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The Institutional Foundation of AI readiness: Analysis of developing economies

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Abstract

Recognizing AI's transformative potential, a nation's capacity to adopt and integrate AI technologies is fundamentally shaped by its underlying institutional and structural environment. This study investigates the impact of institutional foundations on Artificial Intelligence (AI) readiness in developing countries using Nigeria data. The study utilized Robust Least Squares (RLS) regression model to provide empirically sound estimates by mitigating the influence of heterocsedasticity often present in time series analysis. The findings reveal a significant and positive relationship between key institutional indicators and AI readiness. Specifically, the results indicate that human capital development and regulatory quality are critical determinants of a country's preparedness for the AI era. High levels of human capital encompassing skills, education, and labor market development, suggest a greater capacity to leverage, innovate, and adapt to AI systems. Similarly, superior regulatory quality, which ensures clear, predictable, and effective policy frameworks, fosters a supportive environment for AI investment, deployment, and ethical governance. The study concludes that to significantly boost Nigeria's AI readiness and harness its potential for economic growth, policymakers must prioritize strategic investments in both talent development and the strengthening of regulatory and governance frameworks because these institutional pillars are essential prerequisites for transitioning from AI awareness to successful national AI integration.

Keyword: Institutional Foundation; AI Readiness; Human Capital Index; Regulatory Quality; Ethical Governance; Economic Growth.

1. Introduction

1.1. Background to the study

The rapid advancement of Artificial Intelligence (AI) over the past decade has transformed industries, economies, and societies globally. AI technologies (from machine learning algorithms to natural language processing) are driving innovation in sectors such as healthcare, finance, manufacturing, and agriculture (Russell & Norvig, 2021). According to a report by McKinsey & Company (2021), AI has the potential to add $13 trillion to the global economy by 2030, underscoring its economic significance. However, this AI-driven growth is not uniformly distributed. The digital divide (the gap between those who have access to digital technologies and those who do not) has widened, especially between developed and developing countries (World Bank, 2020). While high-income nations have rapidly integrated AI into their economic frameworks, many low- and middle-income countries face significant barriers, including inadequate infrastructure, limited human capital and weak institutional frameworks (UNCTAD, 2021).

According to a recent study by the International telecommunication Union (2020), the digital divide manifests in several dimensions such as: i) Access to infrastructure. This means that many developing countries lack reliable internet connectivity, which is fundamental for AI adoption. For example, while broadband penetration exceeds 80% in OECD

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countries, it remains below 30% in parts of Sub-Saharan Africa (World Bank, 2020). ii) Problem of skills gap. This means that there is a significant disparity in AI and digital literacy between the developed and developing countries, while the developed countries invest heavily in STEM education, on the other hand, many developing nations struggle with limited training opportunities (ILO, 2021). iii) Issue of data availability. This entails that, AI models require large datasets which most developing countries often have limited digital data ecosystems, hindering AI innovation (UNCTAD, 2021). And iv) Policy and regulatory frameworks. Effective governance is crucial for fostering AI growth however; many developing countries lack a comprehensive policy, which hampers their ability to leverage AI responsibly (OECD, 2021).

The Implications of the widening digital divide risks exacerbating existing inequalities, leading to a "second digital divide" where benefits of AI are concentrated among the already privileged (World Economic Forum, 2020). This dynamic threatens to leave behind the Global South in the AI economy, impacting development goals such as reducing poverty and improving health and education outcomes.

1.2. Problem Statement

Artificial Intelligence (AI) is recognized globally as a transformative tool for economic development and solving complex societal challenges. Despite Nigeria's significant potential and strategic intent to become a digital powerhouse, the nation continues to record sub-optimal levels of AI readiness, hindering the large-scale integration and utilization of AI technologies. While anecdotal evidence and sector-specific studies point to challenges in infrastructure and skills, there is a critical absence of robust, country-level empirical analysis that systematically quantifies how macro-institutional foundations, such as human capital development and regulatory quality, influence this national readiness level. Consequently, policymakers lack the precise, evidence-based understanding needed to prioritize institutional reforms that directly and effectively bridge the AI readiness gap. This study addresses this deficiency by employing a Robust Least Squares model to rigorously determine the causal effect of these foundational institutional indicators on Nigeria's AI readiness, thereby providing clear strategic direction for national policy, hence this study is profound.

1.3. Research Questions

The research questions formulated for this study are:

- -What is the effect of regulatory quality metrics on Nigeria's AI readiness?
- -What role do human capital index play in fostering AI readiness in Nigeria?
- -What strategies can Nigerian institutions adopt to enhance their AI readiness?

1.4. Significance of the study

The importance of institutions foundation in shaping AI readiness is especially critical for developing countries, where capacities and resources are often limited. Strong institutions and effective governance frameworks are essential to harness AI's potential for sustainable development, while mitigating risks and ensuring equitable benefits.

Equally, this study espouses the importance of establishing an effective regulatory quality framework. This is because developing countries need clear policies and regulations to promote AI innovation responsibly because; effective governance helps prevent misuse, bias, and ethical issues associated with AI deployment (OECD, 2021). Without this, AI adoption may be hindered by public mistrust or legal uncertainties.

As well, this study underscores the importance of building institutional capacity, because institutions must develop expertise in AI and digital policy. This includes investing in human capital, research, and infrastructure to support AI-driven growth. Inadequate institutional capacity can slow down AI adoption and limit benefits (UNCTAD, 2021).

In addition, this study elucidates on the need to enhance data governance because, for AI to be effective, access to quality data is necessary. Institutions play a vital role in establishing data privacy, security, and sharing policies. Proper data governance fosters innovation while protecting citizens' rights (World Bank, 2020).

Finally, the study underscores the need for policy makers to foster inclusive development this is because, strong governance can ensure that AI benefits are distributed equitably; reducing digital divides within and between countries. Inclusive policies can help marginalized groups access AI-driven opportunities (World Economic Forum, 2020).

2. Literature Review

2.1. The concept of institutions in relations to AI readiness

AI Readiness refers to the preparedness of a country, organization, or community to effectively adopt, implement, and leverage artificial intelligence (AI) technologies. It encompasses various dimensions, including technological infrastructure, human capital, regulatory frameworks, data ecosystems, and institutional capacity, which collectively determine how well an entity can benefit from AI innovations. The key dimensions of AI readiness includes: a) reliable internet connectivity, computing resources, and data storage capabilities which are fundamental for AI deployment (OECD, 2021). b) Availability of a skilled workforce trained in AI, data science, and related fields are crucial for developing and maintaining AI systems (World Economic Forum, 2020). c) access to high-quality, relevant datasets and policies on data privacy and sharing underpin effective AI applications (UNCTAD, 2021). d) clear policies and ethical guidelines ensure responsible AI development and build public trust (Floridi, et al., 2018). e) Strong governance structures and institutional leadership facilitate coordinated efforts in AI research, policymaking, and deployment (OECD, 2021). f) Adequate funding for research, startups, and infrastructure supports AI innovation and scaling (McKinsey & Company, 2021).

2.1.1. Institutions and AI Readiness

The concepts of institutions are fundamental to AI readiness, particularly in shaping how countries develop, adopt, and regulate artificial intelligence technologies. These frameworks determine the capacity of a country to effectively leverage AI for economic growth, social development, and ethical considerations. Institutions refer to the formal and informal rules, organizations, and norms that influence behavior within a country. In the context of AI, strong institutions provide the foundational infrastructure for innovation, data management, research, and policy implementation (OECD, 2021). They include government agencies, research bodies, regulatory authorities, and educational institutions that collectively facilitate AI development and deployment. The role of institutions in AI Readiness includes the following:

- *Policy formulation and regulation*: Institutions craft policies that foster innovation while safeguarding ethical standards (Floridi et al., 2018).
- *Capacity building:* They support research, education, and skill development necessary for AI expertise (UNCTAD, 2021).
- *Data governance*: Institutions also establish frameworks for data privacy, security, and sharing, which are critical for AI systems (World Bank, 2020).

Effective AI readiness depends on the synergy between strong institutions and robust governance structures. Institutions operationalize governance policies, translating them into actionable programs that foster innovation, ethical standards, and societal trust (OECD, 2021).

2.1.2. Challenges and opportunities in AI development and deployment in developing countries.

The development and deployment of Artificial Intelligence (AI) in developing countries presents a unique duality of formidable structural challenges and unprecedented "leapfrogging" opportunities. The Challenges of AI development in developing countries includes;

- *Limited infrastructure and digital access:* Many developing countries lack the basic digital infrastructure, such as reliable internet and electricity, which hampers AI deployment and access (World Bank, 2020).
- *Data scarcity and quality issues*: AI systems require large, high-quality datasets. Developing countries often face data scarcity, fragmentation, and quality issues, limiting AI's effectiveness (UNCTAD, 2021).
- *Skills and capacity gaps*: There is a shortage of AI experts, researchers, and skilled workforce in these countries, impeding local innovation and adoption (OECD, 2021).
- *Financial constraints*: Limited financial resources restrict investments in AI research, infrastructure, and capacity building, making it difficult to compete globally (McKinsey & Company, 2021).
- *Regulatory and governance gaps*: Many developing nations lack robust legal and ethical frameworks to govern AI, risking misuse or unethical applications (Floridi et al., 2018).
- *Risk of exacerbating inequality*: Without inclusive policies, AI could widen existing social and economic inequalities, especially if benefits are confined to urban or affluent populations (World Economic Forum, 2020).

The Opportunities of AI Development in Developing Countries includes the following:

- *Addressing local challenges*: AI can be leveraged to tackle local issues such as agriculture productivity, healthcare, education, and disaster management (UNCTAD, 2021).
- *Leapfrogging development stages*: AI offers an opportunity to bypass traditional development bottlenecks, enabling rapid growth without extensive physical infrastructure (World Bank, 2020).
- *Fostering innovation and entrepreneurship*: The AI ecosystem can stimulate local startups and innovation hubs, creating jobs and promoting technological sovereignty (OECD, 2021).
- *Enhancing public services:* AI-powered solutions can improve the efficiency and reach of public services, such as healthcare diagnostics, financial inclusion, and governance (McKinsey & Company, 2021).
- *International collaboration and funding*: Developing countries can benefit from global partnerships, technology transfers, and funding aimed at inclusive AI development (Floridi et al., 2018).
- *Promoting inclusive growth*: When strategically implemented, AI can help reduce inequalities by providing marginalized communities with access to new opportunities (World Economic Forum, 2020).

2.2. Theoretical review of institutional foundation and AI readiness

The theoretical review of institutions with respect to AI readiness explores the frameworks and models that explain how institutional structures influence the development, regulation, and deployment of AI technologies. According to Obomeghie (2025a), several theories from political science, public administration, and technology governance provide insights into the role of institutions in fostering an environment conducive to AI innovation.

2.2.1. New institutionalism

This perspective emphasizes the importance of formal rules, norms, and organizational structures in shaping policy outcomes and technological adoption. In the context of AI, strong institutions establish the legal and regulatory frameworks necessary for safe and ethical AI development. Equally, effective institutions can reduce uncertainty and transaction costs associated with AI deployment, fostering innovation and trust. (Lecours, 2005

2.2.2. Regulatory governance theory

This theory focuses on how regulatory frameworks and governance mechanisms guide technological innovation while balancing risks and benefits (Baldwin, Cave, & Lodge, 2012). AI, adaptive and forward-looking regulations are crucial. Governance structures that incorporate multi-stakeholder participation help in managing AI's ethical and societal implications (Floridi et al., 2018).

2.2.3. Institutional capacity theory

This theory highlights the importance of institutional capacity (including human resources, infrastructure, and policy tools) in enabling technological adoption (Kaufmann, Kraay, & Mastruzzi, 2010). Countries or organizations with high institutional capacity are better equipped to implement AI strategies effectively.

2.2.4. Innovation systems theory

This theory focuses on the interactions among institutions, policies, and actors that foster innovation. An innovation system with strong institutional support accelerates AI research, development, and commercialization. Policies that promote collaboration among academia, industry, and government are vital for AI readiness (World Economic Forum, 2020).

These theories collectively suggest that the strength, adaptability, and inclusiveness of institutions are fundamental determinants of AI readiness. They provide a basis for designing policies that foster innovation while safeguarding ethical standards and societal interests.

2.3. Empirical review of institutions concerning AI readiness

The empirical review of institutions concerning AI readiness highlights the critical role that robust institutional frameworks play in enabling effective AI development and deployment. Several studies and reports provide insights into how institutional quality influences a country's or organization's AI readiness. Empirical research suggests that countries with strong institutions) characterized by rule of law, regulatory quality, and government effectiveness) are better positioned to adopt and regulate AI technologies effectively. For instance, a study by Gold & Dignum, (2021) indicates that institutional strength correlates positively with AI innovation and implementation, as it provides the

necessary legal and ethical frameworks to foster trust and accountability. The development of clear regulations and ethical guidelines is essential for responsible AI deployment. Empirical analysis by Floridi, et al. (2018) emphasizes that countries with proactive governance structures that incorporate ethical considerations tend to experience higher levels of AI readiness, as they can better manage risks such as bias, privacy violations, and misuse.

Research by OECD (2021) demonstrates that government effectiveness and transparency significantly influence public trust in AI systems. Countries with effective institutions are more likely to implement AI policies that promote inclusivity and protect citizens' rights, which in turn accelerate AI adoption.

Empirical data from the World Economic Forum (2020) shows that governance quality impacts the development of innovation ecosystems by providing stable policy environments, funding mechanisms, and intellectual property protections, all of which are conducive to AI research and commercialization. According to UNCTAD, (2021), weak institutions marked by corruption, lack of transparency, and inadequate legal systems pose significant barriers to AI readiness. These barriers can hinder data sharing; undermine ethical standards, and slow regulatory processes, thereby stifling AI innovation

Overall, empirical evidence underscores that strong institutions are foundational to AI readiness. They facilitate the creation of enabling environments through regulation, ethical oversight, transparency, and capacity-building, which are essential for harnessing AI's potential responsibly and inclusively.

2.4. Research Gaps in previous studies

While there is evidence that strong institutions support AI adoption, there is a lack of comprehensive empirical studies focusing specifically on how institutional quality (e.g., regulatory capacity) impacts AI readiness in developing countries. Most existing research is concentrated on developed nations, leaving a gap in understanding regional variations.

There is a gap in research on effective strategies and frameworks for capacity-building within institutions in developing countries to manage AI risks and opportunities. Studies often focus on technological aspects rather than institutional readiness. This study intends to cover this gap using dataset from Nigeria

The role of multi-stakeholder approaches in shaping AI governance in developing countries remains underexplored. Understanding how these models function and their efficacy is crucial for inclusive AI development. This is another area this study intend to cover

Addressing these gaps requires focused empirical research to understand how institutional and human capital factors uniquely influence AI readiness in developing countries. Such insights are essential for designing contextually appropriate policies and building resilient institutional frameworks. (Obomeghie & Obomeghie, 2025a).

3. Methodology and Data

3.1. Research design

This study employs robust regression techniques, specifically the Huber M-estimator, to estimate the relationship between manufacturing growth and economic complexity in line with similar studies by Obomeghie, & Obomeghie, (2025b).

3.2. Method of data collections

Secondary data were used for the study, the data were collected from both the CBN statistical bulletin (2024) and the World Bank's World Development Indicators database (2024) covering annual data from 2003 to 2023.

3.3. The model and variables of the study.

A Robust Least Squares (OLS) regression equation with AI as the dependent variable, while human capital index and regulatory quality are the independent variables was specified as follows:

$$AI_t = \beta_0 + \beta_1 HDI_t + \beta_2 RQ_t + \epsilon_t$$

Where;

AI_t = AI readiness refers to a country's preparedness to adopt and effectively utilize artificial intelligence technologies, including having the necessary infrastructure, skills, data, and strategic plans in place. In this study both mobile subscription rate and internet usage is used as a proxy for AI readiness.

β_0 = This is the intercept term, representing the expected value of the dependent variable when all independent variables are zero.

β_1 β_2 = Refers to the slope coefficient for the first and second independent variables, indicating the change in the dependent variable associated with a one-unit change in that independent variable.

HDI_t = The Human Development Index (HDI) is a composite statistical measure used to assess and compare the overall level of human development across different countries. It considers three fundamental dimensions, Health, Education and standard of living. The HDI provides a single score between 0 and 1, with higher values indicating higher levels of human development. It helps to evaluate and compare the social and economic progress of nations beyond just income levels.

RQ_t = Regulatory quality refers to the ability of a country's government to formulate and implement sound policies and regulations that promote sustainable economic growth, protect property rights, ensure fair competition, and effectively manage risks. It reflects the strength and effectiveness of the regulatory framework in facilitating a stable and predictable business environment

$\epsilon_{t=}$ This is the error term.

The little 't' subscript at the end of each variable refers to time subscript.

The analytical framework for the study are hypothesizes in the table 1 below;

Table 1 Hypothesized analytical framework

Variable	Expected sign	Rational
HDI	Positive (+)	High human capital support the development of an environment that is favorable to AI through innovation and health expenditure. (UNDP, 2021)
RQ	Positive (+)	Well defined regulatory framework positively impact AI readiness by reducing uncertainties and providing clear guidelines (WEF 2021)

Source; Authors compilation.

3.4. Justification of the preferred method.

The robust regression method is preferred in this study because; OLS is highly sensitive to outliers. Even a few extreme data points can disproportionately influence the OLS regression result, leading to biased coefficient estimates and misleading conclusions. Robust regression methods down-weight the influence of outliers, providing a model that better fits the analysis. Also, robust regression techniques, like Huber-White standard errors, can provide consistent standard error estimates even in the presence of heteroscedasticity. Robust regression methods also directly address heteroscedasticity in the estimation process.(Pervez & Ali, 2024).

4. Results and discussions

The results of our robust regression estimates are presented and discussed in the tables below.

From table 2 which represents the descriptive statistics, it can be seen that the AI has the highest mean with a value of 59.92629 while RQ has the lowest mean with a value of -0.907021. Again, AI has the highest standard deviation with 31.20567 while HDI has the lowest standard deviation with 0.032025.

Table 2 Descriptive statistics

	AI	HDI	RQ
Mean	59.92629	0.505238	-0.907021
Median	70.28300	0.504000	-0.894972
Maximum	99.85800	0.560000	-0.681769
Minimum	2.296000	0.449000	-1.292818
Std. Dev.	31.20567	0.032025	0.164147
Skewness	-0.514708	0.017277	-0.830456
Kurtosis	2.000905	1.812626	3.189865
Jarque-Bera	1.800653	1.234669	2.445342
Probability	0.406437	0.539380	0.294443
Sum	1258.452	10.61000	-19.04743
Sum Sq. Dev.	19475.88	0.020512	0.538887
Observations	21	21	21

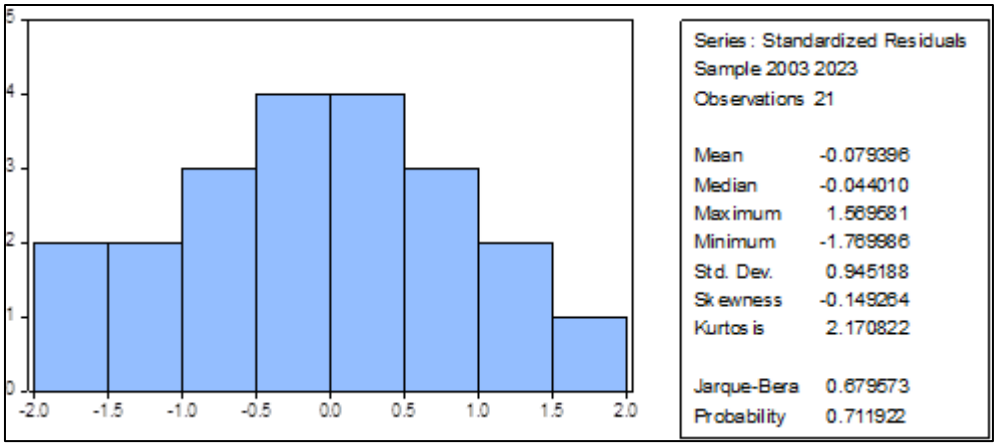
Source; Authors computation using E-view econometric packages

Table 3 Summary of panel unit root test

Variable	Order	AADF test	5% critical value	Conclusion
D(AI)	1 (1)	-5.391839 (0.0004)	-2.86	Stationary
D (HDI)	1 (1)	-6.043466 (0.0001)	,,	Stationary
D (RQ)	1 (1)	-4.685098 (0.0019)	,,	Stationary

Source; Authors computation using E-view econometric packages

From table 3 which depicts the stationarity test using the ADF test, it can be seen that all our variables are stationary at first difference.



Source; Authors computation using E-view econometric packages

Figure 1 Normality test

Figure 1 depict the normality test which indicates that the `distribution is normally distributed with a Jarque-Bera value of 0.679573 and a probability value of 0.711922

Table 4 Robust Least square estimates

Dependent Variable: AI				
Method: Robust Least Squares				
Method: M-estimation				
M settings: weight=Bisquare, tuning=4.685, scale=MAD (median centered)				
Huber Type I Standard Errors & Covariance				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
HDI	944.8591	61.58255	15.34297	0.0000
RQ	27.27402	12.01464	2.270066	0.0232
C	-393.1469	32.87598	-11.95848	0.0000
	Robust Statistics			
R-squared	0.757663	Adjusted R-squared		0.730736
Rw-squared	0.949169	Adjust Rw-squared		0.949169
Akaike info criterion	26.01555	Schwarz criterion		30.33157
Deviance	1162.057	Scale		7.403995
Rn-squared statistic	239.6123	Prob(Rn-squared stat.)		0.000000
	Non-robust Statistics			
Mean dependent var	59.92629	S.D. dependent var		31.20567
S.E. of regression	9.067334	Sum squared resid		1479.898

Source; Authors computation using E-view econometric packages

4.1. Interpretation

The model explains about 94.92% of the variance in the outcome variable, which indicates a very strong explanatory power. The high statistical significance (p-value < 0.0001) confirms that the model's explanatory variables collectively have a significant relationship with the dependent variable. This shows that the model is both a good fit and statistically meaningful.

The coefficient for HDI is approximately 944.86, which indicates that for each unit increase in HDI, the AI increased by about 944.86 units, holding RQ constant. The p-value associated with HDI is less than 0.0001, which is highly statistically significant. This further indicates that, higher levels of HDI are strongly associated with higher AI readiness, suggesting that improvements in human development are linked to increases in AI readiness.

The coefficient for regulatory quality is approximately 27.27, indicating that for each unit increase in regulatory quality, AI increases by about 27.27 units, holding HDI constant. The p-value for regulatory quality is 0.0232, which is less than the conventional significance level of 0.05, indicating that this relationship is statistically significant. This means that regulatory quality has a positive and significant association with AI readiness, although the effect size is smaller compared to that of HDI. Overall, both variables are statistically significant predictors of AI readiness in the model. The very small p-values indicate that these relationships are unlikely to be due to random chance.

The magnitude of the coefficients suggests that HDI has a much larger impact on AI compared to regulatory quality. The model's robustness (using robust regression) suggests that these estimates are reliable even if there are violations of heteroskedasticity assumption.

5. Conclusion

The findings of the analysis indicate a significant positive association between Human Development Index (HDI) and AI readiness in Nigeria. Specifically, higher levels of human development are associated with increased preparedness for artificial intelligence adoption and integration. This imply that advancements in human development create a conducive environment for AI readiness, likely due to better infrastructure, skilled human capital, and increased technological awareness.

These results are consistent with global research emphasizing the importance of human development in fostering technological innovation and AI deployment. (Behera, et, al. 2025).

On the other hand, the analysis indicates that regulation quality plays a vital role in enhancing AI readiness in Nigeria. A significant positive relationship suggests that improvements in regulatory frameworks can facilitate the development and deployment of AI technologies, fostering innovation, investment, and trust among stakeholders (World Economic Forum, 2020). Given Nigeria's emerging digital economy, strengthening regulation quality could serve as a catalyst for integrating AI solutions across various sectors, thereby supporting sustainable economic growth and technological advancement (Anamoji, 2024). This finding further aligns with global evidence emphasizing the importance of robust regulatory environments in AI adoption (OECD, 2021).

5.1. Policy recommendations for enhancing AI readiness in Nigeria

Nigeria government should invest in education and skill development, this is because improving literacy, technical skills, and higher education enhances human capital, which is crucial for AI adoption and innovation. This can be achieved through the expansion of Science, Technology, Engineering, Mathematics, (STEM) education at all levels, promote vocational training in digital skills, and support lifelong learning programs.

Also, Nigeria policy makers should strengthen digital infrastructure because adequate infrastructure, including internet connectivity and electricity, is fundamental for AI deployment. This can be achieved through investment in nationwide broadband expansion, reliable power supply, and data centers to create an enabling environment for AI technologies.

As well, policy managers in Nigeria have to promote policies that support innovation and research. This is because, encouraging research and development (R&D) fosters local AI solutions tailored to Nigeria's unique challenges. This may be achieved through the provision of grants, tax incentives, and establish innovation hubs to stimulate AI research and startups.

With respect to regulatory quality, Nigeria policy makers are advised to strengthen its regulatory frameworks to boost AI readiness. This is because, enhancing regulation quality can serve as a catalyst for increasing AI readiness among Nigerian businesses, government agencies, and educational institutions. This can be attained through ensuring AI benefits reach all segments of society, including underserved regions.

In summary, Prioritizing investments in education, infrastructure, innovation policies, ethical frameworks, and inclusive development can significantly enhance Nigeria's AI readiness. These strategies will leverage the positive association between human development and AI readiness, fostering sustainable economic growth and societal progress. In Nigeria, improving regulation quality appears to directly enhance AI readiness. Obomeghie, & Asekomhe, (2025). Therefore, policymakers should prioritize developing comprehensive, transparent, and adaptable regulatory frameworks, invest in capacity building, foster multi-stakeholder engagement, and embed ethical considerations into AI policies. These steps can accelerate AI adoption, leading to higher economic growth and societal benefits.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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