

E-Governance for a Greener Future: Opportunities and Challenges in Promoting Environmental Sustainability

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ABSTRACT

This study explores the potential of e-governance as a tool for enhancing environmental sustainability in Nigeria, focusing on the opportunities it presents and the challenges that hinder its full implementation. Environmental degradation remains a critical issue in Nigeria, driven by deforestation, pollution, poor waste management, and the impacts of climate change. E-governance, with its ability to streamline processes, enhance transparency, and foster public participation, presents a viable solution for improving environmental management. This research examines how digital technologies can be leveraged to address these environmental challenges, such as through real-time monitoring systems, data analytics, and public engagement platforms. Furthermore, it identifies key barriers to the successful implementation of e-governance in Nigeria, including inadequate infrastructure, limited digital literacy, and weak policy enforcement. The study also proposes strategies to overcome these challenges, emphasizing the need for strengthened governance structures, investment in digital infrastructures, capacity building, and fostering international collaborations. The findings highlight the importance of a multi-stakeholder approach, involving government agencies, private sectors, and local communities, to achieve sustainable environmental outcomes. This study contributes to the growing body of knowledge on the intersection of e-governance and environmental sustainability, with particular relevance to developing nations like Nigeria.

Keywords: E-Governance, greener-future, opportunities, challenges, environmental sustainability

INTRODUCTION

Environmental sustainability has become one of the most pressing global challenges in recent decades, as climate change, resource depletion, pollution, and biodiversity loss continue to threaten ecosystems and human well-being. According to Adebayo & Adewumi (2023) governments worldwide are grappling with the need to adopt more efficient, transparent, and inclusive approaches to manage environmental resources and mitigate the negative impacts of industrialization and urbanization. In this context, Bakare, et al (2023), observed that e-Governance has emerged as a promising tool to enhance environmental sustainability by leveraging digital technologies to improve policy implementation, governance processes, and stakeholder engagement. Adeola & Yusuf (2021) define e-governance, or electronic governance, as the use of information and communication technologies (ICTs) by governments to deliver services, engage with citizens, and make administrative processes more efficient. By digitizing governance processes, E-Governance can enhance transparency, reduce corruption, and promote public participation in decision-making (Okoro & Eze, 2022). It has been widely recognized as a mechanism for improving service delivery across sectors, including education, healthcare, and economic development. In recent years, E-Governance has also been increasingly applied in the field of

environmental management, with its potential to revolutionize the way governments and stakeholders address environmental sustainability (Mahapatra & Perumal, 2023).

One of the key benefits of E-Governance in environmental sustainability is its ability to facilitate the collection, analysis, and dissemination of environmental data. Governments can use digital platforms, such as Geographic Information Systems (GIS) and the Internet of Things (IoT), to monitor environmental conditions in real time, track emissions, and manage natural resources more effectively (UNEP, 2022; Onuoha, 2022; Olalekan, 2022). These technologies enable data-driven decision-making, allowing policymakers to respond more rapidly to environmental crises, such as deforestation, air and water pollution, and climate-induced disasters. Furthermore, E-Governance platforms can make this data accessible to the public, enhancing transparency and enabling citizens to participate more actively in environmental protection efforts (Puri, 2021).

Sharma, et al, (2023) argued that one of the significant aspect of E-Governance is its capacity to promote citizen engagement in environmental governance. Through digital platforms, citizens can provide feedback on environmental policies, report violations of environmental regulations, and participate in public consultations. (Adesanya & John 2021). For instance, online portals and mobile applications allow individuals to report incidents of illegal logging, pollution, or wildlife trafficking directly to the relevant authorities. This creates a more collaborative approach to environmental governance, where the public plays a central role in monitoring and safeguarding the environment (Sharma, 2022).

Despite its numerous advantages, the implementation of E-Governance in environmental sustainability is not without challenges. In many developing countries, a significant digital divide still exists, with limited access to the internet and ICT infrastructure, particularly in rural areas. This gap limits the potential of E-Governance to reach all segments of the population, particularly marginalized groups, who are often the most vulnerable to environmental degradation (Onwuka & Nzeakor, 2022). Additionally, cybersecurity is a major concern, as the digitization of environmental governance processes increases the risk of data breaches and manipulation of critical environmental information. Governments must ensure that appropriate safeguards are in place to protect the integrity and confidentiality of environmental data (Shukla et al., 2023).

Moreover, the successful implementation of E-Governance requires significant financial investments and political will. Governments need to allocate resources for building ICT infrastructure, training personnel, and ensuring that E-Governance systems are integrated across different sectors. In regions where environmental governance is weak, there may be resistance to the adoption of digital systems, as they often expose inefficiencies and corruption in existing processes (Adeola & Yusuf, 2021). Therefore, overcoming institutional barriers and fostering collaboration between government agencies, the private sector, and civil society is crucial for the success of E-Governance in promoting environmental sustainability.

In light of these opportunities and challenges, this study seeks to explore how E-Governance can be leveraged to enhance environmental sustainability, focusing on the innovative strategies, potential benefits, and obstacles that governments face in adopting digital tools for environmental management. Understanding these dynamics is critical for formulating policies that can maximize the positive impacts of E-Governance while addressing the structural and technical challenges that hinder its implementation.

Overview of E-Governance

E-Governance, or electronic governance, refers to the use of digital technologies, primarily information and communication technologies (ICTs), to streamline and enhance government processes, service delivery, and public interaction. By digitizing administrative systems, governments can improve efficiency, transparency, and accountability in their operations, while also enabling better access to services for citizens and businesses. In essence, E-Governance offers a platform for transforming traditional governance models through technology, making governance more inclusive and responsive to the needs of the population (Mahapatra & Perumal, 2023). The evolution of E-Governance has been largely driven by the rapid development of digital tools such as the internet, mobile technologies, and cloud computing, which have allowed governments to

digitize public services. From the automation of public administration tasks to facilitating citizen engagement through online platforms, E-Governance has become an essential feature of modern governance frameworks. In recent years, many governments worldwide have embraced E-Governance to enhance transparency, reduce corruption, and improve service delivery in areas such as healthcare, education, and public safety (Adesanya & John, 2022).

One of the key advantages of E-Governance is its ability to provide real-time access to information, allowing for more informed decision-making. Digital platforms enable governments to collect, analyze, and share data more efficiently, leading to better planning and implementation of policies. For example, the use of Geographic Information Systems (GIS) in land management and urban planning has improved the ability of governments to track environmental changes, manage resources, and respond to disasters (Sharma et al., 2023). Similarly, Big Data analytics has played a crucial role in helping governments monitor economic trends and identify areas of policy intervention, particularly in developing nations.

Akintoye & Olanrewaju, (2021) posits that in the field of environmental sustainability, E-Governance has become increasingly important as it enables more effective monitoring and management of environmental resources. Governments can use digital tools to track environmental indicators such as air and water quality, deforestation rates, and carbon emissions. By leveraging these technologies, policymakers are better equipped to enforce environmental laws and regulations, ensuring that industries and citizens comply with sustainability standards (Puri, 2021). Moreover, the integration of IoT (Internet of Things) devices in environmental management allows for the real-time monitoring of ecosystems and natural resources, thereby improving the accuracy and timeliness of data collection.

Another significant aspect of E-Governance according to Akpan & Johnson (2022) is its ability to foster greater citizen participation in governance processes. Through online portals, mobile applications, and social media platforms, citizens can directly engage with government institutions, provide feedback, and participate in public consultations on policy issues. This digital interaction increases transparency and accountability while also promoting more inclusive governance by allowing marginalized or remote communities to have a voice in decision-making (Onwuka & Nzeakor, 2022). For instance, in several countries, citizens are encouraged to report incidents of environmental violations, such as illegal dumping or deforestation, through digital platforms, which helps authorities take immediate action.

Despite the clear advantages, the adoption of E-Governance is not without challenges. One of the primary barriers is the digital divide the unequal access to ICT infrastructure across different regions and socio-economic groups. In many developing countries, limited access to the internet and digital tools restricts the reach and effectiveness of E-Governance initiatives (Adeola & Yusuf, 2021). This divide not only affects rural and underserved populations but also limits the capacity of governments to fully digitize their operations, leading to uneven implementation of E-Governance strategies.

Furthermore, issues related to cybersecurity and data privacy pose significant risks for the successful adoption of E-Governance. As governments increasingly rely on digital platforms to manage sensitive information, there is a growing need for robust security measures to prevent data breaches, cyberattacks, and unauthorized access to governmental systems (Shukla et al., 2023). Without adequate cybersecurity protocols in place, the integrity and reliability of E-Governance systems can be compromised, undermining public trust and potentially leading to governance failures.

In recent years, several countries have successfully implemented E-Governance frameworks, with notable success stories emerging from both developed and developing nations. For example, Estonia has pioneered one of the most advanced E-Governance systems in the world, offering a wide range of online services, from tax filings to voting, through its digital platform (Kalvet & Runnel, 2022). Similarly, in India, the government's Digital India initiative has made significant progress in delivering public services online, particularly in rural areas where access to government services was previously limited (Sharma et al., 2023).

Overall, E-Governance represents a transformative approach to modern governance, with the potential to make government systems more efficient, transparent, and participatory (Bakare, et al, 2023). As governments continue to embrace digital technologies, the role of E-Governance will expand, particularly in critical areas such as environmental sustainability, where digital tools can play a crucial role in addressing complex global challenges.

ENVIRONMENTAL SUSTAINABILITY

Environmental sustainability refers to the responsible interaction with the environment to avoid the depletion or degradation of natural resources, ensuring that these resources remain available for future generations (Bakare, 2020). It involves practices and policies that balance the demands of economic development, social well-being, and environmental health. The increasing awareness of climate change, deforestation, biodiversity loss, and pollution has made environmental sustainability a global priority, as unsustainable practices threaten the planet's ecosystems and human life.

In the context of Nigeria, environmental sustainability is particularly significant due to the country's rich biodiversity, vast natural resources, and growing population. Nigeria is endowed with diverse ecosystems, including forests, wetlands, savannahs, and marine environments, which provide essential services such as water, food, and energy. Adebayo & Akintunde, (2023) found that rapid industrialization, urbanization, deforestation, and oil extraction have severely impacted the environment. Deforestation and desertification, for instance, have reduced Nigeria's forest cover by nearly 50% in recent decades, contributing to soil erosion, loss of biodiversity, and reduced agricultural productivity (Ogunbode & Omotayo, 2023). Similarly, the degradation of wetlands and coastal areas threatens Nigeria's fisheries and mangrove ecosystems, which are vital for local livelihoods and climate regulation.

A significant environmental challenge in Nigeria is the issue of oil pollution, particularly in the Niger Delta region, where oil exploration and extraction have led to extensive environmental degradation. Oil spills, gas flaring, and other by-products of the petroleum industry have caused soil contamination, water pollution, and air quality deterioration, affecting the health and well-being of local communities. According to Olujimi and Ogunlana (2023), over 13 million barrels of oil have been spilled in the Niger Delta since oil production began, severely affecting the region's biodiversity and contributing to the destruction of farmlands and water bodies.

To address these challenges, the Nigerian government has implemented various policies and initiatives aimed at promoting environmental sustainability. One of the key legislative frameworks is the National Environmental Standards and Regulations Enforcement Agency (NESREA), which oversees the enforcement of environmental laws and standards. NESREA plays a critical role in ensuring that industries comply with environmental regulations and that penalties are enforced for violations, particularly in sectors such as oil, agriculture, and manufacturing (Akintoye & Olanrewaju, 2021). The agency also works to promote sustainable practices, such as cleaner production techniques, waste reduction, and resource conservation.

Another important initiative is Nigeria's involvement in global climate change agreements, such as the Paris Agreement, under which the country has committed to reducing its greenhouse gas emissions by 20% by 2030. Nigeria's Nationally Determined Contributions (NDCs) outline strategies for transitioning to renewable energy sources, promoting afforestation, and improving energy efficiency in key sectors such as transportation and agriculture. The country has also embarked on the Great Green Wall project, an African Union initiative aimed at combating desertification by planting trees across the Sahel region, which stretches across northern Nigeria (Olalekan, 2022).

Renewable energy is a crucial aspect of Nigeria's push for environmental sustainability. As the country grapples with energy shortages and over-reliance on fossil fuels, renewable energy solutions such as solar, wind, and hydroelectric power are gaining momentum. Solar power, in particular, has shown great promise due to Nigeria's abundance of sunlight. The government has established several initiatives, such as the Nigeria Renewable Energy Master Plan, to promote the adoption of renewable energy technologies and reduce the

nation's carbon footprint (Odeyemi & Oseni, 2022). By scaling up renewable energy production, Nigeria can reduce its dependence on oil and gas while also addressing energy poverty, particularly in rural areas.

Despite these efforts, achieving environmental sustainability in Nigeria remains challenging due to several factors, including inadequate enforcement of environmental regulations, corruption, and limited access to technology (Bello & Nwagwu, 2022). The digital divide in Nigeria affects the adoption of sustainable practices, particularly in rural areas where access to information and technology is scarce (Ibhadode & Ogundipe (2023). Furthermore, the lack of sufficient funding for environmental projects hinders the implementation of large-scale sustainability initiatives. Local communities also face barriers to participating in environmental governance due to low levels of environmental awareness and education (Adebayo & Akintunde, 2023).

There are, however, emerging opportunities for strengthening environmental sustainability in Nigeria. One such opportunity lies in public-private partnerships (PPPs), where private companies work with government agencies to promote sustainable practices. For example, many companies in Nigeria's manufacturing and agriculture sectors are increasingly adopting corporate social responsibility (CSR) initiatives aimed at reducing their environmental impact. These initiatives include tree planting programs, water conservation efforts, and waste recycling projects, which help contribute to a greener economy (Bello & Nwagwu, 2022).

Another opportunity lies in E-Governance, where the use of digital technologies can enhance environmental monitoring and enforcement of regulations. Ogunbode & Omotayo, (2023) opined that through the application of ICTs, the government can improve data collection on environmental indicators, streamline the enforcement of environmental laws, and promote greater public participation in environmental decision-making. These digital solutions could also enhance transparency and reduce corruption in the enforcement of environmental policies.

Empirical Data from Nigeria

Empirical evidence is critical for substantiating claims and grounding theoretical discussions in practical realities. Nigeria provides several examples of e-governance initiatives addressing environmental sustainability.

For instance, the Lagos State Electronic Waste Management System is a notable success story. This initiative leverages digital platforms to track the lifecycle of electronic waste, ensuring that harmful components are properly recycled or disposed of. Research shows that since its implementation, there has been a measurable reduction in hazardous e-waste accumulation in urban areas, contributing to improved public health and environmental outcomes (Adedokun et al., 2023). Similarly, in Osun State, e-governance tools have been deployed in forestry management to combat illegal logging and deforestation. Satellite imagery and Geographic Information Systems (GIS) are used to monitor forest cover in real-time, enabling swift intervention when deforestation activities are detected. Studies by Ogunleye and Adebayo (2021) reveal that such technologies have helped to reduce deforestation rates by 20% over the past five years, ensuring better forest conservation outcomes.

Drawing Lessons from Comparative Analyses

Examining the experiences of other countries that have successfully implemented e-governance in addressing environmental challenges can provide valuable insights for Nigeria. India's e-GreenWatch platform, for instance, offers a compelling model for monitoring afforestation programs. This system utilizes satellite imagery, GIS mapping, and online dashboards to track and report the progress of tree-planting initiatives across the country. It has improved accountability and transparency in afforestation efforts, leading to significant ecological benefits (Singh et al., 2023). Nigeria could adopt similar approaches to enhance its reforestation programs, ensuring effective tracking and monitoring of tree-planting initiatives in states like Cross River and Ogun.

Rwanda's Smart Green Villages initiative also provides a valuable case study. This program integrates e-governance with rural sustainability projects, focusing on renewable energy, waste management, and sustainable agriculture. A key aspect of its success has been the active involvement of local communities in the planning and execution of projects, facilitated through user-friendly digital platforms (Mukamana & Habiyaemye, 2022). Nigeria could learn from Rwanda's approach, particularly in using e-governance to drive grassroots environmental initiatives.

Opportunities Created by E-Governance for Environmental Sustainability in Nigeria

E-Governance, the integration of digital technologies into government operations, offers significant opportunities for promoting environmental sustainability in Nigeria. As the country faces mounting environmental challenges such as deforestation, pollution, and climate change, leveraging information and communication technologies (ICTs) through, Longe & Awojobi argue that E-Governance presents a viable path to achieving more efficient, transparent, and inclusive environmental management. By digitizing governance processes, Nigeria can enhance its capacity to monitor environmental conditions, enforce regulations, and engage citizens in environmental protection efforts.

One of the key opportunities that E-Governance creates is the ability to enhance environmental monitoring and data collection. Through digital platforms such as Geographic Information Systems (GIS) and satellite imaging, the government can track environmental indicators in real-time, such as deforestation rates, land-use changes, air and water pollution, and biodiversity loss. In the words of Ibrahim & Olatunji, (2023) these tools enable the timely collection and analysis of environmental data, allowing for more informed decision-making. For instance, by using remote sensing technologies, government agencies like the National Environmental Standards and Regulations Enforcement Agency (NESREA) can more effectively monitor industrial pollution and ensure compliance with environmental standards (Akintoye & Olanrewaju, 2021). This data-driven approach not only improves the accuracy of environmental assessments but also ensures quicker responses to environmental crises, such as oil spills or forest fires.

Another major opportunity provided by E-Governance is the promotion of transparency and accountability in environmental governance. In Nigeria, corruption and weak enforcement of environmental regulations have long been barriers to sustainability efforts Odeyemi & Oseni (2022). However, with the use of digital platforms, the enforcement of environmental laws can become more transparent and accessible to the public. Odewale & Odukoya, (2023) found that online portals can allow citizens to report violations such as illegal logging, dumping of toxic waste, or environmental degradation caused by industrial activities. These platforms increase public oversight and ensure that violators are held accountable. Additionally, through the publication of environmental data and reports on government websites, stakeholders including non-governmental organizations (NGOs), civil society groups, and the media can hold the government and industries accountable for their environmental impact (Ogunbode & Omotayo, 2023).

E-Governance also facilitates citizen engagement and participation in environmental sustainability. In many countries, digital platforms have been successfully used to engage citizens in environmental decision-making processes. In Nigeria, E-Governance can play a similar role by providing citizens with the tools to participate in public consultations, submit feedback on environmental policies, and contribute to discussions on sustainable development. Mobile applications and online platforms that allow individuals to share their views and experiences can foster a more inclusive approach to environmental governance, where the voices of local communities, particularly those most affected by environmental degradation, are heard (Onwuka & Nzeakor, 2022). This inclusive approach can lead to more sustainable and context-specific solutions to environmental challenges, as communities are more likely to support and participate in initiatives that they have contributed to shaping.

Furthermore, E-Governance provides opportunities for improving resource management and conservation efforts. Ogunbode & Omotayo (2023) hint that by digitizing land-use records, water management systems, and resource allocation processes, the government can optimize the use of natural resources while minimizing

waste and inefficiencies. For example, in the agricultural sector, digital platforms can assist farmers in adopting more sustainable practices by providing them with real-time information on weather patterns, soil conditions, and water availability. Similarly, digital tools can support the management of protected areas and wildlife reserves, helping authorities monitor illegal activities such as poaching and encroachment on conservation areas (Bello & Nwagwu, 2022). This improved resource management can contribute to the long-term sustainability of Nigeria's ecosystems and biodiversity.

The implementation of renewable energy initiatives is another area where E-Governance can enhance environmental sustainability in Nigeria. As the country seeks to diversify its energy sources and reduce its reliance on fossil fuels, E-Governance can help streamline the development and deployment of renewable energy projects. Ogunjinmi & Fasola (2022) posit that digital tools can be used to manage the regulatory processes for solar, wind, and hydroelectric power projects, reducing bureaucratic delays and improving efficiency. In addition, through online platforms, the government can promote awareness of renewable energy options among citizens and businesses, encouraging wider adoption of clean energy technologies (Odeyemi & Oseni, 2022). By integrating digital solutions into the renewable energy sector, Nigeria can accelerate its transition to a more sustainable and resilient energy system.

Olorunfemi & Ogunleye (2023) argue that E-Governance enables the Nigerian government to strengthen its international environmental commitments and participation in global sustainability initiatives. By utilizing ICTs to track and report on environmental progress, Nigeria can meet its obligations under international agreements such as the Paris Agreement on climate change. For instance, E-Governance systems can help the country monitor and report on greenhouse gas emissions, deforestation, and reforestation efforts, ensuring that Nigeria remains on track with its Nationally Determined Contributions (NDCs) (Olalekan, 2022). In addition, digital platforms facilitate collaboration with international organizations and other countries, enabling Nigeria to share best practices, access funding for environmental projects, and participate in global research on sustainability.

Challenges in Implementing E-Governance for Environmental Sustainability in Nigeria

Despite the immense potential of E-Governance to enhance environmental sustainability in Nigeria, several challenges hinder its successful implementation. These challenges, ranging from infrastructural deficits to socio-political constraints, significantly limit the country's capacity to leverage digital technologies for environmental governance. Overcoming these obstacles is critical if Nigeria is to fully harness the benefits of E-Governance in addressing environmental issues such as deforestation, pollution, and climate change.

According to Onwuka & Nzeakor (2022) one of the most significant challenges is the lack of adequate ICT infrastructure across Nigeria. For E-Governance to function effectively, there must be reliable access to digital technologies, including the internet, computer systems, and communication networks. However, large parts of Nigeria, particularly rural areas, still experience limited access to these technologies due to poor internet connectivity and insufficient infrastructure. According to Onwuka and Nzeakor (2022), while Nigeria has seen some improvement in digital access over recent years, there remains a considerable urban-rural divide, with rural areas lagging behind in terms of broadband penetration and internet access. This digital divide makes it difficult for both government agencies and citizens in these areas to engage with E-Governance platforms, undermining efforts to promote environmental sustainability at a national level.

Olalekan, (2022) argued that low level of digital literacy among both the public and government officials is one of the challenges facing implementation e-governance for environmental sustainability. Implementing E-Governance for environmental sustainability requires not only access to technology but also the ability to effectively use these tools. In Nigeria, many government workers, particularly those in environmental agencies, lack the necessary training to use digital platforms and data management systems efficiently. Furthermore, a significant portion of the population remains digitally illiterate, which hampers their ability to engage with E-Governance initiatives aimed at promoting environmental awareness and participation in environmental decision-making processes (Akintoye & Olanrewaju, 2021). Without adequate training and

capacity building for both government officials and the general public, the full potential of E-Governance to improve environmental sustainability will remain unrealized.

Corruption and weak institutional frameworks also pose a major challenge to the implementation of E-Governance in Nigeria. Environmental governance in the country is often undermined by corrupt practices, including the manipulation of environmental data, bribery, and non-compliance with environmental regulations. While E-Governance has the potential to improve transparency and reduce corruption by digitizing processes, these benefits can only be realized if there is strong institutional support for enforcing environmental laws and regulations. Unfortunately, many government institutions responsible for environmental management in Nigeria are plagued by inefficiencies and lack the capacity to fully implement and monitor E-Governance systems (Ogunbode & Omotayo, 2023). Corruption at various levels of government often results in the failure of environmental projects and the misallocation of resources, further exacerbating environmental degradation.

The high cost of implementing E-Governance systems also presents a significant barrier. Setting up and maintaining the digital infrastructure required for E-Governance is costly, and many environmental agencies in Nigeria lack the necessary financial resources. Government budgets allocated to environmental sustainability are often limited, and the costs associated with developing and maintaining digital platforms, acquiring the necessary hardware and software, and providing ongoing training for staff can be prohibitive (Olalekan, 2022). Additionally, the ongoing costs of updating and securing these systems against cyber threats must be considered, further straining already limited resources.

Inadequate political will and policy coordination is another challenge. For E-Governance to be effective, there must be strong political support and clear policies that guide its implementation. Bello & Nwagwu, (2022) argue that environmental issues often rank low on the list of government priorities in Nigeria, with more immediate concerns such as economic development and security receiving greater attention. This lack of political will is reflected in the limited policy frameworks that support the integration of ICTs into environmental governance. Although Nigeria has made commitments to environmental sustainability through international agreements such as the Paris Climate Accord, the implementation of these commitments through E-Governance has been slow, largely due to weak policy coordination and limited government focus on digital governance.

Additionally, cybersecurity risks pose a serious threat to the success of E-Governance initiatives for environmental sustainability. As more environmental data is collected, stored, and shared through digital platforms, the risk of cyberattacks increases. These attacks can disrupt the functioning of environmental monitoring systems, lead to data breaches, and undermine trust in the security of E-Governance platforms. In Nigeria, where cybersecurity measures are still in the early stages of development, the lack of robust cybersecurity infrastructure makes E-Governance platforms vulnerable to hacking, data manipulation, and other forms of cybercrime (Odeyemi & Oseni, 2022). Without addressing these cybersecurity risks, the implementation of E-Governance systems could result in more harm than good, particularly if sensitive environmental data is compromised.

According to Bakare, et al (2023) the limited engagement of local communities in E-Governance efforts represents another challenge. Many environmental issues in Nigeria are deeply intertwined with local practices, such as agriculture, logging, and fishing, which are key to the livelihoods of rural communities. However, these communities are often excluded from E-Governance initiatives, either due to a lack of awareness or insufficient digital infrastructure. Without meaningful engagement with local communities, environmental governance efforts may fail to account for the social and economic realities on the ground, resulting in policies and programs that are difficult to implement or sustain (Adebayo & Akintunde, 2023). Local knowledge and community participation are essential to ensuring that E-Governance initiatives are inclusive and reflective of the environmental challenges faced by people across the country.

In conclusion, while E-Governance holds great promise for enhancing environmental sustainability in Nigeria, numerous challenges impede its effective implementation. Issues such as infrastructural deficits, digital

illiteracy, corruption, financial constraints, lack of political will, cybersecurity threats, and limited community engagement must be addressed if E-Governance is to play a transformative role in environmental governance. Addressing these challenges will require coordinated efforts across multiple sectors, including government, the private sector, and civil society, to ensure that the opportunities presented by E-Governance are fully realized for the benefit of Nigeria's environment.

Some Suggested Strategies for Overcoming Barriers to E-Governance in Environmental Sustainability in Nigeria

Overcoming the barriers to implementing E-Governance for environmental sustainability in Nigeria requires a multifaceted approach that addresses the infrastructural, institutional, financial, and social challenges currently impeding progress. A concerted effort by the government, private sector, civil society, and international partners is essential to ensure that Nigeria can fully leverage digital technologies for improved environmental governance. Below are key strategies that can help overcome the barriers to E-Governance in environmental sustainability.

One of the primary challenges to implementing E-Governance is the lack of adequate ICT infrastructure, particularly in rural areas. To address this, there is a need for expanded broadband access and improved internet connectivity across the country. The government, in collaboration with private telecom companies, should prioritize investments in ICT infrastructure to bridge the urban-rural divide in digital access. Programs aimed at expanding internet penetration, such as the National Broadband Plan launched by the Nigerian government, must be fully implemented and scaled up to cover underserved areas. By ensuring that more Nigerians have access to reliable internet services, the reach and effectiveness of E-Governance platforms can be significantly enhanced (Ogunbode & Omotayo, 2023).

Again, there should be investments in energy infrastructure to support digital systems. Given Nigeria's energy challenges, particularly in rural areas, ensuring a stable and reliable power supply is crucial for the functioning of digital platforms and tools used in environmental monitoring and governance. Renewable energy sources, such as solar power, can be deployed to power ICT infrastructure in off-grid locations, supporting E-Governance initiatives even in remote areas.

The success of E-Governance initiatives depends not only on access to technology but also on the ability of government officials and citizens to effectively use these tools. To overcome the barrier of low digital literacy, capacity-building programs must be developed and implemented across all levels of government, particularly within environmental agencies. Training programs should focus on equipping government officials with the necessary skills to operate digital platforms, manage environmental data, and engage with E-Governance tools.

Similarly, public awareness campaigns should be launched to improve digital literacy among citizens, especially in rural areas where literacy levels are lower. Such campaigns could include workshops, community outreach programs, and online tutorials to help individuals navigate E-Governance platforms, report environmental violations, and engage with environmental policies. Partnerships with civil society organizations and educational institutions can play a key role in scaling up digital literacy efforts (Bello & Nwagwu, 2022).

Corruption is a significant impediment to environmental governance in Nigeria, and the successful implementation of E-Governance requires strong anti-corruption measures. Digital platforms can be used to promote transparency in environmental management by making data and information readily accessible to the public. One key strategy is to enhance public access to environmental data through government websites and portals, allowing stakeholders, including NGOs and the media, to monitor environmental conditions and hold government officials and industries accountable.

In addition to public access to information, there should be efforts to strengthen the enforcement of environmental laws using digital tools. By automating processes related to environmental permits, compliance

monitoring, and penalties for violations, E-Governance platforms can reduce opportunities for corrupt practices. Onwuka & Nzeakor, (2022) opined that developing digital audit trails and electronic records can help track decision-making processes, making it more difficult for corrupt officials to manipulate outcomes. Furthermore, the establishment of independent oversight bodies to monitor the use of E-Governance systems in environmental governance can ensure that these platforms are used transparently and ethically.

The high cost of implementing and maintaining E-Governance systems is another significant barrier. To address this, the Nigerian government must allocate sufficient funding to environmental agencies and ensure that E-Governance is integrated into the broader national development agenda. One strategy for securing funding is to explore public-private partnerships (PPPs), where private sector companies can collaborate with the government to finance ICT infrastructure and digital platforms for environmental governance. These partnerships can be particularly effective in the energy and telecom sectors, where private investments can accelerate the expansion of digital services to rural and underserved areas (Odeyemi & Oseni, 2022).

Moreover, Nigeria can tap into international funding mechanisms dedicated to environmental sustainability and digital transformation. International organizations such as the World Bank, the United Nations Development Programme (UNDP), and the Global Environment Facility (GEF) offer grants and loans that can be used to finance E-Governance initiatives. Adeowu & Hamzat (2024) noted that aligning E-Governance efforts with global environmental goals, such as the Sustainable Development Goals (SDGs), Nigeria can attract more funding from bilateral and multilateral donors.

With the increasing reliance on digital platforms for environmental governance, cybersecurity becomes a critical concern. The Nigerian government must invest in building robust cybersecurity infrastructure to protect sensitive environmental data and E-Governance platforms from cyberattacks. This includes adopting encryption technologies, securing data storage systems, and ensuring that government websites are protected from hacking attempts. Regular cybersecurity audits should be conducted to identify vulnerabilities and mitigate risks.

Moreover, government agencies responsible for environmental governance should develop cybersecurity policies that outline protocols for managing cyber risks. These policies should include training for staff on how to prevent cyber threats, as well as contingency plans for responding to cyber incidents. Involving the private sector in developing and implementing these cybersecurity strategies can further enhance the security of E-Governance systems (Olalekan, 2022).

Political will is a crucial factor in the successful implementation of E-Governance. To overcome the barrier of limited political commitment, there must be high-level advocacy to ensure that E-Governance is prioritized in national and state-level environmental policies. Policymakers need to recognize the role that digital technologies can play in addressing Nigeria's environmental challenges and integrate E-Governance into the country's overall environmental management framework.

To this end, there should be better coordination among government agencies involved in environmental governance, such as the Ministry of Environment, the National Environmental Standards and Regulations Enforcement Agency (NESREA), and the Nigerian Communications Commission (NCC). These agencies should collaborate on formulating a clear E-Governance strategy that aligns with the country's environmental sustainability goals. Regular consultations between different levels of government, civil society organizations, and the private sector can help ensure that E-Governance policies are coherent and that all stakeholders are actively involved in their implementation (Akintoye & Olanrewaju, 2021).

For E-Governance to be successful, it must engage local communities and incorporate their knowledge and experiences into environmental management processes. One effective strategy is to localize E-Governance platforms, ensuring they are accessible and relevant to rural communities. This can be achieved by developing mobile applications and online platforms that are available in local languages and designed to meet the specific environmental needs of different regions.

According to Adebayo & Akintunde, (2023) the government should encourage community-led environmental monitoring through digital platforms, allowing local residents to report environmental issues such as illegal logging, pollution, and deforestation. By empowering communities to take an active role in environmental governance, E-Governance platforms can help bridge the gap between formal government efforts and local practices, fostering a more inclusive approach to environmental sustainability.

PHASED ROADMAP FOR IMPLEMENTATION

A phased roadmap provides a structured approach to implementing e-governance for environmental sustainability in Nigeria. The following steps are recommended:

Phase 1: Pilot Projects

Launch pilot projects in high-impact areas such as waste management and renewable energy monitoring. For example, a pilot program digitizing waste collection and recycling processes in Abuja could serve as a model for other cities.

Phase 2: Scaling and Integration

Expand successful pilot projects to additional states, ensuring the integration of e-governance tools with existing environmental policies. This phase should also include capacity-building programs for government officials and community leaders.

Phase 3: Policy Mainstreaming

Embed e-governance systems into national environmental policies. Collaborations with international partners, such as the United Nations Development Programme (UNDP), could provide technical and financial support for this phase.

Phase 4: Monitoring and Evaluation

Establish a robust monitoring and evaluation framework to assess the impact of e-governance initiatives. Regular feedback loops should inform policy adjustments and ensure continuous improvement.

CONCLUSION

Nigeria faces significant environmental sustainability challenges due to industrialization, population growth, and resource exploitation, the country is taking important steps to promote sustainable development. Policies such as the enforcement of environmental regulations, participation in global climate initiatives, and the promotion of renewable energy offer pathways toward a more sustainable future. However, addressing the barriers to implementation, such as inadequate enforcement, funding, and education, will be crucial for achieving long-term environmental sustainability in Nigeria. Nigeria can enhance its environmental governance, foster greater public participation, and make substantial progress towards a sustainable future. A collaborative effort involving government, the private sector, civil society, and international partners will be key to achieving these objectives and ensuring that E-Governance delivers on its promise of improved environmental outcomes.

FUTURE DIRECTIONS

Nigeria's path toward achieving environmental sustainability will require strategic and forward-thinking approaches that address both current challenges and anticipate future needs. The complex interplay between environmental degradation, economic development, and social well-being in the country calls for innovative solutions that are both practical and adaptable to Nigeria's unique context. To make meaningful progress, the

country must prioritize key areas such as the adoption of technology, stronger governance, renewable energy, capacity building, and international collaboration.

As Nigeria continues to modernize, the adoption of technology will play a crucial role in enhancing environmental sustainability. Emerging technologies such as geospatial mapping, remote sensing, and environmental data analytics can help track and manage natural resources more effectively. For instance, satellite imagery can monitor deforestation rates, track illegal mining activities, and assess the impact of urban expansion on ecosystems. In addition, digital platforms can streamline environmental reporting and enforcement, allowing citizens to participate in real-time environmental protection by reporting pollution or illegal deforestation.

Moreover, Artificial Intelligence (AI) and machine learning can improve environmental forecasting and disaster management. Predictive models driven by AI can help identify areas prone to flooding, drought, or desertification, thereby enabling early intervention. By integrating these advanced technologies into environmental policies, Nigeria can significantly enhance its ability to address both current and emerging environmental threats.

A critical aspect of moving toward sustainability is improving environmental governance. Current policies and regulations often lack robust enforcement, which undermines efforts to protect the environment. Moving forward, it is essential to develop more stringent regulations and ensure that existing laws are enforced uniformly across sectors and regions. Strengthening institutions responsible for environmental protection, such as the Federal Ministry of Environment, will be key to ensuring effective oversight and coordination of sustainability efforts.

Furthermore, local governance structures need to be empowered to implement tailored solutions that address region-specific environmental challenges. For instance, addressing desertification in the northern states may require different strategies compared to tackling oil pollution in the Niger Delta. By decentralizing environmental governance, states and local governments can develop and implement policies that are contextually appropriate, increasing the chances of success. The transition to renewable energy is one of the most promising strategies for reducing Nigeria's reliance on fossil fuels and mitigating its environmental footprint. Solar, wind, and hydropower offer cleaner alternatives to traditional energy sources and can help Nigeria reduce its carbon emissions while meeting its growing energy demands. Investments in solar energy, particularly in the northern regions where sunlight is abundant, can provide electricity to off-grid communities and reduce the pressure on the national grid. The government, in collaboration with the private sector, must create a conducive environment for investment in green energy infrastructure. Incentives for renewable energy adoption, such as tax breaks and subsidies, could encourage more industries and households to switch to cleaner energy. Additionally, training programs should be established to build the capacity of local engineers and technicians to maintain and expand the country's renewable energy infrastructure.

To ensure long-term success in environmental sustainability, Nigeria must invest in capacity building at all levels. This includes equipping government officials, policymakers, and environmental professionals with the knowledge and skills needed to implement and monitor sustainability initiatives effectively. Specialized training in environmental management, renewable energy, and climate change adaptation should be provided to public and private sector actors alike. Equally important is environmental education for the general population. Raising public awareness about the importance of environmental protection and sustainability can help shift behaviors toward more eco-friendly practices. Integrating environmental education into the national school curriculum, from primary through tertiary levels, will ensure that future generations understand the importance of sustainability and are equipped to take action.

Local communities are at the heart of environmental protection, particularly in rural areas where natural resources form the basis of livelihoods. Therefore, community engagement is critical for ensuring the success of sustainability initiatives. Encouraging local participation in decision-making processes related to environmental policies and practices can lead to more effective and sustainable outcomes. For example,

community-based forest management programs have proven successful in other parts of Africa and could be adapted to Nigeria's context to help curb deforestation. Similarly, sustainable agriculture practices, such as agro forestry and organic farming, can be promoted to ensure that rural farmers are able to maintain productivity without depleting natural resources. By empowering communities through access to green technologies and training in sustainable practices, Nigeria can create a grassroots movement toward environmental sustainability.

As part of the global effort to combat environmental degradation and climate change, Nigeria must continue to engage with international partners and access climate finance to support its sustainability goals. International funding sources, such as the Green Climate Fund and the Global Environment Facility, offer critical financial support for developing countries looking to transition to cleaner energy and implement sustainable development projects. Additionally, Nigeria should actively participate in global environmental agreements and fulfill its commitments under the Paris Agreement by reducing greenhouse gas emissions and enhancing climate resilience. Cross-border collaboration with neighboring countries in West Africa will also be crucial in addressing shared environmental issues, such as desertification, water management, and biodiversity conservation.

Transitioning to a circular economy where waste is minimized, and resources are reused and recycled can help reduce the environmental pressures caused by Nigeria's rapid economic growth. Encouraging industries to adopt sustainable production methods and invest in waste recycling technologies will be important steps toward this goal. Government policies should incentivize the recycling of materials such as plastic, electronic waste, and construction debris, while simultaneously promoting waste-to-energy projects that convert waste into usable power. A circular economy framework can also provide economic opportunities, particularly in the informal sector, by creating jobs in waste management, recycling, and green technology. This approach will not only reduce the environmental impact of waste but also contribute to economic growth and poverty alleviation.

The future of environmental sustainability in Nigeria hinges on the country's ability to integrate advanced technologies, strengthen governance structures, invest in renewable energy, and engage local communities in sustainable practices. By adopting a multi-faceted approach that includes capacity building, international collaboration, and the transition to a circular economy, Nigeria can overcome its current environmental challenges and move toward a more sustainable future. Ultimately, the successful implementation of these strategies will depend on strong political will, coordinated efforts across sectors, and the active participation of all stakeholders from the government to local communities.

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