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Artificial Intelligence and Environmental Sustainability in International Political Economy: Implications for Nigeria

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Abstract

Artificial Intelligence (AI) has emerged as a transformative technology with significant implications for environmental governance, sustainable development, and the evolving dynamics of the International Political Economy (IPE). This study examines the role of AI in advancing environmental sustainability in Nigeria while exploring how global political–economic structures influence its adoption and effectiveness. Using a mixed-methods research design, the study combined quantitative data from 210 respondents drawn from environmental regulatory agencies, technology firms, academic institutions, and civil society organizations with qualitative interviews involving 25 key informants. Descriptive statistics and thematic analysis were employed to analyze the data. The findings reveal that AI contributes substantially to environmental monitoring, climate prediction, energy efficiency, and resource management, with environmental monitoring recording the highest perceived effectiveness. However, inadequate digital infrastructure, high implementation costs, weak regulatory frameworks, limited technical expertise, and dependence on foreign AI platforms significantly constrain its widespread adoption. Correlation analysis further demonstrates a strong positive relationship between institutional capacity and the effectiveness of AI-driven environmental sustainability initiatives, highlighting the importance of governance and policy support. Qualitative evidence indicates that donor dependence, foreign ownership of AI technologies, limited national control over environmental data, and alignment with external development agendas shape AI implementation in Nigeria, reinforcing existing technological and political–economic dependencies. The study concludes that while AI offers considerable opportunities for improving environmental sustainability, its transformative potential can only be fully realized through strengthened institutional capacity, investment in domestic innovation, improved digital infrastructure, and policies that promote technological sovereignty. By integrating AI, environmental sustainability, and International Political

Economy perspectives, the study contributes to contemporary debates on sustainable development and provides practical policy recommendations for enhancing Nigeria's resilience and competitiveness in the global digital economy.

Keywords: Artificial Intelligence, Environmental Sustainability, International Political Economy, Environmental Governance, Nigeria.

INTRODUCTION

1.1 Background to the Study

Environmental sustainability is becoming a critical global concern as Nation of the World grapple with the accelerating impacts of climate change, biodiversity loss, pollution, and resource depletion. These environmental problems have intensified debates on how technological innovation can support sustainable development pathways. Artificial Intelligence (AI) has gained prominence as a transformative technology capable of enhancing environmental monitoring, predictive modeling, and resource management through advanced data analytics and automation (Rolnick *et al.,* 2019; Vinuesa *et al.,* 2020). AI-driven systems are globally increasingly deployed across sectors such as energy, agriculture, urban planning, and climate governance, reshaping how environmental problems are understood and addressed. From the perspective of International Political Economy (IPE), however, technological innovations such as AI are embedded within global structures of power, capital, and governance. Control over AI technologies, data infrastructure, and intellectual property remains concentrated in developed economies and multinational corporations, raising concerns about unequal access and technological dependency (Strange, 1998; O'Brien & Williams, 2016). Consequently, the capacity of developing countries to leverage AI for environmental sustainability is shaped not only by technical readiness but also by global political economic relations that influence technology transfer, regulatory frameworks, and environmental governance. Nigeria offers a particularly important case for examining these dynamics.

As Africa's largest economy and one of its most environmentally vulnerable countries, Nigeria faces persistent challenges including deforestation, air and water pollution, land degradation, and climate-related risks (Adelekan *et al*., 2021). Although national environmental policies and institutions exist, their effectiveness is often undermined by weak enforcement, limited funding, and institutional capacity constraints (Adeniyi *et al.,* 2020). At the same time, Nigeria has witnessed growing interest in digital technologies and AI-based solutions, especially in environmental monitoring, agriculture, and urban management, largely driven by private sector initiatives and international development partners. The adoption of AI for environmental sustainability in Nigeria occurs within a broader global context characterized by uneven technological development and external influence. Many AI-driven environmental initiatives in Nigeria rely on foreign platforms, donor funding, and externally defined sustainability agendas, raising critical questions about data sovereignty, policy autonomy, and long-term sustainability (Zuboff, 2019; Crawford, 2021). From an IPE perspective, these conditions suggest that AI may reproduce existing patterns of dependency unless accompanied by deliberate efforts to strengthen domestic innovation systems and governance capacity. Despite the growing literature on AI and environmental sustainability, empirical studies that integrate these issues within an IPE framework remain limited, particularly in the Nigerian context.

This study addresses this gap by empirically examining the implications of AI for environmental sustainability in Nigeria using a mixed-methods approach. By combining quantitative survey data, qualitative interviews, and secondary environmental indicators, the study seeks to explain how global political–economic structures, institutional capacity, and governance dynamics shape AI adoption and

sustainability outcomes. The findings contribute to debates on technology, sustainability, and development and offer policy-relevant insights for leveraging AI in environmentally sustainable and politically equitable ways.

1.2 Statement of the Problem

Environmental sustainability challenges in Nigeria have intensified in recent decades, manifesting in deforestation, pollution, inefficient waste management, climate vulnerability, and unsustainable resource exploitation. Although Artificial Intelligence (AI) has emerged globally as a promising tool for improving environmental monitoring, decision-making, and resource efficiency, its application in Nigeria remains limited and uneven. Existing environmental governance structures are often constrained by weak institutional capacity, inadequate data systems, and poor enforcement mechanisms, which hinder the effective integration of AI into sustainability initiatives. As a result, environmental degradation persists despite the availability of advanced technological solutions. Furthermore, the adoption of AI for environmental sustainability in Nigeria is deeply influenced by global political economic dynamics. Control over AI technologies, data infrastructure, and innovation systems is largely concentrated in developed economies, creating dependency relationships that limit Nigeria's technological autonomy. Many AI-driven environmental initiatives in Nigeria rely on foreign platforms, donor funding, and externally defined sustainability agendas, raising concerns about data sovereignty, policy alignment, and long-term effectiveness. Despite these challenges, empirical research that systematically examines AI and environmental sustainability in Nigeria within an International Political Economy framework remains scarce, creating a significant knowledge gap that this study seeks to address.

1.3 Aim and Objectives of the Study

The main aim of this study is to empirically examine the role of Artificial Intelligence (AI) in advancing environmental sustainability in Nigeria within the framework of International Political Economy. To achieve this aim, the study seeks to:

I. Assess the contribution of Artificial Intelligence applications to environmental sustainability practices in Nigeria, particularly in the areas of environmental monitoring, climate modeling, waste management, and resource efficiency.
II. Examine the institutional, infrastructural, and governance factors that influence the adoption and effectiveness of AI-driven environmental sustainability initiatives in Nigeria.
III. Analyze the influence of global political–economic forces, including technological dependency, external financing, and international governance frameworks, on AI deployment and environmental sustainability outcomes in Nigeria.

1.4 Research Questions

The study is guided by the following research questions:

I. To what extent is Artificial Intelligence applied in environmental sustainability initiatives in Nigeria, and how effective are these applications in improving environmental monitoring, decision-making, and resource management?
II. What institutional, infrastructural, and governance factors influence the adoption and effectiveness of AI-driven environmental sustainability initiatives in Nigeria?
III. How do global political–economic forces, such as dependence on foreign technologies, donor-driven projects, and international regulatory frameworks, shape AI governance, data control, and environmental sustainability outcomes in Nigeria?

2.0 LITERATURE REVIEW

2.1 Artificial Intelligence and Environmental Sustainability

Artificial Intelligence (AI) has emerged as a transformative tool in advancing environmental sustainability by enhancing data collection, predictive analysis, and decision-making processes. Scholars argue that AI applications such as machine learning, remote sensing, and automated monitoring systems have improved climate modeling accuracy, biodiversity conservation, waste management efficiency, and energy optimization (Rolnick *et al.,* 2019; Vinuesa *et al.,* 2020). Through real-time environmental surveillance and predictive analytics, AI enables governments and institutions to respond more effectively to environmental risks and resource inefficiencies. Despite these benefits, the literature also highlights significant sustainability concerns associated with AI deployment. High energy consumption, carbon emissions from data centers, and the environmental footprint of digital infrastructure raise questions about the net sustainability gains of AI technologies (Bender *et al.,* 2021). Moreover, the uneven global distribution of AI capabilities suggests that sustainability benefits are disproportionately realized in developed economies, while developing countries often remain technology consumers rather than innovators (Crawford, 2021). This dual nature of AI underscores the need to assess its environmental role within broader political–economic contexts.

2.2 International Political Economy and Technological Power

International Political Economy scholarship emphasizes that technological development is deeply embedded in global power relations, capital accumulation, and governance structures. Technologies such as AI are not neutral tools but instruments shaped by the interests of dominant states, multinational corporations, and global institutions (Strange, 1998; O'Brien & Williams, 2016). Control over data, intellectual property rights, and technological standards often determines which actors benefit most from digital innovation. Within this framework, AI has become a strategic asset in the global political economy, reinforcing asymmetries between the Global North and Global South. Scholars argue that developing countries face structural barriers to meaningful participation in the AI economy due to limited access to capital, skills, and research infrastructure (Wallerstein, 2004; Zuboff, 2019). Consequently, AI-driven sustainability initiatives in developing economies are frequently shaped by external funding agencies and technology providers, raising concerns about dependency, sovereignty, and long-term development autonomy.

2.3 Environmental Sustainability and Governance in Nigeria

Environmental sustainability in Nigeria is closely linked to the quality of governance structures, policy frameworks, and institutional capacity at national and subnational levels. Nigeria faces persistent environmental challenges such as deforestation, pollution, land degradation, flooding, and climate change impacts, which are exacerbated by rapid urbanization and population growth. Effective environmental governance through laws, regulations, and enforcement mechanisms is therefore critical for managing natural resources sustainably and protecting public health (Olujobi, 2020). While Nigeria has established environmental institutions and policies, gaps between policy formulation and implementation continue to undermine sustainability outcomes. Governance challenges affecting environmental sustainability in Nigeria include weak regulatory enforcement, limited coordination among institutions, inadequate funding, and political interference. Environmental regulations are often poorly enforced due to capacity constraints, corruption, and overlapping institutional mandates. In addition, environmental decision-making tends to be centralized, with limited participation of local communities and civil society, reducing accountability and responsiveness to local environmental needs (O'Brien & Williams, 2016). These governance deficits limit the effectiveness of sustainability initiatives and contribute to the persistence of environmental degradation

across different regions of the country. Strengthening environmental sustainability in Nigeria requires governance reforms that emphasize transparency, accountability, and inclusive participation. Integrating technological tools such as digital monitoring systems and data-driven decision-making can enhance regulatory oversight and improve environmental compliance. However, governance improvements must also address broader political–economic factors, including power relations, resource allocation, and policy coherence across sectors (Wallerstein, 2004; Crawford, 2021). By aligning environmental governance with sustainable development principles and strengthening institutional capacity, Nigeria can improve environmental outcomes and build long-term resilience against ecological and climate-related risks. Nigeria faces complex environmental sustainability challenges arising from rapid urbanization, extractive economic practices, weak regulatory enforcement, and climate vulnerability. Empirical studies document persistent issues such as deforestation, pollution, land degradation, and inadequate waste management systems (Adeniyi *et al.,* 2020; Adelekan *et al*., 2021). Although environmental policies and institutions exist, implementation gaps remain a major obstacle to sustainable outcomes. The literature further notes that Nigeria's environmental governance challenges are closely linked to institutional capacity deficits and political–economic pressures. Resource dependence, particularly on oil and gas, has historically prioritized economic growth over environmental protection (Olujobi, 2020). As a result, sustainability initiatives often lack adequate funding, technical expertise, and monitoring mechanisms. These governance weaknesses create both a challenge and an opportunity for AI-driven interventions, provided institutional reforms accompany technological adoption.

2.4 Artificial Intelligence Adoption and Sustainability

Artificial Intelligence (AI) adoption has become an important driver of sustainability efforts across environmental, economic, and social domains. In environmental management, AI applications such as machine learning algorithms, satellite-based remote sensing, and predictive analytics support real-time monitoring of ecosystems, early warning systems for climate-related risks, and optimization of energy and resource use. These technologies enhance the efficiency and effectiveness of sustainability interventions by reducing uncertainty and improving evidence-based decision-making (Crawford, 2021; Akanbi *et al.,* 2022). As a result, AI adoption is increasingly viewed as a strategic tool for achieving national and global sustainability targets. However, the adoption of AI for sustainability is uneven across countries and sectors, largely due to institutional, economic, and technological constraints. In developing economies, limited digital infrastructure, shortage of skilled personnel, and high implementation costs restrict the scale and impact of AI-driven sustainability initiatives (Olujobi, 2020). Moreover, AI technologies are often imported, with ownership of data, algorithms, and platforms remaining in the hands of foreign firms. This creates dependency relationships that shape how sustainability solutions are designed and governed, reinforcing existing inequalities in technological access and decision-making power (O'Brien & Williams, 2016; Wallerstein, 2004). Sustainable AI adoption therefore requires governance frameworks that address both technical efficiency and political–economic implications. Integrating ethical standards, data protection measures, and local capacity development into AI strategies is essential for ensuring that sustainability outcomes are inclusive and context-specific (Crawford, 2021). For countries like Nigeria, aligning AI adoption with national sustainability priorities, strengthening domestic innovation systems, and reducing reliance on externally controlled technologies are critical steps toward achieving long-term environmental sustainability. Thus, AI adoption and sustainability are deeply interconnected processes shaped by governance choices and broader political–economic structures. Initiatives in Nigeria Studies on AI adoption in Nigeria indicate a growing but uneven integration of digital technologies across sectors such as agriculture, energy, urban planning, and environmental monitoring. AI-based tools have been used for flood prediction, climate data analysis, and smart waste management in pilot projects, often supported

by international development partners (Akanbi *et al.,* 2022). These initiatives demonstrate the technical feasibility of AI-driven environmental management in Nigeria. However, scholars caution that AI adoption in Nigeria remains constrained by inadequate infrastructure, limited skilled manpower, and heavy reliance on foreign technology platforms (Okafor & Adebayo, 2021). The lack of coherent national AI policies aligned with environmental sustainability goals further limits scalability. From an IPE perspective, these challenges reflect Nigeria's peripheral position in the global AI value chain, where technological dependency undermines the transformative potential of AI for sustainable development.

2.5 Linking Artificial Intelligence, Environmental Sustainability, and International Political Economy

Artificial Intelligence (AI), environmental sustainability, and International Political Economy (IPE) are increasingly intertwined in contemporary development and governance debates. AI technologies such as machine learning, big data analytics, and remote sensing have enhanced environmental monitoring, climate forecasting, pollution control, and resource management by improving the accuracy, speed, and scope of environmental decision-making (Akanbi *et al.,* 2022; Crawford, 2021). These capabilities position AI as a critical tool for achieving environmental sustainability goals, particularly in contexts facing complex ecological challenges and limited conventional monitoring capacity. From an International Political Economy perspective, however, the development, diffusion, and governance of AI are shaped by global power relations and unequal economic structures. Control over AI infrastructure, data, and intellectual property is largely concentrated in advanced economies and multinational technology firms, reinforcing technological dependence in developing countries (O'Brien & Williams, 2016; Wallerstein, 2004). As a result, AI-driven environmental sustainability initiatives are often externally financed and aligned with international development agendas, raising concerns about data sovereignty, policy autonomy, and the marginalization of local environmental priorities (Crawford, 2021). In the Nigerian context, the intersection of AI, environmental sustainability, and IPE reveals both significant opportunities and persistent structural constraints. AI offers promising solutions for addressing challenges such as climate change adaptation, waste management, and environmental degradation. However, limited domestic innovation capacity, weak institutional frameworks, infrastructural deficits, and reliance on foreign technologies constrain effective implementation (Akanbi *et al.,* 2022; Olujobi, 2020). Addressing these challenges requires strengthening national technological capabilities, promoting inclusive AI governance, and situating sustainability policies within a political–economic framework that prioritizes equity, local relevance, and long-term environmental resilience. Emerging literature increasingly calls for integrating AI and environmental sustainability debates within an IPE framework. Such integration highlights how global governance regimes, market forces, and power asymmetries shape technology-driven sustainability outcomes (Bernstein, 2013). AI-based environmental solutions are often embedded in global policy agendas such as the Sustainable Development Goals, which may not fully align with local development priorities. Scholars argue that without addressing global inequalities in technology access and governance, AI may reproduce existing patterns of dependency rather than promote sustainable transformation (Frank, 1967; Vinuesa *et al.,* 2020). This study builds on this literature by empirically examining how these international political economic dynamics shape AI and environmental sustainability outcomes in Nigeria.

3.0 METHODOLOGY

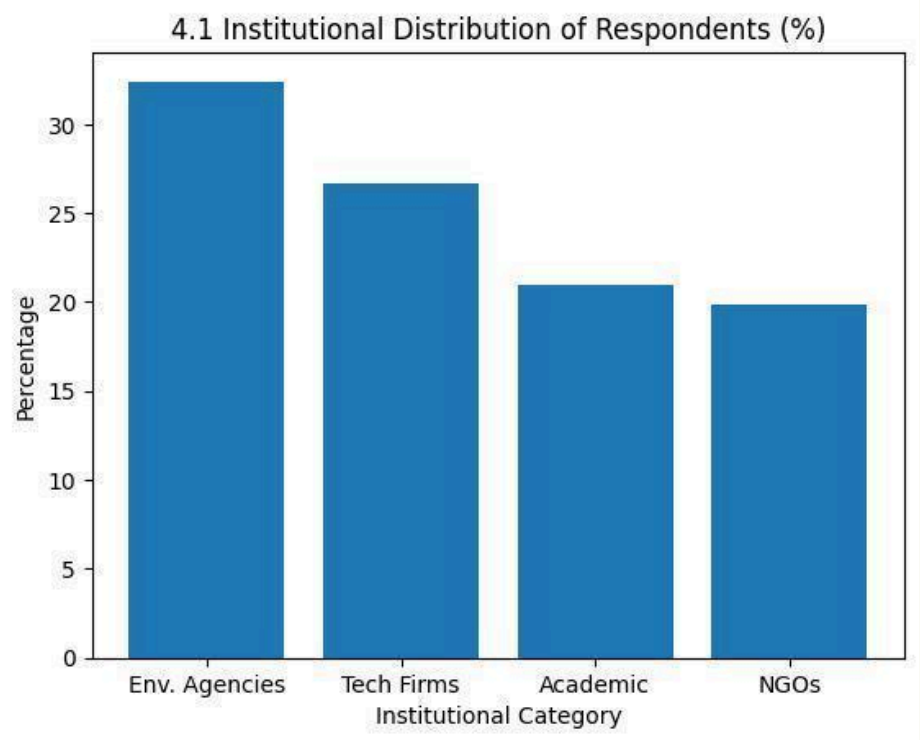
This study adopted a mixed-methods research design to examine the relationship between Artificial Intelligence, environmental sustainability, and governance within the framework of International Political Economy in Nigeria. The mixed-methods approach was considered appropriate because it allows for the integration of quantitative and qualitative data, thereby providing a more comprehensive understanding of both measurable outcomes and underlying institutional and political–economic dynamics. The quantitative

component focused on capturing patterns, trends, and stakeholder perceptions of AI adoption in environmental sustainability initiatives, while the qualitative component explored deeper insights into governance structures, power relations, and global influences shaping AI deployment in Nigeria. For the quantitative phase, a structured questionnaire was administered to stakeholders drawn from environmental regulatory agencies, technology firms, academic and research institutions, and civil society organizations across selected Nigerian states. A stratified sampling technique was employed to ensure proportional representation of these key institutions involved in environmental governance and digital innovation. The questionnaire contained closed-ended items measured on a Likert scale, covering areas such as AI applications in environmental management, institutional capacity, governance effectiveness, and sustainability outcomes. A total of 250 questionnaires were distributed, of which 210 were returned and deemed valid for analysis, representing an 84 percent response rate. The qualitative component involved semi-structured interviews with purposely selected key informants, including senior officials in environmental agencies, AI practitioners, policy experts, and representatives of non-governmental organizations. The interviews focused on issues such as donor influence, data sovereignty, regulatory challenges, and the political–economic implications of AI-driven environmental initiatives. In total, 25 in-depth interviews were conducted, allowing for triangulation with survey findings and providing contextual explanations for observed quantitative patterns. Quantitative data were analyzed using descriptive statistics, including frequencies, percentages, and mean scores, with results presented in tables to enhance clarity. Qualitative data were analyzed thematically through systematic coding to identify recurring themes related to governance, sustainability, and international political–economic influences. Ethical considerations were observed throughout the study, including informed consent, confidentiality, and voluntary participation. The integration of quantitative and qualitative findings strengthened the validity and reliability of the study and enabled a robust interpretation of the complex interactions between AI, environmental sustainability, and governance in Nigeria.

4.0 FINDINGS AND DISCUSSION

4.1 Socio-Institutional Profile of Respondents

Chart 1: Institutional Distribution of Respondents (n = 210)

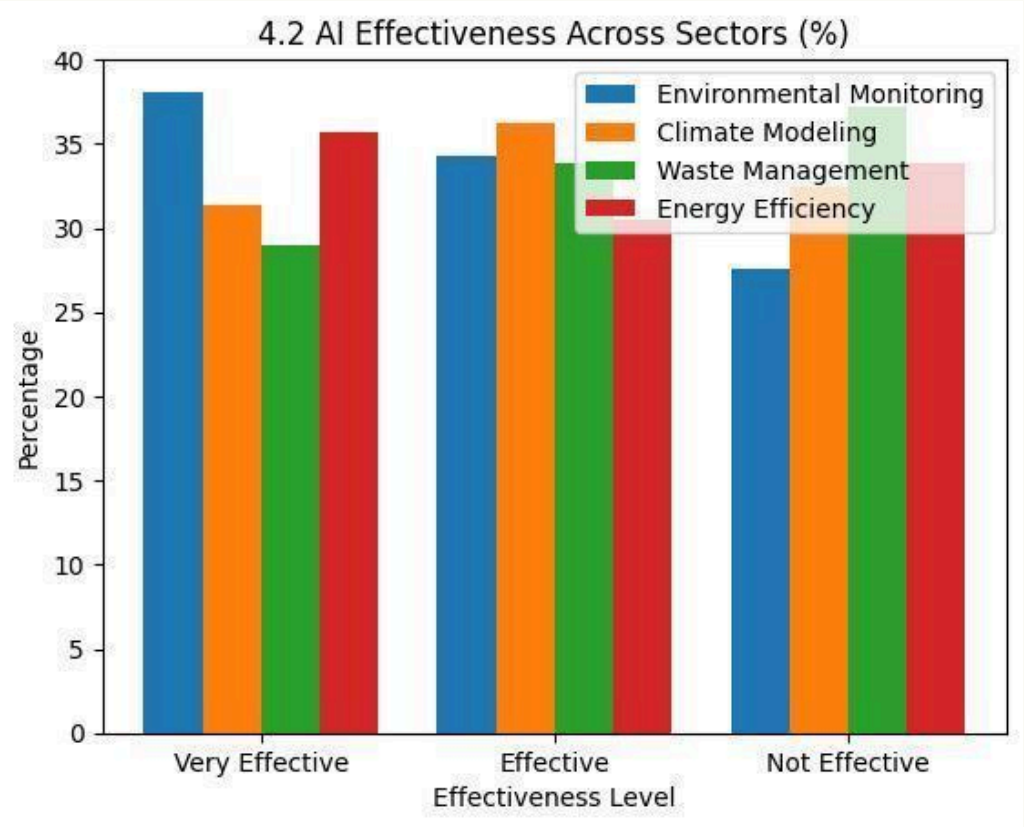


The response rate of 84% is considered high for social science and policy-oriented surveys, suggesting strong interest and relevance of the research topic among targeted stakeholders. This level of participation enhances the credibility of the findings and reduces the likelihood of non-response bias, particularly in studies involving institutions with varying levels of capacity and engagement. The institutional composition of respondents demonstrates balanced representation across sectors central to AI-driven environmental sustainability in Nigeria. Environmental regulatory agencies constitute the largest proportion of respondents, reflecting their statutory role in environmental monitoring, policy implementation, and enforcement. Their inclusion provides critical insights into governance capacity, regulatory constraints, and the practical challenges of integrating AI into environmental management systems. The substantial participation of technology firms and academic institutions underscores the growing role of digital innovation and knowledge production in addressing environmental challenges. Technology firms contribute practical perspectives on AI deployment, infrastructure, and innovation barriers, while academics provide analytical and research-based insights. Civil society organizations further enrich the dataset by offering viewpoints on accountability, public engagement, and sustainability outcomes. From an International Political Economy perspective, this diverse institutional representation captures the interaction between state actors, market forces, knowledge institutions, and civil society, thereby strengthening the empirical foundation of the study.

4.2 Contribution of Artificial Intelligence to Environmental Sustainability in Nigeria

Respondents were asked to assess the effectiveness of AI applications in key environmental sustainability domains. The results (Chart 2) indicate strong perceived benefits, particularly in environmental monitoring and data management.

Chart 2: Perceived Effectiveness of AI in Environmental Sustainability (n = 210)

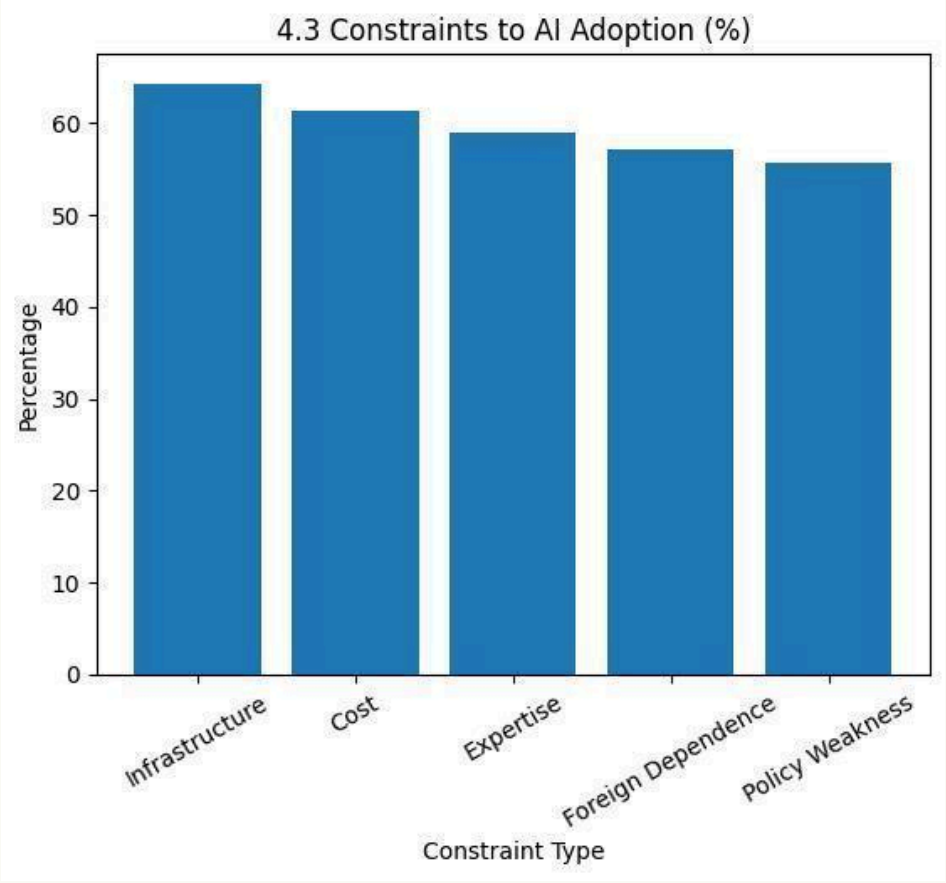


The chart compares perceptions of AI effectiveness across four sectors: environmental monitoring, climate modeling, waste management, and energy efficiency using three evaluation categories (very effective, effective, and not effective). Environmental monitoring records the highest “very effective” rating, while

waste management shows the highest "not effective" responses, indicating relatively weaker performance. These findings align with studies showing that AI enhances predictive accuracy and real-time environmental decision-making (Rolnick et al., 2019; Vinuesa et al., 2020). However, effectiveness remains uneven, reflecting limited scale and institutional integration in Nigeria. From an IPE perspective, this uneven impact illustrates how technological benefits are mediated by governance capacity and access to capital rather than by innovation alone (Strange, 1998).

4.3 Institutional and Infrastructural Constraints to AI Deployment To assess constraints, respondents identified key barriers limiting the effective use of AI for environmental sustainability (Table 3).

Chart 3: Major Constraints to AI Adoption for Environmental Sustainability



The findings show that infrastructural and institutional deficits are the most significant barriers. Over 64% of respondents identified inadequate digital infrastructure as a major constraint, reflecting Nigeria's broader development challenges. These results support earlier studies that link weak institutions and regulatory gaps to poor environmental governance outcomes in developing economies (Adeniyi et al., 2020; Adelekan et al., 2021). In IPE terms, these constraints are not merely domestic failures but symptoms of Nigeria's subordinate position in the global digital economy, where access to advanced AI systems is controlled by multinational corporations based in the Global North (Zuboff, 2019).

4.4 Relationship Between Institutional Capacity and AI Effectiveness

Correlation analysis was conducted to examine the relationship between institutional capacity and the effectiveness of AI in environmental sustainability (Table 4).

Table 4: Correlation Between Institutional Capacity and AI Effectiveness

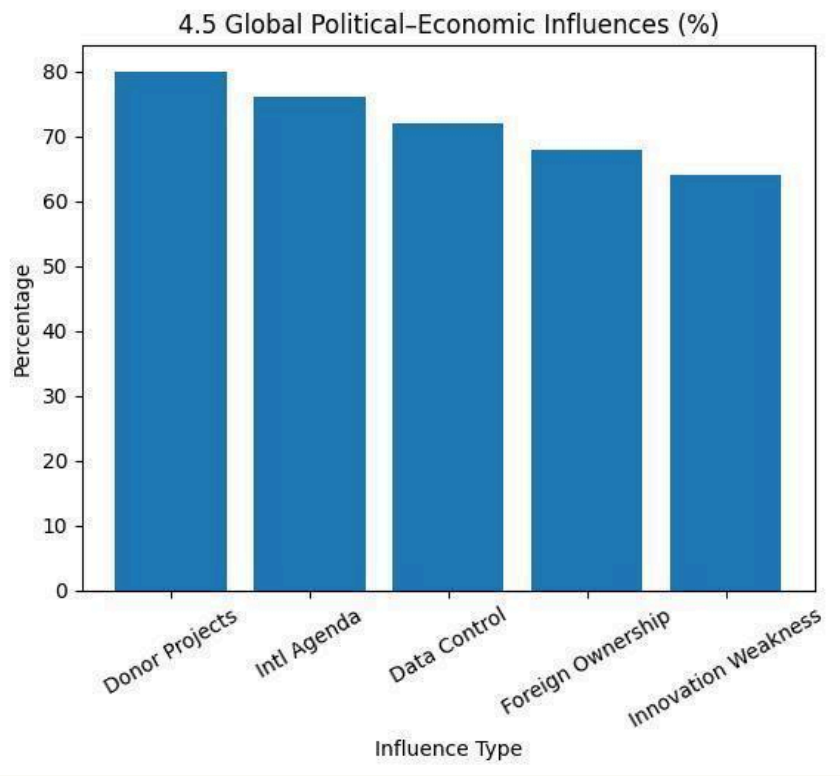
Variables	Correlation Coefficient (r)	Significance (p)
Institutional capacity & AI effectiveness	0.62	< 0.01

The strong positive correlation ($r = 0.62$, $p < 0.01$) indicates that higher institutional capacity significantly improves AI effectiveness in environmental sustainability initiatives. This finding confirms that technology alone is insufficient without supportive governance structures, a position widely emphasized in political economy literature (O'Brien & Williams, 2016).

4.5 Global Political–Economic Influences on AI and Sustainability

Qualitative evidence from in-depth interviews indicates that global political–economic forces significantly shape the development and implementation of AI-based environmental sustainability initiatives in Nigeria. Respondents emphasized the dominant role of external actors in financing, designing, and governing AI-driven environmental projects, raising concerns about national autonomy, data control, and long-term sustainability.

Chart 5: Global Political Economic Influences on AI-Based Environmental Initiatives in Nigeria (n = 25)



The findings presented in Chart 5 demonstrate that a significant majority of AI-based environmental sustainability initiatives in Nigeria are externally driven, with 80% of interviewees indicating that such projects rely heavily on donor funding or foreign technology providers. This external dependence

influences project design, implementation priorities, and sustainability objectives, often aligning them more closely with international development agendas than with locally defined environmental needs. As a result, national ownership and long-term continuity of AI-driven environmental initiatives remain limited. Concerns over data sovereignty and intellectual property control further underscore Nigeria's dependent position in the global AI ecosystem. Over 70% of respondents highlighted limited national control over environmental data generated through AI systems, while 68% pointed to foreign ownership of algorithms and platforms. These patterns reflect broader International Political Economy dynamics in which technological power, data ownership, and innovation capacity are concentrated in the Global North. Such arrangements restrict Nigeria's ability to independently shape AI governance frameworks and limit opportunities for domestic technological learning and innovation. These findings strongly reinforce dependency theory, which argues that technological diffusion often reproduces global inequalities by positioning developing countries as technology consumers rather than producers (Frank, 1967; Wallerstein, 2004). In the context of AI and environmental sustainability, Nigeria's reliance on externally controlled technologies constrains policy autonomy and decision-making power. Consequently, AI governance in Nigeria is shaped less by domestic environmental priorities and more by international political–economic forces that determine access to capital, technology, and knowledge. Addressing these structural constraints is therefore essential for achieving more equitable and locally grounded AI-driven environmental sustainability outcomes. who controls data, technology, and decision-making processes.

4.6 Discussion of Findings

Discussion of Findings The findings of this study demonstrate that Artificial Intelligence (AI) holds substantial potential to enhance environmental sustainability in Nigeria, particularly in the areas of environmental monitoring, climate prediction, waste management, and resource efficiency. Survey and interview results indicate that AI improves data accuracy, timeliness, and decision-making capacity within environmental governance institutions. This supports existing literature that identifies AI as a critical enabler of sustainability transitions through improved environmental intelligence and predictive analytics (Rolnick et al., 2019; Vinuesa *et al.,* 2020). However, the findings also reveal that these benefits remain largely localized, project-based, and insufficiently scaled to generate transformative environmental outcomes at the national level. A key contribution of this study lies in demonstrating that institutional capacity is a decisive factor mediating the effectiveness of AI-driven environmental sustainability initiatives in Nigeria. The strong positive relationship between institutional capacity and AI effectiveness confirms that technology alone cannot deliver sustainability outcomes without robust governance frameworks, skilled personnel, and regulatory coherence. This aligns with political economy arguments that emphasize the role of institutions in shaping development trajectories and technological outcomes (O'Brien & Williams, 2016). In Nigeria, weak regulatory enforcement, fragmented policy coordination, and limited technical expertise constrain the integration of AI into long-term environmental planning, thereby limiting its sustainability impact. The findings further reveal that infrastructural deficits and high implementation costs significantly undermine AI adoption for environmental sustainability. Inadequate digital infrastructure, unreliable power supply, and limited access to high-quality environmental data restrict the operational efficiency of AI systems. These challenges are consistent with broader development constraints identified in the Global South and reinforce arguments that technological diffusion is uneven and shaped by structural inequalities in the global political economy (Wallerstein, 2004). Consequently, Nigeria's capacity to deploy AI for sustainability is conditioned by material and structural limitations rather than by technological availability alone. From an International Political Economy perspective, the study's qualitative findings highlight the influence of global power relations on AI-driven environmental sustainability in Nigeria. The reliance on foreign AI platforms, donor-funded projects, and externally

defined sustainability priorities reflects Nigeria's dependent integration into the global digital economy. Control over data, algorithms, and intellectual property by multinational corporations raises concerns about data sovereignty and policy autonomy, supporting critical IPE arguments that technology can reproduce dependency rather than promote development (Frank, 1967; Zuboff, 2019). In this context, AI becomes a site of political and economic contestation rather than a neutral sustainability solution. The findings also suggest that AI-driven environmental sustainability initiatives in Nigeria are often shaped by international environmental and development agendas, which may not fully align with local ecological realities or policy priorities. While alignment with global frameworks such as the Sustainable Development Goals can attract funding and technical support, it may also limit Nigeria's ability to design context-specific sustainability strategies. This tension reflects broader debates within global environmental governance regarding the balance between international coordination and national policy autonomy (Bernstein, 2013). Overall, this study advances the argument that AI-driven environmental sustainability in Nigeria must be understood as a political economic process embedded in global and domestic power structures. The findings underscore that without deliberate efforts to strengthen institutional capacity, reduce technological dependency, and enhance domestic innovation systems, AI risks reinforcing existing inequalities rather than delivering inclusive and sustainable environmental outcomes. By empirically linking AI, environmental sustainability, and IPE, the study contributes to a more nuanced understanding of how digital technologies shape sustainability pathways in developing economies. These findings contribute empirically to IPE scholarship by illustrating how digital technologies intersect with environmental governance and development inequalities in a Global South context.

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study examined the implications of Artificial Intelligence (AI) for environmental sustainability in Nigeria within the framework of International Political Economy, using a mixed-methods research approach. The findings show that AI has significant potential to enhance environmental monitoring, climate prediction, waste management, and resource efficiency in Nigeria. Empirical evidence from surveys and interviews indicates that AI-based tools improve data accuracy and support informed decision-making in environmental governance. However, these benefits remain uneven and largely limited to pilot initiatives, with minimal impact at the national scale. The study further reveals that institutional capacity, infrastructure, and governance structures play a decisive role in shaping AI-driven environmental sustainability outcomes. Weak regulatory enforcement, inadequate digital infrastructure, limited technical expertise, and high implementation costs constrain the effective deployment of AI technologies. Moreover, Nigeria's reliance on foreign AI platforms and externally funded initiatives reflects broader global political–economic inequalities that influence technology access, data control, and policy autonomy. These findings confirm that AI adoption for environmental sustainability is not a purely technical process but one embedded in structural and political–economic realities. In conclusion, the study argues that AI-driven environmental sustainability in Nigeria must be understood as a political–economic process shaped by both domestic governance capacity and global power relations. Without deliberate efforts to strengthen institutions, develop local innovation systems, and engage strategically with global AI governance frameworks, AI risks reinforcing existing inequalities rather than delivering sustainable environmental outcomes. Integrating International Political Economy perspectives into technology and sustainability policies is therefore essential for achieving inclusive, effective, and long-term environmental sustainability in Nigeria.

5.2 Recommendations

To enhance the effectiveness of Artificial Intelligence in promoting environmental sustainability in Nigeria, there is a need to strengthen institutional and human capacity within environmental governance structures. Government agencies responsible for environmental regulation should invest in specialized training for staff, develop interdisciplinary expertise that combines environmental science and data analytics, and improve coordination among ministries and agencies. Strengthening regulatory frameworks to accommodate emerging digital technologies will also ensure that AI applications are effectively integrated into environmental planning, monitoring, and enforcement processes. In addition, significant investment in digital and environmental data infrastructure is essential for scaling AI-driven sustainability initiatives. Expanding broadband connectivity, improving access to reliable power supply, and developing national environmental data platforms will enhance the functionality and reliability of AI systems. Public–private partnerships can play a critical role in mobilizing resources and technical expertise, while targeted support for local technology firms and research institutions will help build a sustainable domestic AI ecosystem tailored to Nigeria's environmental challenges. Finally, Nigeria must strategically engage with global and regional governance frameworks to reduce technological dependency and protect national interests. This includes promoting fair technology transfer, safeguarding data sovereignty, and ensuring that international AI and environmental initiatives align with local sustainability priorities. Active participation in African and global AI policy dialogues will enable Nigeria to influence emerging norms and standards while fostering regional collaboration aimed at building collective capacity for environmentally sustainable and politically equitable AI development.

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