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Review

The State of Sustainability in Nigeria: Environmental Footprints, Risk and Opportunities

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Abstract

The expansion of Nigeria's digital economy has introduced new pressures on the environment while simultaneously creating opportunities for sustainability-driven innovation. This study examined how the country's rapid digitalisation intersected with four critical domains: carbon and energy footprints, electronic waste, regulatory readiness, and green innovation. Rather than treating digital growth as environmentally neutral, the paper framed it as a system of trade-offs in which efficiency, inclusion, and ecological responsibility competed for priority. Case evidence from renewable-powered data centres, certified recycling plants, and grassroots upcycling projects illustrated how local actors experimented with circular economy principles despite policy gaps. The findings suggested that Nigeria's pathway to sustainable digitalisation depended less on technology adoption alone and more on governance choices, enforcement mechanisms, and the willingness of stakeholders to integrate sustainability into design, infrastructure, and regulation. By positioning sustainability as a strategic imperative, Nigeria could transform digitalisation from an environmental liability into a model for green growth in Africa.

Keywords: digital sustainability; Nigeria; ICT policy; environmental trade-offs; e-waste management; renewable integration; circular economy

Introduction

Digitalisation is a cornerstone of Nigeria's socio-economic development agenda. The Nigerian digital economy is expanding rapidly, contributing significantly to the national GDP while transforming communication, commerce, and governance. However, the environmental footprint of this growth is becoming increasingly evident. Rising energy demands from data centres, widespread e-waste generation, and carbon-intensive supply chains highlight sustainability risks that demand urgent attention (International Telecommunication Union [ITU], 2022; World Bank, 2023). At the same time, opportunities for greener digital transformation exist leading to the need for strategic investment in renewable-powered infrastructure, circular e-waste systems, and climate-smart digital solutions, with all these in place Nigeria can be seen as a leader in sustainable digital development across Africa.

The ICT sector now accounts for over 18% of Nigeria's GDP, underscoring its importance to national growth (National Bureau of Statistics [NBS], 2024). Yet, digital expansion has environmental trade-offs, including increasing carbon emissions, energy consumption, and electronic waste. Globally, ICT contributes 2–4% of greenhouse gas emissions, and Nigeria mirrors these trends as it scales its digital infrastructure (United Nations Environment Programme [UNEP], 2022). This report explores the state of digital sustainability in Nigeria by examining its environmental footprints, risks, and opportunities, while also aligning findings with Nigeria's commitments under the Paris

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Agreement and the National Digital Economy Policy and Strategy (Federal Ministry of Communications, Innovation and Digital Economy [FMCIDE], 2021).

Methodology

The study adopts a dual approach, combining secondary data analysis with case study reviews. Secondary sources that include government reports, industry publications, and international datasets on ICT and sustainability. Case studies of Nigerian and regional initiatives such as renewable-powered data centres, e-waste recycling schemes, and mini-grid electrification, were examined to contextualise findings (Reuters, 2024; Adu & Awuah, 2025). The analysis was guided by thematic coding across four sustainability dimensions: (i) energy and carbon footprints, (ii) electronic waste and circular economy, (iii) risks and regulatory gaps, and (iv) opportunities for green digital innovation. The methodology emphasises triangulation, ensuring that both quantitative trends and qualitative insights are represented.

Current State of the Digital Sector

Nigeria's digital sector is one of Africa's most dynamic, with over 122 million internet users and rapid expansion of fintech, e-commerce, and data infrastructure (NBS, 2024). Yet, this progress has ecological costs. Data centres rely heavily on fossil-fuelled power due to unstable grid electricity, resulting in significant carbon footprints (DatacenterDynamics, 2024). Meanwhile, Nigeria generates more than 1 million tonnes of e-waste annually, much of it processed informally in sites such as Lagos and Aba, creating health and environmental hazards (UNEP, 2022; Adu & Awuah, 2025). Risks are further compounded by regulatory enforcement gaps in extended producer responsibility (EPR) schemes. Nonetheless, opportunities for greener pathways are emerging. Nigeria's Rural Electrification Agency is scaling renewable-powered mini-grids to support digital access while cutting emissions (Reuters, 2025). Private-sector actors are piloting solar-powered data infrastructure and recycling hubs, demonstrating viable models for green digital transformation. If scaled effectively, these initiatives could balance Nigeria's digital growth with sustainability imperatives.

Environmental Impacts of Digital Technologies

Nigeria is accelerating in digitalisation and expanding opportunities across sectors, raising questions about environmental footprints. The ICT sector globally accounts for around 1–1.5% of energy-related greenhouse gas emissions, mainly from data centres and communication networks (IEA, 2025a). While efficiency improvements have historically offset traffic growth, the rise of high-density computing, particularly artificial intelligence, is expected to push global data-centre energy demand upward (IEA, 2025b). In Nigeria, where the electricity grid is carbon-intensive and unreliable, digital infrastructure often depends on diesel generators. This reality makes the marginal emissions per unit of ICT demand higher than in markets with cleaner power mixes (The Guardian, 2025).

Telecommunications networks constitute the largest share of Nigeria's digital energy use. A GSMA (2021) study reported that in 2020, nearly 26,000 telecom towers operated in "bad-grid" or "off-grid" conditions, with more than 97% powered by diesel. These towers alone emitted about 1.9 million tonnes of CO_2 annually. Although the Nigerian Communications Commission (NCC) announced in 2025 that it would enforce renewable energy adoption in the telecom sector, implementation remains limited (BusinessDay, 2025).

Resource extraction is another area of concern. Nigeria is experiencing rising exploration of lithium, a key mineral for batteries, while Africa contributes significantly to global cobalt and rare earth supplies (IEA, 2025a). Unregulated mining carries risks of deforestation, water contamination, and social exploitation. Water use in ICT also matters manufacturing semiconductors requires vast amounts of ultrapure water, and some data-centre cooling systems can intensify local water stress if not managed efficiently.

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The challenge of electronic waste is very visible. Around the world, 62 million tonnes of e-waste were generated in 2022, projected to rise to 82 million tonnes by 2030, with only 22% formally recycled (AP, 2024; UNITAR/ITU, 2024). Africa's formal collection rate remains below 1%, and Nigeria is no exception. A surge in smartphones, laptops, and solar-battery systems has created an informal recycling economy where devices are dismantled under unsafe conditions, releasing heavy metals and toxic fumes. NESREA's 2022 regulations expanded Extended Producer Responsibility (EPR) to cover electronics, but enforcement remains patchy (NESREA, 2022).

Case Studies

Despite these challenges, Nigeria and Africa offer positive examples. In Lagos, Rack Centre became the first African data centre to achieve IFC's EDGE green building certification, cutting embodied and operational energy use (IFC EDGE, 2023). MainOne/MDXi, now part of Equinix, has similarly pursued international certifications for energy-efficient designs. In South Africa, Teraco and Africa Data Centres have integrated solar and renewable energy at scale, showing that high-capacity facilities can align with sustainability goals (Equinix, 2023; Teraco, 2024). Nigeria also has a growing ecosystem of e-waste recyclers. Hinckley Recycling operates a certified facility in Lagos, recovering valuable materials in compliance with environmental regulations (Hinckley Recycling, 2024). E-Terra Technologies provides secure asset disposition services for businesses, reducing the leakage of e-waste to the informal sector (E-Terra, 2024). Innovators like Quadloop have taken a circular approach, upcycling discarded lithium-ion batteries into solar lanterns and other affordable devices, thereby reducing waste while extending energy access (Quadloop, 2023). On the software side, the movement toward "green coding" is still nascent in Nigeria but gaining attention. Globally, the Green Software Foundation has developed the Software Carbon Intensity (SCI) specification and Carbon Aware SDK to help developers measure and reduce their code's carbon footprint. Nigerian companies have begun exploring these approaches, particularly in fintech and edtech, where cloud optimisation and lightweight mobile applications can lower costs and emissions (Green Software Foundation, 2024).

Gap Analysis

Nigeria still lags in several areas compared with global best practices. Europe, for example, formally collects and recycles over 40% of its e-waste (UNITAR/ITU, 2024), whereas Nigeria processes less than 1%. In the data centre sector, global leaders publish power usage effectiveness (PUE) and water usage effectiveness (WUE) metrics as part of ESG reporting; such disclosures are rare in Nigeria. Renewable energy integration in telecoms remains minimal, even as countries like India and Kenya have scaled solar-hybrid towers.

Policy frameworks are present but fragmented. The Climate Change Act 2021 set a net-zero goal for 2060, and NESREA updated e-waste regulations in 2022 (NESREA, 2022). Yet Nigeria still lacks specific guidelines for green data-centre operations, comprehensive incentives for renewable power procurement, and robust enforcement mechanisms for EPR compliance. Market gaps also persist: most organisations do not report ICT-related emissions, software teams lack training in carbon-aware practices, and reliable national statistics on e-waste flows remain scarce.

Closing these gaps will require mandatory efficiency disclosures for extensive digital facilities, more substantial incentives for renewable energy adoption, fully operationalised EPR schemes, and targeted training for local developers in green coding. More broadly, embedding environmental accounting into Nigeria's digital transformation strategies will ensure that the benefits of digitalisation do not come at the cost of long-term ecological harm.

Opportunities and Improvement

Nigeria's rapid growth in digital technology has created many chances for long-term growth, however there are still big problems with the environment and infrastructure.

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The agricultural sector has shown both progress and problems. The advent of technology in agriculture has been a game changer for farmers and those at the fore front of agriculture in Nigeria. Farmers are leveraging on digital technologies like AI, drones, and blockchain to improve planting, watering, and pest control (Benjamin & Foye, 2022; Okonkwo, Idika, & Kalu, 2024). Also, Start-ups like Hello Tractor and Farmcrowdy have made it easier for smallholder farmers to get credit, use machines, and connect with markets, which has helped them be more productive. Unlike traditional farming, that relies on plain intuition and experience of the farmers, the adoption of technology has boosted the process and produce of agriculture. However, regardless of the advantages that technological advancement has to offer, the adoption is still uneven. The root of this problem is because these technologies are often too expensive for small-scale farmers. According to studies conducted by (Matthew et al., 2024) if smallholder farmers start using digital tools more quickly, agricultural output could go up by NGN 3.3 trillion by 2028, This would mean more jobs, higher yields, and more value-added contributions.

Digital technologies have also helped the education sector, especially through distance learning, AI in teaching support, and mobile-based learning platforms.

According to Richa & Anoop (2021), the advancements in ICTs have made it possible to develop new approaches to expand the reach of education. Typically, the educational sector leverages technological tools like the use of Artificial Intelligence to aid teaching and learning, the use of mobile devices like smartphones and tablets, interactive whiteboards (IWB) to fully enhance the teaching process to the students for better understanding.

The advent of Edtech platforms have removed the constriction of education within the four corners of the classroom. With the Edtech platforms, students can learn at their convenience and comfort, but the use of ICT in Nigerian schools is slowed down by old, power-hungry infrastructure and unreliable electricity. A lot of schools use diesel generators to power their ICT labs, which costs more and releases more pollution (Omoniyi, Adebisi, & Adepoju, 2025).

The readiness of Nigeria is slow in accepting this technology also. According to the Network Readiness Index, Nigeria ranked 106 out of the 134 ranked Countries. This indicates that there is a lot of work to be done in this regard. However, Nigeria ranks 18th out of 54 African Countries in the 2025 Artificial Intelligence (AI) talent readiness. These numbers clearly indicate that there are still major gaps that must be bridged to attain a higher technological number.

Solar energy which is one of the cleanest and sustainable form of generating power is undermined in Nigeria. Increasing the use of renewable energy, especially solar energy, can help digital learning by providing a stable power source and cutting down on the use of fossil fuels.

Furthermore, integrating sustainability education into curricula can equip future generations to utilise technology responsibly (Falola, Ogueyungbo, Adeniji, & Adesina, 2022). In addition, (Falola et al., 2022). suggest that schools can adopt digital learning platforms, e-textbooks, and online resources to reduce the demand for paper, printing, and physical logistics, thereby promoting efficiency while minimizing environmental footprints.

In Osun State for example, the Osun State government shared an educational infused tablet to the students for free to engage their learning. However, the initiative was curbed as a result of underutilization and the teachers lacking the necessary capacity to use the tablet. To curb these issues, it is necessary to ensure that ICT is mandatory at the recruitment of teachers.

Digital tools have started to change how services are delivered in the government. Recent advancements, including e-taxation, automated public service platforms, biometric voter registration, and the 2023 digital census, demonstrate the capacity of technology to enhance efficiency and transparency (Matthew et al., 2024). But many ministries and state agencies still use paper records and slow ICT systems, which adds to the waste and carbon emissions caused by bureaucracy (Oghuvbu, 2022). Moving to paperless systems and using energy-efficient e-governance platforms are two ways to lower environmental impacts while increasing accountability (Kehinde-Awoyele, Adebowale, & Jekayinoluwa, 2025).

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Also, embedding sustainability principles into governance also requires capacity building. It is important for Civil servants to be trained on digital responsibility, data protection, and green ICT practices to ensure long-term efficiency. On the other side, increased collaboration between federal and state governments, civil society, and the private sector can empower and aid the co-creation of sustainable digital governance frameworks in Nigeria.

The Covid-19 Pandemic forced the healthcare industry to also go digital. This speed up the use of mobile platforms for public health communication and disbursement of information relating to Covid.

It must be noted that a common problem most hospitals have is still lack of electronic health records. There is a heavy reliance on paper files. The consequence of this is that when such hospitals face power shortages, there is a force dependence on diesel generators (World Health Organization [WHO], 2022). More electronic health records, telemedicine, and mobile health apps can help people get care more fairly, cut down on waste, and lower emissions from travel. Combining these digital systems with renewable energy in hospitals would make them more resilient and have less of an effect on the environment (Eze, Okoye, & Onwujekwe, 2023).

Opportunities for improvement include scaling the adoption of renewable energy, particularly solar solutions, to power hospitals and clinics sustainably. A major solution that should be considered is the integration of EHRs, telemedicine platforms, and mobile health applications, as this would significantly help to reduce paper use, cut patient travel emissions, and improve access to care in underserved communities.

Another way to attain digital sustainability is to embed sustainability into health policies through green hospital initiatives, sustainable procurement practices, and medical e-waste recycling, which can reduce the sector's ecological footprint.

With coordinated investment at both federal and state levels, Nigeria's health sector can leverage digital tools not only for efficiency but also for long-term environmental and social sustainability (Onwujekwe et al., 2021;)

The Nigeria's financial services industry has been a frontrunner in adopting digital technologies, with fintech, mobile banking, and electronic payment platforms driving inclusion and efficiency.

This dimension of digital finance includes various innovative technologies and applications, such as artificial intelligence, blockchain, robo-advisors, peer-to-peer lending, and crowdfunding (Okoye & Nwosu, 2022). The adoption of digital payment solutions, blockchain technology, insurtech, and peer-to-peer lending platforms has surged, providing individuals and businesses with easier access to financial services and driving financial inclusion (Olaniyan & Lawal, 2021).

However, the rapid digital expansion has come with sustainability concerns. High energy consumption from data centers, extensive use of paper receipts, and reliance on non-renewable energy sources for banking operations have added to the sector's carbon footprint (Central Bank of Nigeria [CBN], 2023). Furthermore, gaps in digital literacy and rural connectivity have left significant portions of the population excluded from fully participating in the digital financial ecosystem (Adediran & Ojo, 2022).

There are, however, significant opportunities for improvement. Banks and fintechs can transition to green data centers powered by renewable energy and adopt cloud-based services that optimize energy efficiency. The promotion of paperless banking, through e-receipts and digital documentation, can reduce resource use while improving customer convenience. Additionally, investments in inclusive digital literacy programs and state-level infrastructure for rural connectivity can extend the reach of financial services in a more equitable and sustainable manner. At the policy level, the CBN can incentivize sustainable banking practices by integrating green finance guidelines, carbon reporting, and climate-risk disclosure into regulatory frameworks. Such reforms would not only align Nigeria's financial system with global sustainability standards but also strengthen resilience against future environmental and economic shocks (CBN, 2023; United Nations Environment Programme Finance Initiative [UNEP FI], 2022

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Suggestions for Policy and Industry

To take advantage of these chances, policymakers need to work together and make planned changes. It is important to note that at the federal level, Nigeria must integrate digital sustainability into national frameworks such as the Climate Change Act of 2021 and its updated Nationally Determined Contribution, which currently aim for a 47 percent reduction in emissions by 2030 but do not explicitly incorporate ICT-related emissions (Omoniyi et al., 2025).

A Digital Sustainability Roadmap could set clear goals for using renewable energy in data centres and telecommunications to improve systems for dealing with e-waste and set standards for the efficiency of ICT infrastructure. Nigeria

Fiscal policies such as tax incentives for firms investing in renewable-powered data centers and penalties for high-emission operations could further accelerate industry compliance (Okonkwo et al., 2024). Regulatory agencies including the Nigerian Communications Commission (NCC) and the National Information Technology Development Agency (NITDA) should implement monitoring and reporting frameworks to improve accountability (Akinola & Ogunmodede, 2023).

At the state level, subnational governments can champion sustainability by incorporating digital solutions into climate action plans. For instance, states like Lagos and Kano could require solar-powered ICT laboratories in schools and enforce e-waste collection programs through local environmental agencies. State-level incubator programs and grants could foster green-tech innovation in areas such as drone-enabled agriculture, digital recycling platforms, and AI-based energy optimization (Kehinde-Awoyele et al., 2025).

A multi-stakeholder approach is also essential. Partnerships between telecom firms, renewable energy providers, and financial institutions can mobilize resources for hybrid energy solutions. Civil society and academic institutions can fill knowledge gaps by producing reliable data on ICT emissions, while NGOs and international organizations such as the ITU and World Bank can provide technical support and financing (UNDESA, 2022). Finally, public awareness campaigns can encourage sustainable digital practices at the individual level, such as responsible device recycling and energy-conscious internet use.

Conclusions

Nigeria is at a critical crossroads where digital transformation and environmental sustainability intersect. While the expansion of ICT offers opportunities to transform agriculture, education, governance, healthcare, and finance, these advances also carry ecological risks if not strategically managed. The opportunities for improvement outlined across sectors demonstrate that renewable energy adoption, efficient ICT infrastructure, circular e-waste management, and sustainability education can collectively reduce the environmental footprint of Nigeria's digital economy.

The recommendations presented emphasize the need for alignment between national climate policies and digital sustainability goals, with strong leadership at both federal and state levels. Industry and civil society partnerships, coupled with international cooperation, will be vital in mobilising resources and technical expertise. Ultimately, the integration of sustainability into Nigeria's digital journey will not only ensure environmental protection but also foster inclusive growth, enhance global competitiveness, and position Nigeria as a continental leader in sustainable digital transformation.

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