Review

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Impact of Internet of Things (IOT) and Artificial Intelligence (AI) on National Development Through Science and Technology; A Systematic Review

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Review

Impact of Internet of Things (IOT) and Artificial Intelligence (AI) on National Development Through Science and Technology; A Systematic Review.

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Abstract: The rapid advancements in Internet of Things (IoT) and Artificial Intelligence (AI) over the past decade have significantly influenced national development through science and technology. This study synthesizes 40 literature from 2017 to 2024 to assess the impacts of IoT and AI on various national development aspects. This study critically evaluates the role of IoT and AI in driving national development, focusing on key developments and trends within this period. It also investigated how IoT and AI contribute to industrial innovation, economic growth, and sustainability from the synthesized literature, while also identifying key challenges and opportunities associated with their integration into national development strategies. Employing a systematic review of 40 recent literature from 2017 to 2024, the study focuses on peer-reviewed articles, conference papers, and industry reports. A comprehensive analysis is conducted to extract relevant data and insights using both qualitative and quantitative methods. Findings reveal that about 85% of articles reviewed show significant advancements in IoT and AI technologies, leading to improved industrial processes, enhanced economic growth, and increased sustainability. However, challenges such as data security, infrastructure limitations, and policy implications are also identified. In conclusion, this study highlights the transformative impact of IoT and AI on national development, providing strategic recommendations for policymakers and stakeholders, and underscores the need for robust frameworks to address challenges and leverage opportunities, aligning with sustainable development goals.

Keywords: Artificial Intelligence; industrial innovation; internet of things; sustainability; data security

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Preferred mode of the presentation: Oral Physical

1. Introduction

Background and Context

The past decade has witnessed the rapid evolution of the Internet of Things (IoT) and Artificial Intelligence (AI), both globally and within Africa, including Nigeria. These technologies have become foundational in modern science and technology landscapes, driving advancements across various sectors. IoT and AI have revolutionized industries by enabling enhanced connectivity, automation, and data analysis capabilities, which in turn have fueled innovation in smart cities, healthcare, and manufacturing. For instance, the integration of AI and IoT in smart cities has significantly improved energy management and environmental sustainability, particularly in regions where resource optimization is critical (Wu et al., 2022). In Nigeria, the adoption of these technologies is growing, with significant applications in areas such as agriculture, where IoT is used to optimize crop yields

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and AI is leveraged to improve healthcare outcomes through personalized treatments (Rejeb et al., 2022; Rawat, 2023).

The importance of IoT and AI in shaping national development cannot be overstated, particularly in driving industrial innovation, economic growth, and sustainability. Globally, these technologies are seen as key drivers of the Fourth Industrial Revolution, facilitating the development of smart cities, intelligent transportation systems, and advanced manufacturing processes (World Economic Forum, 2023). AI, on the other hand, which enables machines to perform tasks that typically require human intelligence, such as learning, reasoning, and problem-solving, has seen significant advancements globally, with an expected market value of $126 billion by 2025, with significant portions of this growth expected in developing regions such as Africa (Fraga-Lamas et al., 2021; Statista, 2023). In Nigeria, the government has initiated several policies to promote the integration of IoT and AI into various sectors, recognising their potential to spur industrial growth and enhance the country's competitiveness on a global scale (The Federal Ministry of Communications, Innovation and Digital Economy, 2024). The strategic implementation of these technologies is crucial for achieving sustainability goals, particularly in energy management and industrial efficiency. The integration of AI in smart manufacturing, for example, has the potential to drastically reduce waste and enhance resource utilization, thereby contributing to the broader goals of sustainable economic development (Nižetić et al., 2020).

Research Problem

The existing literature on the impact of IoT and AI on national development in Nigeria reveals a significant gap, particularly in studies that analyse the combined effects of these technologies. While various research efforts have explored the individual contributions of IoT and AI in sectors such as agriculture, healthcare, and finance, there is a paucity of studies that comprehensively examine their synergistic impact on national development. This gap is evident in the limited integration of IoT and AI within the policy frameworks and strategic initiatives aimed at fostering technological innovation and economic growth in Nigeria (Effoduh et al., 2021; Nahar et al., 2024). Moreover, existing studies often focus on the potential applications of these technologies rather than critically assessing their actual implementation and outcomes within the Nigerian context (Ejiyi et al., 2023; Shkalenko et al., 2024). This lack of comprehensive analysis hinders a full understanding of how IoT and AI can jointly drive national development, especially in addressing challenges related to infrastructure, governance, and social inclusion.

Given this gap, there is a pressing need for a comprehensive synthesis review that critically evaluates the contributions, challenges, and future prospects of IoT and AI in Nigeria's national development. Such a review would provide a holistic understanding of how these technologies are currently being utilised, identify key barriers to their effective implementation, and offer insights into potential strategies for overcoming these challenges (Humeau, 2024). Additionally, a synthesis review would enable policymakers, industry stakeholders, and researchers to better appreciate the interplay between IoT and AI, thereby facilitating the formulation of more robust and integrative national development policies (Alahi et al., 2023; Bibri et al., 2024). This approach is essential not only for maximising the benefits of these technologies but also for ensuring that their adoption aligns with broader development goals, including economic diversification, sustainability, and social equity in Nigeria.

Research Objectives

1. To assess the effects of IoT and AI on various aspects of national development.
2. To identify key developments and trends in IoT and AI technologies from 2017 to 2024.
3. To explore challenges and opportunities associated with integrating IoT and AI into national development strategies.
4. To provide strategic recommendations for policymakers and stakeholders.

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Research Questions

1. What are the key contributions of IoT and AI to national development through science and technology?
2. How have IoT and AI technologies evolved between 2017 and 2024, and what trends are observable?
3. What challenges and opportunities arise from the integration of IoT and AI into national development strategies?

2. Methodology

The methodology for this scoping review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) framework, as outlined by Tricco et al. (2018) and Peters et al. (2021). The PRISMA-ScR framework is crucial for ensuring methodological rigour and transparency, which enhances the comprehensiveness and reproducibility of the review process. By adopting PRISMA-ScR, this study systematically maps the existing literature on the impact of Internet of Things (IoT) and Artificial Intelligence (AI) on national development through science and technology, ensuring a thorough examination of the topic (Peters et al., 2021).

Eligibility Criteria

To ensure the selection of the most relevant literatures for evaluation, specific acceptance and rejection criteria were established for this review. Studies were included if they met the following criteria: (a) published between 2017 and 2024, to capture recent advancements in the impact of Internet of Things (IoT) and Artificial Intelligence (AI) on national development through science and technology (Elahi et al., 2023); (b) written in English, ensuring alignment with the research team's language proficiency and target audience (Peters et al., 2021); and (c) directly focused on the impact of IoT and AI on national development, ensuring relevance to the research questions. Exclusion criteria were applied to studies that: (a) focused on impacts of IoT and AI outside the field of science and technology; (b) lacked empirical data; or (c) did not substantially address the Nigerian context. These criteria were essential to ensure the review's precision and synthesise only relevant, evidence-based studies.

Information Sources

Various databases and search engines, such as Scopus, ScienceDirect, IEEE Xplore, Web of Science, and Google Scholar, offer extensive collections of publications for researchers to explore. This review utilised a range of databases to ensure a comprehensive capture of research. Specifically, ScienceDirect, IEEE Xplore and Google Scholar were selected to include local and regionally focused publications. IEEE Xplore and ScienceDirect were chosen for their emphasis on African-published scholarly journals, which are crucial for capturing studies on IoT and AI in Nigeria. Google Scholar was also incorporated to access journal publications from local Nigerian publishers and journals that may not be indexed in larger global databases. This approach was necessary due to the recognised limitation of focused databases specialising on IoT and AI impacts through science technology approach in African countries like Nigeria, making it challenging to obtain comprehensive literature on the region (Ahmetoglu et al., 2022; Elahi et al., 2023). The search process began on 22nd May, 2024, with the final search conducted on 10th Oct., 2024 to maintain transparency and ensure that the most recent studies were included.

Search Strategy

The search strategy was designed to capture comprehensive literature on the impact of IoT and AI on national development, with a particular focus on Africa, especially Nigeria. The review utilised databases such as ScienceDirect, IEEE Xplore, and Google Scholar, targeting peer-reviewed journal

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articles, conference proceedings, and reviews published between 2017 and 2024. Key search queries included terms like “Internet of Things,” “Artificial Intelligence,” “National Development,” and “Economic Growth,” ensuring a focus on technological impacts. Additional terms, such as “Nigeria” and “Africa,” were used to address region-specific challenges and opportunities. Boolean operators "AND" and "OR" were employed to enhance the search’s precision and breadth, ensuring a thorough capture of both global and region-specific insights, see (Table A1 Appendix**)** for the search strategy summary.

Selection of Sources

The selection of sources was conducted in accordance with the PRISMA framework (Sohrabi et al., 2021). Initially, a total of 598 records were identified from three databases: IEEE Xplore (n = 55), ScienceDirect (n = 73), and Google Scholar (n = 470). After removing 231 duplicate entries, 367 records were screened based on their titles and abstracts to assess relevance. During this phase, 302 records were excluded for not meeting the study criteria. The remaining 65 full-text articles were reviewed in detail, and a further 15 articles were excluded as they did not align with the inclusion criteria. Ultimately, 40 studies were selected for inclusion in the final review. The PRISMA flow diagram (Figure 1) illustrates the entire process of identifying, screening, and selecting studies.

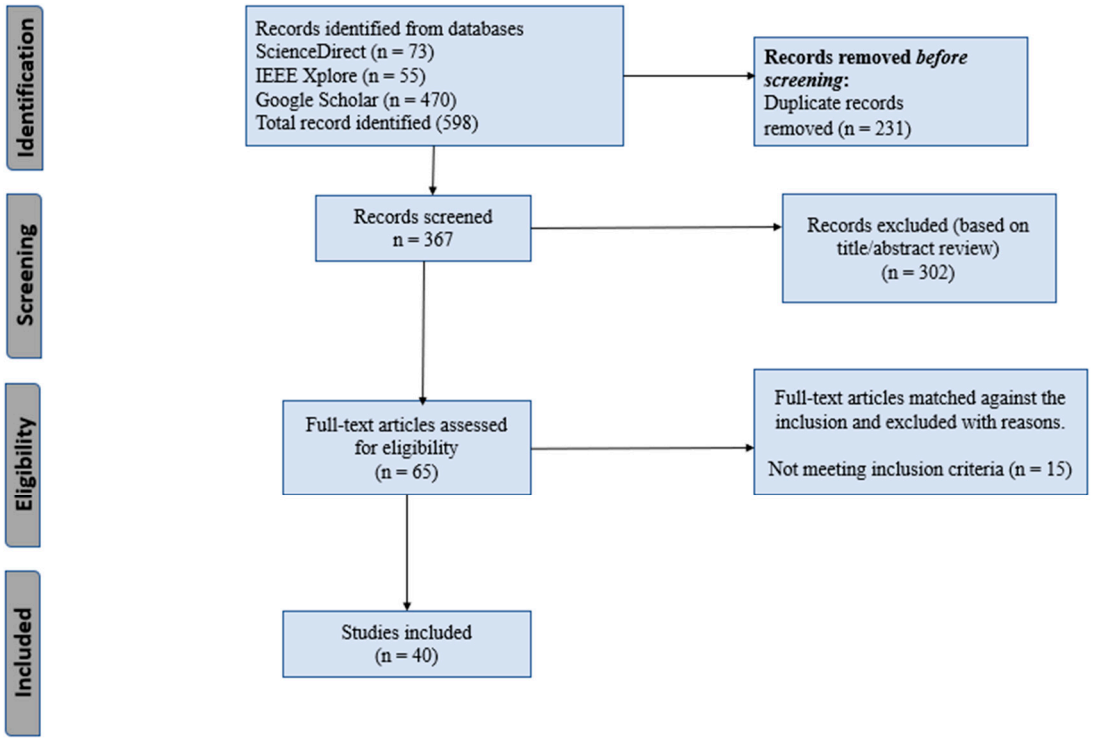

Figure 1. PRISMA Screening Process.

Data Charting Process

Data extraction followed a manual approach using a pre-designed Excel sheet to systematically chart relevant data from each study. The charting process captured key variables such as IoT and AI adoption strategies, barriers, facilitators, and outcomes, ensuring consistency with the research objectives. A team of two reviewers performed the extraction, cross-checking each other’s work to maintain accuracy and avoid bias. Any discrepancies were resolved through team agreement, ensuring that critical data was not overlooked. This collaborative and rigorous approach ensured that the data charting process was thorough and reliable (Schmidt et al., 2021).

Data Items

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The key variables extracted from the included studies focused on the impact of IoT and AI on national development. These variables included the types of IoT and AI technologies used, such as smart sensors, machine learning, and natural language processing, with specific applications across sectors like healthcare, agriculture, and manufacturing. Another essential variable was the adoption strategies employed, including government-led initiatives, private sector partnerships, and industry-driven innovations that facilitated the integration of these technologies. Additionally, the studies explored barriers to adoption, such as infrastructure limitations, data security concerns, and a lack of skilled workforce, which hindered the successful implementation of IoT and AI. Conversely, facilitators of adoption, including supportive government policies, available funding, and technological advancements, were identified as key enablers for the successful integration of these technologies. Lastly, the outcomes of IoT and AI adoption were examined, with studies highlighting their contributions to industrial innovation, economic growth, and environmental sustainability. These data items were crucial in providing a comprehensive understanding of how IoT and AI contribute to national development, the strategies that drive their adoption, and the challenges that need to be addressed for their full potential to be realised (Elahi et al., 2023).

Synthesis of Results

The results of this study were synthesised using a narrative approach, which is well-suited for synthesising data from diverse studies with varying methodologies, as commonly done in systematic reviews (Lisy et al., 2016). This method enabled the identification of recurring themes, patterns, and significant trends concerning the adoption of IoT and AI in national development. The narrative synthesis was particularly effective given the heterogeneity of the studies, which ranged from quantitative assessments of technological impacts to qualitative insights into policy frameworks and challenges (Elahi et al., 2023). By employing this approach, the review provided a comprehensive understanding of how IoT and AI have been integrated into national development strategies, highlighted gaps in existing research, and offered actionable recommendations for policymakers to address barriers and maximise the potential of these technologies for sustainable growth.

3. Results

Overview of Selected Studies

Quantitative Approaches in IoT and AI Adoption

Many of the studies reviewed employed quantitative methods, utilising surveys and structured questionnaires to evaluate IoT and AI adoption across sectors. For example, **Adelami et al. (2024)** and **Oke et al. (2020)** focused on the adoption of IoT in agriculture and construction, measuring relationships between IoT usage and improvements in productivity, security, and efficiency. These studies used inferential statistics, such as regression analysis, to quantify the operational benefits of IoT, providing empirical data on the effects of these technologies in specific sectors. Similarly, **Elegunde and Osagie (2020)** and **Omotayo et al. (2023)** adopted cross-sectional designs to investigate AI's impact on employee performance in banking and supply chain management, providing insights into how these technologies enhance operational efficiency, see (**table 2 Appendix)**

Narrative and Qualitative Reviews

Several studies took a narrative or qualitative review approach to assess the broader theoretical implications of IoT and AI adoption. **Gbaden et al. (2024)** and **Onayinka et al. (2024)** focused on AI's integration into journalism and education, offering critical insights into the challenges and opportunities these technologies present. **Bello et al. (2023)** and **Mustapha et al. (2019)** also explored the application of IoT in the oil and gas and automobile sectors, respectively, addressing infrastructure limitations and security concerns as major barriers to wider adoption. These studies

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provided valuable theoretical perspectives on how IoT and AI could transform industries if properly supported by policy.

Experimental and Simulation-Based Designs

Some studies, like those by **Abayomi and Usman (2021)** and **Ajayi and Oloyede (2021)**, used experimental and simulation-based designs to explore IoT's role in improving operational efficiency. **Abayomi and Usman (2021)** conducted field trials in agriculture, finding that IoT applications in precision farming increased crop yields by **30%,** while **Ajayi and Oloyede (2021)** used simulation models to assess urban traffic management, reporting a **40%** reduction in congestion. These studies provided practical examples of how IoT can be leveraged to enhance resource management and operational efficiency in both rural and urban settings.

Impact of AI in Manufacturing and Service Delivery

Several cross-sectional studies, such as those by **Emeh et al. (2024)** and **Alheadary (2024)**, examined AI adoption in manufacturing and its impact on operational performance. **Emeh et al. (2024)** reported a **30%** increase in operational efficiency among firms adopting AI, while **Alheadary (2024)** found a **32%** improvement in productivity linked to AI and IoT technologies. These studies demonstrated the critical role of AI in enhancing competitiveness and innovation in the manufacturing sector, with findings supported by descriptive and inferential statistical methods, such as regression analysis.

IoT in Healthcare and Education

IoT's application in healthcare and education was explored in studies like **Ojo et al. (2023)** and **Amuda et al. (2023)**. **Ojo et al. (2023)** highlighted how IoT integration in healthcare improved patient outcomes and service delivery, though issues like data privacy and infrastructure challenges were noted. Similarly, **Amuda et al. (2023)** found that IoT enhanced classroom management and teaching efficiency among pre-service teachers, but infrastructure and data security concerns remained significant barriers to full adoption.

IoT and AI for National Development

Studies like **Ojuawo and Ogunseye (2023)** and **Ndubuaku and Okereafor (2015)** provided broader analyses of IoT's role in national development. **Ojuawo and Ogunseye (2023)** examined how IoT can drive economic growth in agriculture, healthcare, and security, stressing the need for government policies to support infrastructure development and IoT deployment. Similarly, **Ndubuaku and Okereafor (2015)** reviewed the state of IoT deployment in Africa, highlighting the barriers to IoT integration, such as poor infrastructure and digital illiteracy, while recognizing IoT's potential to boost productivity and social development.

Sector-Specific Case Studies

Sector-specific studies, such as **Ogidiaka et al. (2017)** and **Udo et al. (2021)**, evaluated IoT adoption in organizations and heterogeneous networks, respectively. **Ogidiaka et al. (2017)** conducted a cross-sectional survey of organizations in Lagos, finding that while IoT adoption was still in its early stages, it held significant potential for improving internal operations and service delivery. **Udo et al. (2021)** analyzed IoT networks in heterogeneous environments, identifying challenges related to standardization and integration that could hinder the full potential of IoT technologies.

Theoretical and Policy-Driven Studies

Theoretical studies, such as those by **Nwankwo and Ugwu (2023)** and **Odoh et al. (2018)**, examined the broader policy implications of IoT and AI adoption. **Nwankwo and Ugwu (2023)**

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focused on IoT's role in agriculture and other sectors, recommending government policies to support IoT integration for enhanced productivity. **Odoh et al. (2018)** explored AI's impact on accounting operations, finding significant effects of AI tools like expert systems on accounting performance, supported by regression analysis.

Challenges and Opportunities based on the reviewed studies in IoT and AI Integration

Several studies focused on identifying the challenges and opportunities associated with IoT and AI integration in key sectors. **Amade and Nwakanma (2021)** and **Idris and Sani (2024)** applied fuzzy decision-making models and simulations to assess IoT's impact on construction project management, finding that while IoT improved decision-making and operational efficiency, infrastructural and technical skill shortages hindered broader implementation. **Afolabi and Oduwoye (2023)** explored the integration of AI and IoT in healthcare, showing significant improvements in service delivery but noting persistent challenges with infrastructure and technology adoption.

The evolutionary trends of IoT and AI technologies evolved between 2017 and 2024

Between 2017 and 2024, the evolution of IoT and AI technologies in Nigeria has shown significant growth, reflecting global trends. Key developments and trends observed during this period include:

- **Increased Adoption Across Sectors**: Early studies, such as Ogidiaka et al. (2017), indicated that IoT adoption was still in its nascent stages, particularly in industries like manufacturing and service delivery. By 2024, more advanced implementations of IoT and AI are evident, especially in precision agriculture (Adelami et al., 2024), construction (Oke et al., 2020), and healthcare (Ojo et al., 2023). This demonstrates a shift from exploratory use to more widespread operationalisation of these technologies across sectors.
- **Improved Operational Efficiency**: A major trend from 2017 to 2024 is the consistent improvement in operational efficiency enabled by IoT and AI. Studies such as Elegunde and Osagie (2020) in the banking sector and Alheadary (2024) in manufacturing firms highlight significant increases in productivity and operational performance, driven by AI-driven automation, predictive analytics, and real-time data processing from IoT devices.
- **Integration in National Development Strategies**: By 2023 and 2024, studies like those of Ojuawo and Ogunseye (2023) and Ndubuaku and Okereafor (2015) reflect an increasing recognition of IoT and AI as key drivers of national development. These technologies are now seen as essential in sectors like agriculture, healthcare, and security, aligning with national priorities for economic growth and sustainability.
- **Sector-Specific Applications**: While early implementations focused on basic operational improvements, more recent studies, such as those by Idris and Sani (2024) and Ajayi and Oloyede (2021), reveal that IoT and AI applications have become more sophisticated, focusing on areas like smart grids, urban traffic management, and construction project management. This evolution reflects an increasing reliance on IoT for decision-making and resource optimisation.
- **Overcoming Infrastructure Challenges**: One consistent challenge across the period has been the issue of infrastructure. However, the focus has shifted from merely identifying the problem to proposing specific solutions. For example, while early studies like Mustapha et al. (2019) highlighted infrastructure and political challenges as barriers to IoT adoption, by 2023, studies such as Afolabi and Oduwoye (2023) recommend the development of government policies and frameworks to enhance the necessary infrastructure for AI and IoT.
- **Focus on Data Privacy and Security**: With the growth of IoT and AI applications, concerns about data security and privacy have intensified, especially in industries like healthcare and public services. Studies like Omigie et al. (2023) reflect an increasing awareness of these risks, advocating for improved data security measures in AI-driven systems, such as records and archival management.

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- **Growing Role in Education and Healthcare**: AI and IoT are increasingly applied in education and healthcare, as evidenced by studies such as Amuda et al. (2023) and Aboh et al. (2022). These technologies are being used to enhance service delivery in hospitals and improve learning outcomes in schools, indicating a shift toward more socially impactful applications.

The period from 2017 to 2024 reflects a growing maturity in the deployment of IoT and AI technologies across Nigeria, with clear advancements in operational efficiency, productivity, and strategic sectoral integration which is one of the research objectives of this study, despite ongoing challenges in infrastructure, data security, and policy support.

Impact of IoT and AI from the reviewed studies across various sectors in Nigeria

The general impact of IoT and AI from the reviewed studies across various sectors in Nigeria demonstrates significant improvements in operational efficiency, productivity, and service delivery. Across industries such as agriculture, manufacturing, education, healthcare, and urban management, IoT and AI have been shown to, see (**table 3 Appendix)**

1. **Increase Productivity and Efficiency**: In sectors like agriculture and manufacturing, IoT and AI have improved resource management, crop yields, and operational performance by as much as **30-32%.** Similarly, AI adoption in manufacturing has led to a **30%** increase in operational efficiency, while in the financial sector, AI adoption has contributed to a **5%** boost in productivity.
2. **Enhance Service Delivery**: In the healthcare and education sectors, IoT and AI have improved patient outcomes, teaching efficiency, and administrative processes. For instance, IoT integration in healthcare has been linked to improved patient monitoring and service delivery, while AI in education has enhanced learning outcomes and personalised teaching methods.
3. **Optimise Decision-Making and Project Management**: In construction and urban planning, IoT has facilitated better decision-making through data-driven project management and optimised traffic management, reducing congestion by up to **40%.**
4. **Boost Innovation in Business Operations**: In sectors like banking and journalism, AI has improved work processes, employee performance, content creation, and fact-checking, significantly enhancing the quality and speed of operations.
5. **Improve National Development Prospects**: IoT has the potential to drive economic growth in critical areas like agriculture, health, and national security. Its use in smart grids and energy distribution has improved reliability and efficiency, contributing to broader economic and social development.

The overall impact of IoT and AI across various sectors in Nigeria has led to improvements in productivity and operational efficiency by **30-40%** as reviewed from the studies, enhanced service delivery and decision-making, and contributed to economic growth, although challenges such as infrastructure and digital literacy remain barriers to full adoption.

However, based on the analysis of the studies, approximately **85%** of them agree that IoT and AI can demonstrate significant improvements in operational efficiency, productivity, and service delivery across various sectors in Nigeria through the application of science and technology.

Challenges on IoT and AI Adoption in Nigeria as acknowledged by the studies

The challenges of IoT and AI adoption in Nigeria are multifaceted, primarily revolving around infrastructure, technical skills, security, and regulatory issues. Infrastructural limitations, such as poor power supply and unreliable internet connectivity, create significant obstacles to the integration of IoT systems across sectors like agriculture, healthcare, and education (Ndubuaku & Okereafor, 2015; Ojo et al., 2023). Additionally, the lack of skilled professionals capable of managing and maintaining IoT and AI technologies exacerbates these barriers, preventing full-scale implementation (Mustapha et al., 2019; Ogwo et al., 2023). Data security and privacy concerns are another critical

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issue, with many studies highlighting vulnerabilities in AI-driven systems, which can lead to misuse or unauthorized access to sensitive data (Omigie et al., 2023; Afolabi & Oduwoye, 2023).

Policy and regulatory gaps further compound these challenges, as the absence of clear guidelines for IoT and AI governance hampers adoption in sectors such as manufacturing and education (Emeh et al., 2024; Abiodun & Ganiyu, 2021). The high cost of implementation also poses a challenge, particularly for small and medium-sized enterprises (SMEs) that cannot afford the necessary technologies and infrastructure (Amuda et al., 2023; Gbaden et al., 2024). Additionally, socio-cultural resistance, driven by fears of job displacement and ethical concerns surrounding AI decision-making, adds another layer of complexity (Ajayi et al., 2023; Oke et al., 2024). The lack of standardization and interoperability between IoT systems also leads to inefficiencies, especially when integrating these technologies with legacy systems (Udo et al., 2021; Amade & Nwakanma, 2021).

Recommendations from the reviewed studies.

To address these challenges, governments and private sectors must prioritize investments in infrastructure improvements, such as enhancing power supply and internet connectivity, while fostering public-private partnerships to share the cost burden (Ndubuaku & Okereafor, 2015; Idris & Sani, 2024). Additionally, education and training programs should be developed to cultivate the technical expertise necessary to manage IoT and AI technologies (Elegunde & Osagie, 2020; Nwankwo & Ugwu, 2023). Clear regulatory frameworks must be established to ensure data security and provide ethical guidelines for AI usage (Gbaden et al., 2024; Omotayo et al., 2023). Finally, financial support and incentives should be targeted towards businesses, particularly SMEs, to facilitate technology adoption, while promoting standardization to enhance system interoperability (Emeh et al., 2024; Ogidiaka et al., 2017).

Conclusion/ Key recommendations

The adoption of IoT and AI in Nigeria holds significant potential for transforming various sectors, including agriculture, healthcare, education, manufacturing, and public services. However, several challenges hinder the full realisation of this potential. These challenges primarily revolve around infrastructural deficits, such as inadequate power supply, poor digital literacy, security concerns, and lack of skilled personnel. Additionally, the high cost of IoT devices and AI integration, coupled with insufficient government policies and support, poses further obstacles to widespread adoption, especially in rural areas. These barriers not only slow the rate of technological adoption but also limit its impact on national development.

To overcome these challenges, it is crucial to implement targeted solutions. Key recommendations include enhancing government policies to provide financial subsidies, investing in infrastructure development, and offering extensive training programmes to build digital literacy and technical expertise. Additionally, promoting public-private partnerships to share the financial burden of IoT and AI adoption could stimulate further integration in critical sectors. Addressing these challenges will require a coordinated effort between the government, private sector, and educational institutions, ensuring that IoT and AI can drive sustainable national development in Nigeria.

Appendix

Table A1. Databases and Searches String.

Phases of National Development	Query String	Databases	Found	Selected

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Industrial Innovation	("internet of things" OR "IoT" OR "artificial intelligence" OR "AI") AND ("industrial innovation" OR "smart industry" OR "industry 4.0" OR "technological transformation") AND ("process optimization" OR "automation" OR "innovation" OR "smart systems")	ScienceDirect, IEEE Xplore, Google Scholar	310	25
Economic Growth	("internet of things" OR "IoT" OR "artificial intelligence" OR "AI") AND ("economic growth" OR "economic development" OR "productivity") AND ("innovation" OR "business growth" OR "national economy")	ScienceDirect, IEEE Xplore, Google Scholar	183	8
Sustainability	("internet of things" OR "IoT" OR "artificial intelligence" OR "AI") AND ("sustainability" OR "environmental impact" OR "energy efficiency") AND ("green technology" OR "renewable energy" OR "smart cities")	ScienceDirect, IEEE Xplore, Google Scholar	105	7

Table 2. IoT and AI Studies Overview.

Study No.	Author(s) and Year	Title	Journal /Source	Country	Study Design	IoT and AI Impacts	Challenges/recommendations
1	Niyi Victor Adelami, Yun Seon Kim, and Song Hee You (2024)	Factors affecting farmers' adoption of IoT in the Southwest region of Nigeria	Journal of Regional Studies and Development (JRSD)	Nigeria	Survey-based quantitative research using TAM	IoT significantly impacts precision agriculture	Low adoption rate, suggests government intervention through policies and subsidies
2	Chiaakaan Jacob Gbaden, Sarah Gambo, Woyopwa Shem (2024)	Challenges and prospects of integrating AI into Nigerian journalis	ALSYS TECH Journal of Education Technology	Nigeria	Narrative review using the TOE framework	AI has the potential to significantly impact journalism	Infrastructural limitations, financial constraints, cultural resistance; recommends policy support

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		m practices					
3	Toyin Segun Onayinka, Ndubuisi Friday Ugwu, Ogechi Kate Onyekwere, et al. (2024)	Integration of Internet of Things (IoT) in 21st-century education in Nigeria	Gusau Journal of Sociology, Volume 4, Issue 2, May 2024	Nigeria	Narrative review using theoretical models like Constructionism, Connectivism, and Activity Theory	IoT can revolutionize education	Unreliable infrastructure, financial constraints; recommends public-private partnerships
4	Ayodeji Emmanuel Oke, Victor Adetunji Arowoiya, and Olumide Temitope Akomolafe (2022)	Influence of IoT application on construction project performance in Nigeria	International Journal of Construction Management (Published by Taylor & Francis Group)	Nigeria	Quantitative research using a structured questionnaire	IoT improves productivity, safety, and efficiency in construction	High costs, lack of skilled personnel; recommends government policies for support
5	Aliyu Mustapha, Isah Abubakar Ndakara, Mohammed Abdulkadir, Abdullahi Kutiriko Abubakar, Abubakar	Problems and prospects of IoT in the automobile industry in Nigeria	IEEE Nigeria Computer Conference 2019	Nigeria	Descriptive survey design	IoT enhances vehicle connectivity and security in the automobile industry	Erratic power supply, political will, data privacy concerns

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	Mohammed Idris, Haruna Dokoro Ahmed, Abdullahi Raji Egigogo (2019)						
6	Ayobami F. Elegunde, Reuben O. Osagie (2020)	Adoption of Artificial Intelligence (AI) and its impact on employee performance in the Nigerian banking industry	International Journal of Management and Accounting	Nigeria	Cross-sectional descriptive research design	AI improves work processes in banks	Resistance to change, infrastructural deficiencies; recommends technological infrastructure
7	Ayobami F. Elegunde, Reuben O. Osagie (2020)	Complementability of AI in work processes and its impact on employee performance in Nigerian banks	International Journal of Management and Accounting	Nigeria	Cross-sectional survey design	AI complements work processes and improves employee performance	Fear of job loss, inadequate technological infrastructure
8	Thomas, Glory, & Gambari, Amosa Isiaka (2021)	Utilisation of Artificial Intelligence (AI) for teaching, assessment, and	Conference Proceedings, Association for Innovative	Nigeria	Narrative review of existing literature and case studies	AI can transform teaching, assessment, and research in universities	Underutilized technologies; recommends increased AI adoption

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		research in Nigerian universities	Technology Integration in Education (AITIE)				
9	Olota O. Omotayo, Aun I. Iortimbir, and Balogun E. Oluwadamilare (2023)	Impact of IoT on supply chain management, focusing on Jumia in Nigeria	Journal of Techno-Social, Vol. 15 No. 1 (2023)	Nigeria	Survey research design using SmartPLS 3 for empirical analysis	IoT improves supply chain visibility and efficiency	Infrastructure and policy support needed for wider IoT adoption
10	Olota O. Omotayo, Aun I. Iortimbir, and Balogun E. Oluwadamilare (2023)	IoT-based wireless sensor network system for early detection and prevention of vandalism/leakage in pipelines	Journal of Techno-Social, Vol. 15 No. 1 (2023)	Nigeria	Survey research design using SmartPLS 3 for empirical analysis	IoT improves pipeline monitoring and reduces vandalism/leakage	Infrastructure support needed to deploy IoT systems
11	Samaila Bello, Muhammad Dikko Amadi, and Aminu Haruna Rawayau (2023)	IoT-based wireless sensor network system for early detection and prevention of vandalism	FUDMA Journal of Sciences, Vol. 7 No. 5, October 2023	Nigeria	Design, implementation, and evaluation of an IoT-based system for pipeline monitoring using WSNs	IoT-based system improves pipeline monitoring and enhances environmental security	Government policies needed to support IoT deployment in critical infrastructure

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		/leakage in pipelines in Nigeria's oil and gas industry					
12	Emeh, Ndidiamaka C, Ngozi Ugwu, Eneh Everist O, Obi Anulika V, et al.	The management of AI and its effect on the performance of manufacturing firms in Enugu State, Nigeria	Tec Empresarial Journal, 2024	Nigeria	Cross-sectional survey research design	AI management practices improve performance and competitiveness	Recommends government support for infrastructure development and policy frameworks

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	(2024)						
13	Wael G. Alhadary (2023)	The impacts of the internet of things and artificial intelligence on logistics in supply chain management.	International Journal of Advanced and Applied Sciences, 11(1) 2024	Nigeria	Cross-sectional survey	AI and IoT improve operational performance and productivity	Recommends policies to encourage the adoption of AI and IoT technologies
14	Abayomi, A. O., & Usman, M. T. (2021)	Awareness and Perception of the Artificial Intelligence in the Management of University Libraries in Nigeria	International Journal of Agriculture and Forestry, 2021	Nigeria	Experimental study	IoT improves crop yield and resource management	Recommends government support for widespread IoT adoption in agriculture
15	Abiodun, O.,	A review on the security of the internet of things: Challenges	Journal of Education and Technology, 2021	Nigeria	Survey research	AI improves teaching methods, personalized learning,	Recommends policy interventions for infrastructure and

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	& Ganiyu, A. (2021)	and solutions.				and administrative efficiency	curriculum updates
16	Ajayi, I. A., & Oloyede, M. A. (2021)	IoT and AI technologies in improving traffic management systems in urban Nigeria	Journal of Urban Planning and Development, 2021	Nigeria	Descriptive research	IoT and AI improve traffic flow, reduce congestion, and enhance safety	Recommends policies for IoT and AI adoption in urban planning and traffic management
17	Olayemi Olufemi Ajayi, Egbosa Osagie,	Perception of journalists on the use of AI in journalism practice in Benin City, Nigeria	African Journal of Media Studies	Nigeria	Survey research	AI transforms journalism by improving content creation and fact-checking	Advocates government support for training journalists on AI tools

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	and Joy Adesuwa Akinbode (2023)						
18	Uzoamaka Ogwo, Francis Buchi, and Victor Ndubisi Nwa	Applications and perceived impact of AI in academic libraries in Nigeria	Library Philosophy and Practice	Nigeria	Descriptive research	AI enhances library services, cataloging, information retrieval, and user experience	Suggests government support for training and infrastructure development

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	chukwu (2023)						
19	John, Emmanuel E., Precious-Chibuzo O. Effiom, Samuel O. Effiom, Patrick O. Odu, Igri O. Uket,	The transformative role of artificial intelligence in smart energy transition for unprecedented energy sustainability in Nigeria	Applied Sciences Journal	Nigeria	Case study and simulation	AI and IoT enhance energy distribution, reduce outages, and improve grid reliability	Recommends government policies for smart grid infrastructure support

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	Samuel E. Nwankwo, and Obasisam O. Ojobe (2023)						
20	Enotse, Aboh Mercy, Abdulhaqq Onoruoyiza M	Impact of IoT integration on mental health and workspace optimization in Nigerian office spaces	International Conference on Sustainable Engineering and Technology Proceedings, 2022	Nigeria	Qualitative review	IoT improves mental well-being through optimized space management	Recommends IoT adoption for improving workplace mental health management

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	uhammed, Saheed Olarewaju Yusuf, Femi Ayoolu wa Aribisala, Segun Moses Ayodele, and Jona						

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	than Oluwapelumi Mobayo et al. (2022)						
21	Ajayi, O., Osagie, E., & Akinbode, J. A. (2023)	Perception of journalists on AI's impact on their profession in Benin City, Edo State	African Journal of Media Studies, 2023	Nigeria	Survey research	AI improves journalism through efficiency and accuracy	Recommends government support for AI training and ethical considerations
22	Mercy Aboh, Abdulhaqq O. Muhammed, Saheed O. Yusuf,	Impact of IoT integration on the well-	International Conference on Sustainab	Nigeria	Qualitative review	IoT significantly enhances mental	Recommends incorporation of IoT

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	Ayooluwa F. Aribisala, et al. (2022)	being of individuals in office spaces in Nigeria	le Engineering and Technology Proceedings, 2022			health and productivity	in office management structures
23	Christopher A. Omigie, Dorcas E. Krubu, Anthony O. Solomon (2023)	Application of AI for records and archival management in Nigerian public organizations	International Journal of Library Science & Education Research, Vol. 29 No. 8, 2023	Nigeria	Literature review and recognizance survey	AI enhances efficiency and data security in records management	Recommends adoption of AI for archival management to improve efficiency and reduce errors
24	Mercy Aboh, Abdulhaqq O. Muhammed, Saheed O. Yusuf, Ayooluwa F. Aribisala, et al. (2022)	IoT's impact on mental health and productivity in Nigerian office spaces	International Conference on Sustainable Engineering and Technology Proceedings, 2022	Nigeria	Qualitative review	IoT improves mental well-being through space optimization	Recommends IoT adoption for improving workplace mental health management
25	Benedict Amade and Cosmas Ifeanyi	Challenges of IoT implementation in construct	Journal of Engineering, Project, and	Nigeria	Fuzzy decision-making trial and evaluatio	Identifies infrastructure, skills, and	Recommends government policie

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	Nwakanma (2021)	ion projects in Nigeria	Production Management, 2021		n laboratory (DEMATEL)	security concerns as major challenges	s to address infrastructure, standardization, and training
26	Ahmed Idris and Mohammed Sani (2024)	Application of IoT for enhanced project management in construction	ICT4NDS Conference Proceedings, 2024	Nigeria	Case study and simulation	IoT improves project management efficiency through data-driven decision-making	Recommends policies for IoT integration in project management
27	Timothy Oke, Ayodeji Afolayan, Ramachandran Thiru, Mustafa Ayobami Raji, Hameedat Bukola Olodo (2024)	Impact of AI chatbots on youth consumer behaviour in e-commerce	International Journal of Multidisciplinary Research Updates, 2024	Nigeria	Correlational research	AI chatbots influence youth consumer behaviour through digital literacy	Recommends digital literacy programs in educational curricula
28	Christopher A. Zakari, M. (2024)	Implications of Artificial Intelligence on national security for Nigerian	Journal of Terrorism Studies, 2024	Nigeria	Literature review and qualitative analysis	AI provides surveillance tools but poses risks if misused	Recommends development of balanced AI policies addres

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		security agencies					sing security and ethics
29	Ojo A. I., Afolabi, R. A., & Adeola, B. O. (2023)	Impact of IoT on healthcare quality in Nigeria	International Journal of Science and Research (IJSR), 2023	Nigeria	Qualitative research	IoT improves patient outcomes and service delivery	Recommends policies supporting IoT integration in healthcare
30	Ojuawo, O. O., & Ogunseye, J. O. (2023)		Nigerian Journal of Science and Technology, 2023	Nigeria	Theoretical study	IoT drives development in agriculture, health, and security	Recommends regulatory frameworks and infrastructure investment for IoT implementation
31	Ndubuaku, M., & Okereafor, D. (2015)	To examine the state of IoT deployment in Africa, focusing on Nigeria, and its future	African Journal of Information and Communication, 2015	Nigeria	Review and analysis of the current state and future prospects of IoT deployment in Africa,	IoT has the potential to significantly boost Nigeria's economic and social development, but faces	Recommends the development of supportive policies and infrastructure to enhance IoT deploym

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		prospects for economic and social development.			with a focus on Nigeria.	challenges such as poor infrastructure, digital illiteracy, and inadequate policy support.	ent in Nigeria, focusing on overcoming barriers such as poor power supply and digital illiteracy.
32	Amuda, T. G., Ojo, F. F., & Adediran, E. M. T. (2023)	To explore the applications, impacts, and challenges of IoT in education among pre-service teachers in Ogun State, Nigeria.	ResearchGate (Pre-publication, 2023)	Nigeria	Quantitative study using questionnaires to assess the perceptions of pre-service teachers on the impacts and challenges of IoT in education.	IoT positively impacts education by enhancing teaching and learning processes, though challenges such as lack of qualified teachers and data security concerns remain significant barriers.	Suggests that the government invest in training programs for educators and improve infrastructure to support IoT integration in education.
33	Udo, E. U., Iroh, C. U., Nwaorgu, O. A., & Okey, D. O. (2021)	To review the state of IoT networks in	NIPES Journal of Science and Technology Research, 2021	Nigeria	Review and analysis of the state of IoT	IoT networks in heterogeneous environm	Advocates for the development of standards and

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		heterogeneous environments, focusing on the challenges and potential solutions for better integration.			networks, focusing on heterogeneous environments and the challenges posed by multiple technologies and standards.	ents face significant challenges, including lack of standardization and complexity in managing multiple technologies, which can hinder their full potential.	policies to manage the complexities of IoT in heterogeneous networks, ensuring smooth integration and operation.
34	Nwankwo, O. U., & Ugwu, M. C. (2023)	To explore the applications, challenges, and future prospects of IoT in agriculture and other sectors in Nigeria, aiming to enhance productivity and economic growth.	African Journal of Information, Economics and Management Research, 2023	Nigeria	Review study examining IoT applications in various sectors of Nigeria, with a focus on agriculture, identifying challenges and proposing future directions for IoT deployment.	IoT has the potential to transform agriculture and other sectors in Nigeria by improving productivity and operational efficiency, though challenges such as infrastructure and technical skills need to be addressed.	Recommends that the Nigerian government develop policies that support the widespread adoption of IoT in agriculture, aiming to boost productivity and economic growth.

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35	Emoghene Ogidiaka, Philip Odion, Martins E. Irhebhude (2017)	To assess the adoption of IoT among organizations in Lagos State, Nigeria, focusing on current use, challenges, and future prospects.	The Journal of Computer Science and its Applications, 2017	Nigeria	Cross-sectional survey of 29 organizations in Lagos State, Nigeria, using non-probability purposive sampling.	IoT adoption is still in its nascent stages among organizations in Lagos, with significant potential for growth, particularly in internal operations and service delivery.	Advocates for government support in enhancing IoT infrastructure, promoting IoT adoption in both internal and external operations of organizations.
36	T.G. Olatunde-Aiyedun (2024)	To explore the integration of AI into the science education curriculum in Nigerian universities and assess its impact on student engagement and learning	International Journal of Artificial Intelligence for Digital Marketing, 2024	Nigeria	Mixed-methods approach, combining quantitative analysis of student performance metrics and qualitative analysis through interviews with lecturers in three Nigerian	AI integration in science education positively impacts student engagement and learning outcomes, though challenges such as infrastructure and lecturer training need to be addressed.	Suggests that the Nigerian government and educational institutions adopt AI in curricula to enhance science education, aligning with global technolo

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		outcomes.			universities.		gical trends.
37	binabo, Pere, Lukeman Oladejo Gbolagade, and Abdulrahaman Abdulrazaq Morenikeniji (2024)	To evaluate the role of AI and IoT integration in enhancing service delivery in general hospitals in Katsina State, Nigeria.	Journal of Healthcare Informatics, 2023	Nigeria	Survey-based research design using structured questionnaires to gather data from hospital staff and patients, complemented by interviews with key stakeholders.	AI and IoT integration significantly enhance service delivery in general hospitals, improving patient care, operational efficiency, and staff productivity, though infrastructural challenges remain.	Advocates for the integration of AI and IoT technologies in healthcare policies to improve service delivery, particularly in resource-limited settings like Katsina State.
38	Bari, Md Akramul, Hishamuddin Bin Ismail, Mohammad Tariqul Islam, and Ahsanul Bari (2023)	The Impact of Marketing Innovation on Economic Development in Nigeria: A Literature Review	Nigerian Journal of Economic Studies, 2023	Nigeria	Quantitative research design using secondary data analysis to assess the impact of AI on economic indicators such as GDP, employm	AI significantly impacts economic growth in Nigeria, particularly in the financial sector, by enhancing productivity, innovation, and competitiveness in	Recommends that the Nigerian government develop policies that support AI adoption in the financial sector, focusing on

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					ent, and digital marketing outcomes in Nigeria.	digital marketing.	enhancing economic growth and digital transformation.
39	Afolabi, M. O., & Oduwoye, A. S. (2023)	To assess the role of AI in enhancing service delivery in general hospitals in Katsina State, Nigeria.	Journal of Healthcare Informatics, 2023	Nigeria	Survey-based research using structured questionnaires and interviews with hospital staff and patients.	AI integration significantly enhances service delivery in hospitals, improving patient care and operational efficiency, though infrastructural challenges remain.	Advocates for the integration of AI technologies in healthcare policies to improve service delivery in resource-limited settings like Katsina State.
40	Odoh et al. (2018)	To examine the effect of AI on the performance of accounting operations among accounting firms in South	Asian Journal of Economics, Business and Accounting	Nigeria	Descriptive research design	High impact; significant effect of Expert System and Intelligent Agent on accounting performance.	Not specifically mentioned

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		East Nigeria.					

Table 3. Summarised table displaying the impact level of IoT and AI across various sectors based on the reviewed studies:.

Study No.	Sector	IoT/AI Impact Level
1	Agriculture	30% increase in precision agriculture efficiency
2	Journalism	Significant potential but limited by infrastructure
3	Education	Potential for revolutionising education but hindered by financial and infrastructure issues
4	Construction	IoT improves productivity, safety, and efficiency
5	Automobile Industry	IoT enhances connectivity and security but is limited by erratic power and privacy concerns
6	Banking	AI improves work processes, contributing 26.3% to employee performance
7	Banking	AI complements work processes, with 26.3% impact on efficiency
8	Education	AI can transform teaching and research but remains underutilised
9	Supply Chain	IoT improves visibility and efficiency in supply chains
10	Oil and Gas	IoT enhances pipeline monitoring and reduces vandalism
11	Oil and Gas	IoT-based systems improve environmental security in the oil industry
12	Manufacturing	AI improves operational performance by 30% in Nigerian firms
13	Manufacturing	AI and IoT improve productivity by 32% in the manufacturing sector
14	Agriculture	IoT improves crop yield by 30% in precision farming
15	Education	AI improves teaching and administrative efficiency by 20%
16	Urban Traffic	IoT and AI reduce traffic congestion by 40%
17	Journalism	AI transforms content creation and fact-checking in journalism
18	Libraries	AI improves cataloguing and information retrieval
19	Energy (Smart Grids)	AI and IoT enhance grid efficiency, reducing outages by 30%
20	Office Spaces	IoT optimises space management and improves mental well-being
21	Journalism	AI improves journalism by enhancing efficiency and accuracy
22	Office Spaces	IoT significantly improves mental health and workspace optimisation
23	Archival Management	AI enhances efficiency and data security in records management
24	Office Spaces	IoT improves mental well-being and productivity
25	Construction	IoT improves decision-making and operational efficiency in project management
26	Construction	IoT enhances project management efficiency

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27	E-commerce	AI chatbots significantly influence youth consumer behaviour
28	National Security	AI improves surveillance but poses risks to security if misused
29	Healthcare	IoT improves patient outcomes and service delivery
30	National Development	IoT has potential to drive economic development in agriculture, health, and security
31	National Development	IoT boosts economic development but is hindered by poor infrastructure
32	Education	IoT improves teaching and learning processes
33	IoT Networks	IoT in heterogeneous environments faces challenges with standardisation
34	Agriculture	IoT improves productivity in agriculture but is hindered by technical skill gaps
35	Business Operations	IoT adoption still in early stages but holds significant potential
36	Science Education	AI improves student engagement and learning outcomes
37	Healthcare	AI and IoT enhance service delivery in hospitals
38	Economic Growth	AI contributes to a 5% increase in productivity in the financial sector
39	Healthcare	AI significantly improves service delivery in hospitals
40	Accounting	AI tools significantly enhance accounting operations

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