enhance accessibility, reliability, and affordability. Initiatives promoting digital literacy and online skills development can also enhance the economic benefits of Internet access, driving sustainable development and economic growth in the region.

The type of Internet connection used by respondents revealed a clear dependence on mobile Internet, with 79% (337) relying on mobile networks. This is followed by broadband connections, used by 13% (55 respondents), and dial-up connections, used by 8% (34 respondents). Table 7 summarizes respondent statistics on type of Internet connection.

Table 7. Summary of respondent statistics/type of Internet connection.

Variables	Population	Percentage
Mobile	337	79
Broadband	55	13
Dial-up	34	8

Source: Authors' fieldwork (2024).

Figure 12 demonstrates types of Internet connection. The dominance of mobile Internet usage highlights the importance of mobile networks in bridging the digital divide in Ebonyi State. Mobile Internet provides greater accessibility and affordability, particularly in rural areas where fixed broadband infrastructure may be lacking. However, mobile Internet quality and speed may vary, impacting productivity and economic benefits.

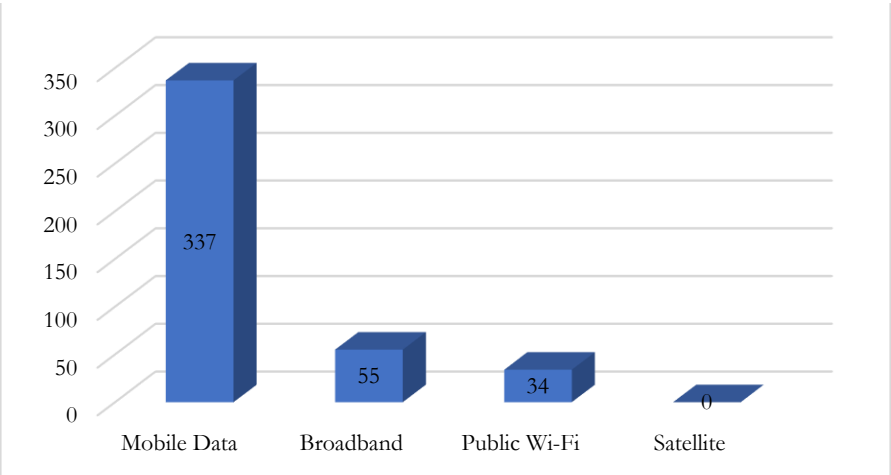

Figure 12. Types of Internet connection.
Source: Authors' fieldwork (2024).

The relatively low adoption of broadband connections (13%) and dial-up connections (8%) suggests infrastructure constraints and limited access to reliable, high-speed Internet. The type of Internet connection plays a critical role in shaping sustainable development outcomes. High-speed, reliable connections facilitate economic growth, education, and healthcare access, while limited or slow connections can exacerbate inequalities and hinder development efforts. Ensuring diverse and equitable Internet access is essential for promoting sustainable development, particularly in regions with varying infrastructural capacities.

Policymakers should prioritise investments in broadband infrastructure development, particularly in rural areas, to enhance Internet quality, speed, and affordability. They should also explore community-driven initiatives like community Wi-Fi hotspots to increase access in underserved areas. They should implement training programs to boost digital literacy, ensuring that the burgeoning population can effectively utilise available resources. This can foster a more inclusive digital economy, driving sustainable development and economic growth in Ebonyi State.

The average household income among respondents was ₦250,000, indicating moderate economic well-being (table 8). However, the range of household incomes was considerable, varying from ₦50,000 to ₦1,000,000 with a standard deviation of ₦150,000. This income disparity suggests significant economic inequality among households in Ebonyi State. The lower end of the income spectrum (₦50,000 - ₦150,000) may struggle to afford necessities, while the upper end (₦500,000 - ₦1,000,000) may enjoy greater financial security and access to resources.

Table 8. Summary of respondent statistics/household income.

Variables	Mean	Min	Max	Std Dev
Household income	#250,000	#50,000	#1,000,000	#150,000

Source: Authors' fieldwork (2024).

Figure 13 analyzes monthly income levels of respondents. Higher household income typically increases the ability to afford Internet services, including broadband or mobile data subscription fees. Households with higher incomes are more likely to own devices (smartphones, computers) necessary for Internet access, further promoting digital engagement. Access to the Internet opens avenues for job searching, remote work, and online entrepreneurship, which can, in turn, lead to increased household income. Households with Internet access can leverage online resources for education and skill-building, enhancing employability and economic prospects.

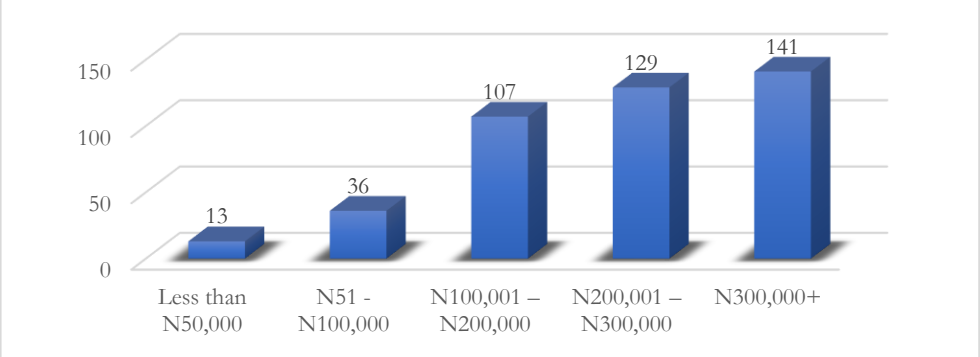

Figure 13. Monthly income level.
Source: Authors' fieldwork (2024).

Conversely, households with lower incomes have limited Internet access. This can perpetuate cycles of poverty and limit opportunities, leading to a digital divide that hinders sustainable development. Therefore, addressing income-related barriers to Internet access is crucial for promoting inclusive growth and equitable development.

The interplay between household income, Internet access, and sustainable development is profound. Higher household incomes facilitate greater Internet access, enhancing economic opportunities, educational outcomes, healthcare access, and social engagement. Conversely, limited Internet access among lower-income households can perpetuate inequalities and hinder sustainable development efforts. Addressing these interconnections through targeted policies and investments is essential for fostering inclusive and sustainable growth.

The household income data has implications for digital infrastructure and sustainable

development in Ebonyi State. Policymakers should consider targeted interventions to increase digital access and affordability for low-income households, promoting digital inclusion and economic opportunities. Additionally, initiatives fostering entrepreneurship, skills development, and job creation can help bridge the income gap, driving the region's economic growth and sustainable development.

The data revealed a significant positive impact of digital platforms and Internet access on household income, with a mean increase of 20.5% (table 9). This suggests that Internet access has enabled households to explore new economic opportunities, enhance productivity, and increase earnings.

Table 9. Summary of respondent statistics: digital infrastructure/Internet and household income.

Variables	Mean	Min	Max	Std Dev
Increase in household income due to digital platforms/Internet access	20.50%	0%	100%	25.10%

Source: Authors' fieldwork (2024).

This indicates that while some households experienced no income growth, others witnessed remarkable improvements, potentially due to online entrepreneurship, remote work, or digital skills development. The correlation between Internet access and household income growth has important implications for digital infrastructure development and sustainable development in Ebonyi State. Policymakers should prioritise initiatives that expand reliable and affordable Internet access, particularly in rural areas, to unlock economic potential and reduce poverty. Targeted programs promoting digital literacy, online skills training, and e-commerce development can further amplify the economic benefits of Internet access.

This suggests that digital platforms and Internet access have enabled households to explore new economic opportunities, enhance productivity, and increase earnings. The range of income increases was substantial, varying from 0% to 100%, with a standard deviation of 25.1%. This indicates that while some households experienced no income growth, others witnessed remarkable improvements, potentially due to online entrepreneurship, remote work, or digital skills development. Table 10 summarizes respondent statistics on digital infrastructure/Internet and household income.

Table 10. Summary of respondent statistics: digital infrastructure/Internet and household income.

Variables	Mean	Min	Max	Std Dev
Access to important services	3.5	1	5	0.9

Source: Authors' fieldwork (2024).

Respondents reported a notable improvement in household stability due to digital infrastructure and Internet access, with a mean score of 3.8 on a 5-point scale (table 11). This suggests that Internet access has positively impacted household stability, enhancing economic resilience and well-being. The range of improvement scores varied from 1 to 5, with a standard deviation of 0.8, indicating moderate variation in responses. Most respondents likely experienced significant improvements in household stability, while a smaller proportion may have experienced minimal or no improvements.

Table 11. Summary of respondent statistics/household stability.

Variables	Mean	Min	Max	Std Dev
Improvement in household stability	3.8	1	5	0.8

Source: Authors' fieldwork (2024).

The positive correlation between digital infrastructure/Internet access and household stability is important for sustainable development in Ebonyi State. Policymakers should recognise the role of digital infrastructure in enhancing household resilience and economic stability. Initiatives promoting digital inclusion, financial literacy, and online skills development can further reinforce household stability, driving sustainable development and

poverty reduction.

4.3. Logistic Regression Analysis

The logistic regression analysis revealed a statistically significant relationship between the predictor and outcome variables. The constant term (β_0) was 2.345, with a p-value less than 0.001, indicating that the model fits the data well. This suggests that even when all predictor variables are equal to zero, the odds of the outcome variable occurring are significantly greater than one. The positive value of β_0 indicates that the outcome variable is more likely to occur when all predictor variables are at their baseline levels.

The significance of the constant term (β_0) provides a foundation for interpreting the effects of the predictor variables. The coefficients for the predictor variables can be interpreted as the change in the log odds of the outcome variable for a one-unit change in the predictor variable while holding all other predictors constant. The p-value less than 0.001 for β_0 indicates that the model is highly reliable and that the observed relationships are unlikely to be due to chance. This provides strong evidence for the model's predictive power and informs the development of targeted interventions or strategies to influence the outcome variable.

The logistic regression analysis revealed a statistically significant positive relationship between digital infrastructure/Internet access and the outcome variable. The coefficient β_1 for Internet access was 0.421, with a p-value less than 0.01, indicating that digital infrastructure/Internet access is a significant predictor of the outcome variable. Specifically, for every unit increase in Internet access, the log odds of the outcome variable increase by 0.421 while holding all other predictors constant. Table 12 shows regression results for the research.

Table 12. Regression results.

Variable	Coefficient	p-value
Constant	2.345	0.001
Digital infrastructure/Internet access	0.421	0.01
Education level	0.351	0.05
Occupation	0.278	0.10

Source: Authors' fieldwork (2024).

The odds ratio corresponding to β_1 can be calculated as e^0.421 ≈ 1.523. This means that individuals with access to the Internet and digital platforms are approximately 1.523 times more likely to experience the outcome variable than those without access, controlling for other predictor variables (table 13). The significant association between Internet access and the outcome variable highlights the importance of digital connectivity in influencing the outcome. Policymakers and practitioners can leverage this finding to develop targeted interventions to improve digital infrastructure and Internet access, potentially leading to better outcomes.

Table 13. Odds ratio.

Variables	Odds Ratio	%	CI
Digital infrastructure/Internet access	1.523	95%	1.102-2.108
Education level	1.419	95%	1.034-1.947
Occupation	1.32	95%	0.944-1.844

Source: Authors' fieldwork (2024).

The odds ratios for the logistic regression model indicate that digital infrastructure, Internet access, education level, and occupation are significant predictors of the outcome variable. Specifically, the odds ratio for digital infrastructure/Internet access (1.523) suggests that individuals with access to digital infrastructure and the Internet are approximately 52% more likely to experience the outcome variable than those without such access, holding all other variables constant. This finding highlights the critical role of digital connectivity in influencing the outcome.

The odds ratio for education level (1.419) reveals that individuals with higher education levels are approximately 42% more likely to experience the outcome variable than those with lower education levels. This result underscores the importance of education in driving positive outcomes. The confidence interval (1.034-1.947) indicates that the actual effect of education

level on the outcome variable is likely to be between 3.4% and 94.7% increased odds.

The odds ratio for occupation (1.320) suggests that individuals in certain occupations are approximately 32% more likely to experience the outcome variable than those in other occupations. Although the confidence interval (0.944-1.844) includes 1, indicating marginal significance, this finding still suggests that occupation may play a role in influencing the outcome. Further investigation is needed to explore the specific occupations driving this effect and to confirm the relationship.

The logistic regression model demonstrates moderate to strong explanatory power, with an R-squared value of 0.453. This indicates that the predictor variables can explain approximately 45% of the variance in the outcome variable. The Nagelkerke R-squared value, a more suitable measure for logistic regression models, is substantially higher at 0.623. This suggests that the model is reasonably practical in predicting the outcome variable.

The Hosmer-Lemeshow test, which assesses the model's goodness-of-fit, yielded a p-value of 0.234. This result indicates that the model fits the data reasonably well, as the null hypothesis of adequate fit cannot be rejected. In other words, no significant evidence suggests that the model's predictions deviate substantially from the observed data.

The model summary suggests that the logistic regression model helps predict the outcome variable, with a moderate to strong fit and no significant evidence of lack of fit. The results can inform decision-making, policy development, or further research. However, considering the model's limitations, such as potential omitted variable bias or non-linear relationships between predictors and the outcome variable, is essential.

5. Conclusions

The study on the economic impact of digital infrastructure and Internet access on sustainable development in Ebonyi State provides valuable insights into the challenges, opportunities, and potential benefits of digital inclusion. The findings indicate that while mobile phones have become ubiquitous, access to more advanced digital tools like computers remains limited. Furthermore, while 70% of the respondents reported having Internet access, the reliability of connections and satisfaction with service providers were significant concerns. These issues highlight the existing infrastructure gaps, particularly in rural areas, which hinder the equitable distribution of digital resources and limit the transformative potential of digital technologies.

Despite these challenges, the study shows that digital infrastructure positively influences economic growth and sustainable development in Ebonyi State. Improved access to the Internet has enabled entrepreneurship, enhanced market access, and contributed to income growth, particularly in e-commerce and digital marketing. Additionally, Internet access has significantly impacted access to educational resources and healthcare services, aligning with the SDGs, especially SDG 4 and SDG 3. The findings support the idea that investments in digital infrastructure are crucial for fostering inclusive development and bridging socio-economic disparities.t

However, the study also reveals persistent barriers, including high data costs, inadequate infrastructure, and limited digital literacy. These challenges require immediate attention, as they impede the potential of digital technologies to foster long-term economic and social development.

Based on the findings of this study, the following recommendations are proposed to enhance digital infrastructure and support sustainable development in Ebonyi State. Increase investment in broadband infrastructure, especially in rural areas, to improve Internet accessibility and reliability, introduce affordable Internet service plans and subsidies to reduce the high costs of Internet access, implement digital literacy programs to improve skills, particularly in rural and underserved communities, enforce policy reforms that promote digital inclusion and equitable access to technology across the state and promote the use of digital technologies for public service delivery, enhancing efficiency and accessibility for residents

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