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FROM INNOVATION TO IMPACT: EVALUATING ARTIFICIAL INTELLIGENCE'S CONTRIBUTION TO THE TRIPLE BOTTOM LINE IN PUBLIC AND PRIVATE SECTOR PROJECT MANAGEMENT IN NIGERIA

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ABSTRACT
Artificial intelligence (AI) is increasingly reshaping project management practices globally, yet its tangible contribution to sustainable development outcomes in emerging economies remains under-explored. This paper evaluates AI's contribution to the triple bottom line economic performance, social value, and environmental sustainability within public and private sector project management in Nigeria. It examines how AI-driven tools such as predictive analytics, automation, machine learning, and decision-support systems are transforming project planning, execution, monitoring, and evaluation across infrastructure, energy, construction, healthcare, and digital service projects. The study analyses AI's role in improving cost efficiency, schedule reliability, and resource optimisation, while also assessing its implications for workforce productivity, skills transformation, transparency, and stakeholder inclusion. From an environmental perspective, the paper explores how AI supports emissions reduction, waste minimisation, and energy efficiency through data-driven optimisation and real-time monitoring. Particular attention is given to Nigeria's contextual realities, including data quality constraints, infrastructural gaps, regulatory readiness, ethical concerns, and capacity limitations that shape AI adoption and impact. By synthesising existing literature, policy frameworks, and sectoral applications, the paper bridges the gap between technological innovation and measurable project outcomes. It concludes that while AI holds significant potential to enhance the triple bottom line in Nigerian project management, realising sustained impact requires aligned governance frameworks, targeted capacity building, ethical safeguards, and inclusive digital transformation strategies.

Keywords:
Artificial intelligence; Triple bottom line; Project management; Sustainable development; Public and private sectors; Nigeria

1. INTRODUCTION

1.1 Background and Rationale

Project delivery in Nigeria's public and private sectors has long been characterised by cost overruns, schedule slippages, inefficient resource utilisation, and weak sustainability performance [1]. These challenges are particularly acute in infrastructure, energy, construction, and public service projects, where traditional project management approaches struggle to cope with uncertainty, scale, and institutional complexity [2]. At the same time, Nigeria faces increasing pressure to align project outcomes with broader economic development goals, social inclusion priorities, and environmental sustainability commitments [3].

Artificial intelligence (AI) has emerged as a powerful enabler of data-driven decision-making across industries, offering advanced capabilities in prediction, optimisation, and automation [4]. In project management, AI has the potential to transform how projects are planned, monitored, and controlled by shifting practices from reactive problem-solving to proactive performance optimisation [5]. Evaluating this potential within the Nigerian context is essential to understanding whether AI can move beyond innovation rhetoric to deliver measurable development impact.

1.2 Artificial Intelligence and Project Management Evolution

Project management practice has evolved from linear, deterministic models toward more adaptive and data-intensive approaches capable of addressing dynamic risks and complex stakeholder environments [6]. AI technologies such as machine learning, predictive analytics, and intelligent automation support this evolution by continuously learning from historical and real-time project data to improve forecasting accuracy and decision quality [7]. In contrast to conventional tools that rely heavily on human judgment and static assumptions, AI-enabled systems can detect patterns, anticipate disruptions, and recommend corrective actions before risks fully

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materialise [8]. This capability is particularly relevant in Nigeria, where project environments are often volatile and information asymmetries are common.

The triple bottom line (TBL) framework reframes project success by integrating economic performance, social value, and environmental responsibility into a unified assessment model [3]. In project management, this framework extends evaluation beyond cost, time, and scope to include workforce wellbeing, stakeholder inclusion, governance quality, and ecological impact [5]. Adopting a TBL perspective is increasingly important in Nigeria, where large-scale projects can generate significant social and environmental externalities if sustainability considerations are inadequately addressed [1]. AI offers a potential mechanism for operationalising the TBL framework through real-time monitoring and data-driven optimisation across project lifecycles [4].

1.3 Nigeria's Public and Private Sector Project Landscape

Nigeria's public sector remains the primary driver of infrastructure and service delivery projects, yet performance is often constrained by bureaucratic processes, fragmented oversight, and limited monitoring capacity [2]. Private sector projects tend to demonstrate greater efficiency and innovation but face challenges related to regulatory uncertainty, financing constraints, and infrastructural deficits [6].

AI adoption across both sectors is uneven, reflecting disparities in digital readiness, data availability, and organisational capability [7]. Understanding how these sectoral differences shape AI's contribution to sustainable project outcomes is critical for designing context-appropriate implementation strategies. Existing research on AI in project management has largely focused on technical efficiency gains or case studies from developed economies [4]. There remains limited analysis of how AI influences economic, social, and environmental outcomes simultaneously within developing country contexts such as Nigeria [5]. Furthermore, comparative insights into public versus private sector AI adoption and impact remain underdeveloped [8].

1.4 Aim and Objectives of the Study

This paper aims to evaluate artificial intelligence's contribution to the triple bottom line in public and private sector project management in Nigeria. The objectives are to examine AI applications in Nigerian projects, assess their economic, social, and environmental impacts, compare sectoral adoption dynamics, and identify governance and capacity requirements for sustainable implementation [1]. The paper is structured as follows. Section 2 presents the conceptual and theoretical framework. Sections 3 to 6 analyse AI applications and their triple bottom line implications. Section 7 discusses implementation challenges and policy implications, while Section 8 concludes the paper.

2. CONCEPTUAL AND THEORETICAL FRAMEWORK

2.1 Artificial Intelligence in Project Management

Artificial intelligence in project management refers to the application of computational systems capable of learning from data, recognising patterns, and optimising decisions across the project lifecycle [7]. AI systems support planning, scheduling, risk management, and performance monitoring by transforming large volumes of project data into actionable insights [9]. Unlike traditional decision-support tools, AI-enabled systems are adaptive, continuously refining outputs as new data becomes available [10]. This adaptive capability is particularly valuable in complex project environments where uncertainty and change are persistent features [11].

The triple bottom line framework provides a multidimensional approach to performance evaluation by integrating economic efficiency, social responsibility, and environmental sustainability [12]. Economic sustainability focuses on productivity, cost control, and long-term value creation. Social sustainability encompasses workforce development, stakeholder engagement, transparency, and ethical governance [13]. Environmental sustainability addresses emissions reduction, resource efficiency, and ecological protection [14]. Applying this framework to project management enables a more holistic assessment of AI's impact beyond short-term operational gains [15].

2.2 Linking AI Capabilities to Triple Bottom Line Outcomes

AI capabilities align closely with the three dimensions of the triple bottom line. Predictive analytics and optimisation algorithms enhance economic outcomes by improving cost forecasting, schedule reliability, and resource utilisation [9]. Automation and decision-support systems strengthen social outcomes by increasing transparency, reducing human error, and supporting inclusive decision-making processes [10]. Environmental outcomes are supported through AI-enabled energy modelling, emissions tracking, and waste minimisation tools that enable data-driven sustainability management throughout project lifecycles [16]. These linkages position AI as a strategic enabler of integrated project sustainability rather than a purely technical solution.

Public sector projects operate within formal accountability structures and regulatory frameworks that can constrain flexibility in technology adoption [11]. Private sector projects, while more agile, must balance innovation with financial risk and compliance obligations [12]. These structural differences influence how AI is

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governed, scaled, and embedded in project management processes, shaping its capacity to deliver consistent triple bottom line benefits across sectors [17].

2.3 Conceptual Framework for AI-Driven Sustainable Project Management

This study adopts a conceptual framework in which AI technologies function as enabling mechanisms that convert project data into insights influencing managerial decision-making and sustainability outcomes [15]. Institutional capacity, data governance, regulatory context, and organisational readiness act as moderating factors shaping AI effectiveness [16]. The framework positions AI as an intermediary between project management practices and triple bottom line performance, providing a structured basis for analysing opportunities and constraints within Nigeria's public and private sector project environments [17].

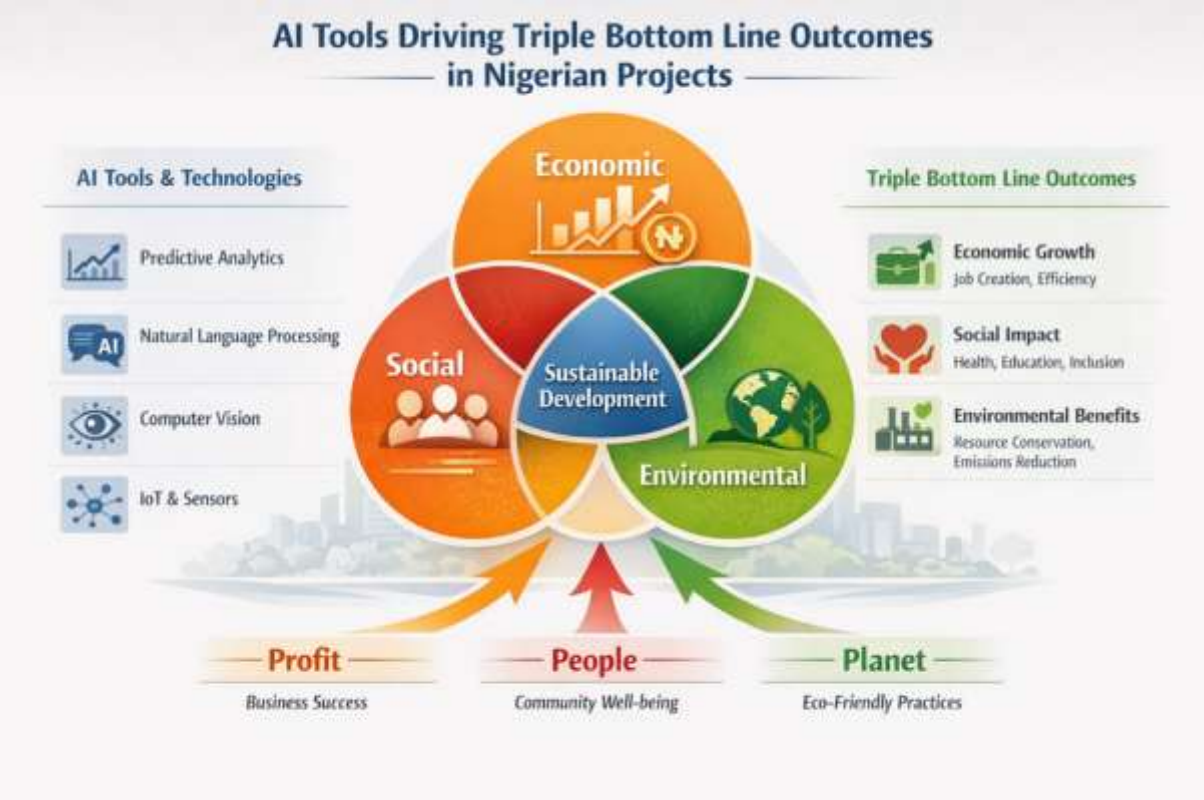

Figure 1: Conceptual framework linking AI tools to triple bottom line outcomes in Nigerian projects

Figure 1 presents a conceptual framework linking AI-enabled project management tools to triple bottom line outcomes in Nigerian projects. The framework illustrates how AI capabilities such as predictive analytics, automation, and natural language processing are integrated at the core of project decision-making processes and interact dynamically with contextual project data. These AI tools influence project outcomes across three interconnected dimensions: economic performance, social outcomes, and environmental sustainability. The model emphasises AI as an enabling mechanism that translates data-driven insights into balanced and sustainable project delivery outcomes within the Nigerian project environment.

3. AI APPLICATIONS IN NIGERIAN PROJECT MANAGEMENT

3.1 Predictive Analytics for Cost and Schedule Optimisation

Predictive analytics represents one of the most impactful applications of artificial intelligence in project management, enabling data-driven forecasting of cost, time, and risk variables [16]. By analysing historical project data alongside real-time inputs, AI models can identify patterns associated with budget overruns and schedule delays, allowing project managers to intervene proactively rather than reactively [17]. In Nigeria, where project environments are frequently affected by inflation volatility, supply chain disruptions, and procurement delays, predictive analytics offers a means of improving forecast accuracy and contingency planning [18]. These

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capabilities are particularly valuable for large-scale public infrastructure and energy projects, where even marginal forecasting errors can translate into significant financial losses.

AI-enabled optimisation tools support more efficient allocation of labour, materials, and equipment by continuously assessing resource demand against project constraints [19]. Machine learning algorithms can evaluate productivity trends, equipment utilisation rates, and workforce performance to recommend optimal deployment strategies across project phases [20]. In the Nigerian context, where skilled labour shortages and inefficient material usage are common challenges, AI-driven resource management can enhance productivity while reducing waste and idle time [16]. Private sector projects, in particular, have begun leveraging these tools to improve operational efficiency and competitiveness, although adoption within the public sector remains more limited [21].

3.2 Automation and Intelligent Decision-Support Systems

Automation represents a critical pathway through which AI enhances project management efficiency and governance [22]. Intelligent systems can automate routine tasks such as progress reporting, document management, compliance checks, and risk flagging, reducing administrative burdens on project teams [17]. Decision-support systems further augment managerial judgment by synthesising complex datasets into actionable recommendations, improving the quality and consistency of project decisions [18]. In Nigeria's public sector, such systems hold potential to strengthen transparency and accountability by reducing discretionary decision-making and information asymmetry [23].

3.3 Sectoral Applications of AI in Nigerian Projects

3.3.1 Infrastructure and Construction

AI applications in infrastructure and construction projects include schedule optimisation, defect detection, and predictive maintenance of assets [19]. These tools enable early identification of construction risks, improve quality control, and support lifecycle cost management. Given Nigeria's extensive infrastructure deficit, AI adoption in this sector could significantly improve project delivery performance and asset sustainability [24].

3.3.2 Energy and Power Projects

In energy and power projects, AI supports demand forecasting, grid optimisation, and emissions monitoring, contributing to both operational efficiency and environmental performance [20]. AI-driven analytics enable more accurate load predictions and equipment maintenance scheduling, reducing downtime and improving system reliability [21]. These applications align closely with Nigeria's energy transition objectives and sustainability commitments [16].

3.3.3 Healthcare and Digital Service Projects

AI is increasingly applied in healthcare and digital service projects to improve service planning, resource allocation, and performance monitoring [22]. In project-based digital health initiatives, AI supports data integration and real-time evaluation of service delivery outcomes, enhancing both efficiency and social impact [23]. These applications demonstrate AI's potential beyond traditional infrastructure projects, extending into socially critical service sectors.

3.4 Comparative Insights: Public vs Private Sector Adoption

AI adoption in Nigerian project management exhibits clear sectoral disparities. Private sector organisations tend to adopt AI tools more rapidly due to greater flexibility, innovation incentives, and access to digital infrastructure [21]. Public sector projects, while recognising AI's potential benefits, face institutional constraints related to procurement processes, data governance, and capacity limitations [24]. These differences influence not only the pace of adoption but also the scale and sustainability of AI-driven project management innovations, underscoring the need for tailored strategies across sectors [17].

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Table 1: Key AI applications and project management functions across sectors in Nigeria

Sector	AI Applications	Project Management Functions Supported	Illustrative Outcomes
Public Infrastructure (Transport, Roads, Housing)	Predictive analytics; machine learning; computer vision	Cost estimation; schedule forecasting; risk identification; progress monitoring	Reduced cost overruns; improved schedule reliability; enhanced accountability
Construction (Public and Private)	Resource optimisation algorithms; automation; defect detection systems	Resource allocation; productivity tracking; quality control; reporting	Improved labour productivity; reduced material waste; better quality assurance
Energy and Power Projects	Demand forecasting models; predictive maintenance; emissions analytics	Planning and forecasting; asset management; risk mitigation; performance monitoring	Improved system reliability; lower downtime; enhanced energy efficiency
Healthcare Projects and Digital Health Initiatives	Data analytics; intelligent scheduling; decision-support systems	Capacity planning; service delivery monitoring; stakeholder coordination	Improved service efficiency; better resource utilisation; increased social impact
ICT and Digital Service Projects	Automation tools; AI-based workflow management; performance dashboards	Task scheduling; monitoring and reporting; decision support	Faster delivery cycles; improved transparency; enhanced decision quality
Private Sector Capital Projects	AI-driven feasibility analysis; financial forecasting tools	Investment appraisal; cost control; risk assessment	Improved return on investment; stronger investor confidence; reduced uncertainty

4. ECONOMIC DIMENSION: AI AND FINANCIAL PERFORMANCE IN PROJECT MANAGEMENT

4.1 Cost Efficiency and Budget Control

Cost overruns remain a persistent challenge in Nigerian project delivery, particularly within large-scale public infrastructure and energy projects [23]. Artificial intelligence enhances cost efficiency by improving budget forecasting accuracy, identifying cost escalation drivers, and enabling real-time financial monitoring across project lifecycles [24]. Machine learning algorithms can analyse historical cost data alongside market indicators such as inflation, material price volatility, and exchange rate fluctuations to generate dynamic cost estimates [25]. In the Nigerian context, where economic instability and procurement delays frequently undermine financial planning, AI-driven cost control tools support earlier intervention and more disciplined budget management [26]. These capabilities contribute directly to improved value for money and reduced fiscal waste in both public and private sector projects.

Schedule delays impose significant economic costs by increasing overheads, extending financing periods, and eroding expected project returns [27]. AI-enabled scheduling tools improve reliability by predicting delay risks and recommending adaptive sequencing strategies in response to emerging constraints [23]. Predictive models can assess the likelihood of schedule slippage based on labour availability, supply chain performance, and environmental conditions, allowing project managers to mitigate risks before delays become critical [28]. For private sector projects, enhanced schedule reliability translates into faster time-to-market and improved investment confidence [29]. In the public sector, it reduces cost escalation associated with prolonged project durations and strengthens accountability for project delivery outcomes [24].

4.2 Productivity Gains and Resource Optimisation

Productivity inefficiencies represent a major source of economic loss in Nigerian projects, often driven by suboptimal labour deployment, equipment downtime, and material waste [25]. AI-driven optimisation tools support more efficient use of resources by continuously analysing performance data and recommending adjustments to workforce allocation and equipment utilisation [26]. By improving coordination across project activities, AI enhances labour productivity and reduces idle time, contributing to measurable cost savings [27]. These gains are particularly important in sectors such as construction and energy, where resource-intensive operations dominate project costs [30].

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Beyond short-term efficiency gains, AI contributes to long-term economic sustainability by improving investment decision-making and project viability assessments [28]. Data-driven insights generated by AI systems enhance risk evaluation, enabling more accurate appraisal of project feasibility and expected returns [29]. In Nigeria, where capital constraints and financing risks are significant barriers to project development, AI-supported decision-making can improve investor confidence and attract private capital [30]. By reducing uncertainty and enhancing financial transparency, AI strengthens the economic foundation of sustainable project delivery across both public and private sectors [23].

Figure 2: Economic performance improvements enabled by AI in project management

Figure 2 illustrates how artificial intelligence enhances economic performance in project management by integrating cost control, schedule efficiency, productivity optimisation, and financial risk management within a continuous data-driven feedback loop. AI-enabled predictive analytics support more accurate forecasting of project costs and timelines, reducing budget overruns and delay-related expenditures. Automation of routine planning and reporting functions lowers administrative overheads while improving labour productivity. In addition, real-time risk identification and scenario modelling enable proactive financial decision-making, improving capital allocation and return on investment. Collectively, these mechanisms position AI as a strategic economic enabler that strengthens project financial resilience, efficiency, and value creation across the project lifecycle.

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5. SOCIAL DIMENSION: WORKFORCE, GOVERNANCE, AND INCLUSION

5.1 Workforce Transformation and Skills Development

The integration of artificial intelligence into project management significantly reshapes workforce structures, skill requirements, and professional roles [29]. AI adoption shifts emphasis from routine administrative tasks toward higher-order analytical, strategic, and oversight functions, requiring project professionals to develop data literacy and digital competencies [30]. In Nigeria, where skills gaps and uneven access to advanced training persist, AI-driven transformation presents both opportunities and challenges [31]. While AI can enhance workforce productivity and professional development, inadequate investment in capacity building risks exacerbating existing inequalities between digitally advanced organisations and those with limited resources [32].

AI-enabled decision-support systems have the potential to strengthen transparency and accountability in project governance by standardising data-driven decision processes [33]. Automated reporting, real-time performance dashboards, and algorithmic risk flagging reduce information asymmetry and improve oversight across project lifecycles [34]. In the Nigerian public sector, where governance challenges have historically undermined project outcomes, AI-supported transparency mechanisms can enhance institutional credibility and public trust [29]. However, the effectiveness of these systems depends on the integrity of underlying data and the clarity of accountability frameworks [35].

5.2 Stakeholder Engagement and Social Value Creation

AI contributes to improved stakeholder engagement by enabling more accurate forecasting of social impacts and facilitating inclusive decision-making processes [30]. Advanced analytics can support community impact assessments, service delivery planning, and beneficiary targeting, particularly in socially sensitive projects such as healthcare, housing, and infrastructure development [31]. By enhancing the responsiveness of project management to stakeholder needs, AI supports the creation of broader social value beyond immediate project outputs [36]. This is particularly relevant in Nigeria, where large-scale projects often intersect with complex community dynamics and social expectations.

Despite its potential benefits, AI adoption raises significant ethical concerns related to algorithmic bias, data privacy, and exclusion [32]. Bias embedded in training data can lead to discriminatory outcomes in resource allocation, workforce evaluation, or stakeholder engagement processes [33]. In Nigeria's diverse socio-economic context, addressing these ethical risks is essential to ensuring that AI contributes positively to social sustainability [34]. Establishing ethical governance frameworks and oversight mechanisms is therefore critical to responsible AI deployment in project management [35].

5.3 Implications for Employment and Labour Structures

AI-driven automation influences employment patterns by reducing demand for certain routine roles while increasing demand for specialised digital skills [36]. In the Nigerian labour market, this transition presents risks of job displacement if reskilling initiatives are insufficiently developed [29]. At the same time, AI adoption can create new professional opportunities in data analysis, systems management, and digital project governance, contributing to long-term workforce resilience [30]. Balancing efficiency gains with social protection and inclusive workforce development remains a central challenge for sustainable AI integration in Nigerian project management [31].

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Table 2: Social Impacts of Artificial Intelligence Adoption in Nigerian Public and Private Projects

Social Dimension	Public Sector Projects	Private Sector Projects	Implications for Sustainable Project Management
Workforce Skills and Capacity	Gradual skills upgrading through training and institutional learning; constrained by budget and bureaucratic processes	Faster skills acquisition driven by competitive pressures and innovation incentives	Highlights the need for structured reskilling programmes to ensure inclusive AI adoption
Employment and Job Structures	Limited displacement due to slower automation; risk of skills mismatch over time	Higher automation potential with increased demand for digital and analytical roles	Emphasises the importance of labour transition and workforce protection mechanisms
Decision Transparency and Accountability	Improved monitoring and reporting; enhanced oversight in procurement and delivery processes	Data-driven managerial decisions; performance-based accountability	Supports improved governance and trust in project decision-making
Stakeholder Engagement and Inclusion	Potential for improved citizen engagement through data-enabled planning; dependent on data quality	Enhanced client and stakeholder responsiveness through real-time analytics	Reinforces the role of AI in social value creation and stakeholder confidence
Ethical Risks and Algorithmic Bias	Higher exposure due to large datasets and public accountability; limited ethical safeguards	Better control mechanisms but risk of commercial bias in algorithm design	Underlines the need for ethical governance frameworks across sectors
Institutional Trust and Social Legitimacy	Increased public trust when AI enhances transparency; risk of mistrust if systems are opaque	Stronger market credibility when AI improves reliability and outcomes	Demonstrates AI's influence on social legitimacy and acceptance of projects

6. ENVIRONMENTAL DIMENSION: AI AND SUSTAINABLE PROJECT OUTCOMES

6.1 Emissions Monitoring and Carbon Reduction

Artificial intelligence plays an increasingly important role in supporting emissions monitoring and carbon reduction across project lifecycles [35]. AI-enabled analytics integrate data from sensors, equipment logs, and operational records to provide real-time visibility into emissions profiles and energy consumption patterns [36]. In Nigeria, where environmental monitoring capacity is often limited and enforcement mechanisms are weak, AI-supported emissions tracking offers a more accurate and continuous approach to environmental performance management [37]. These capabilities enable project managers to identify high-emission activities and implement corrective measures that align with sustainability objectives.

AI contributes to waste minimisation by optimising material usage, improving demand forecasting, and supporting circular resource management strategies [38]. Machine learning models can predict material requirements with greater precision, reducing over-ordering and construction waste [35]. In resource-intensive Nigerian sectors such as construction and energy, waste reduction delivers both environmental and economic benefits by lowering disposal costs and conserving scarce resources [39]. AI-enabled tracking systems further support compliance with environmental standards and promote more sustainable material management practices.

6.2 Energy Efficiency and Climate-Smart Project Delivery

Energy efficiency is a central component of environmental sustainability in project management, particularly in energy-intensive projects [36]. AI-driven optimisation tools enhance energy performance by analysing operational data and recommending efficiency improvements across equipment usage, scheduling, and system design [40]. In Nigeria, where energy supply constraints and reliance on fossil fuels persist, AI-supported energy optimisation contributes to climate-smart project delivery and reduced environmental impact [41]. These applications are particularly relevant for infrastructure and industrial projects seeking to align with national energy transition goals.

AI-enabled environmental management supports alignment between project-level performance and broader sustainability frameworks [37]. Data-driven insights facilitate compliance with environmental regulations, reporting requirements, and sustainability benchmarks at national and international levels [38]. By improving

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environmental transparency and performance measurement, AI strengthens Nigeria's capacity to integrate sustainability considerations into project planning and delivery [39]. This alignment reinforces the role of AI as a strategic tool for advancing environmentally responsible project management rather than a purely technical enhancement [40].

Figure 3: Environmental sustainability outcomes supported by AI-enabled project management
Figure 3 illustrates how AI-enabled project management supports environmental sustainability by integrating energy efficiency, pollution reduction, circular resource use, biodiversity protection, and climate resilience within a continuous decision-making framework. By analysing real-time operational and environmental data, AI systems optimise energy consumption, minimise waste and emissions, support circular material flows, and enhance environmental risk forecasting. This integrated approach enables projects to achieve improved environmental performance while aligning delivery outcomes with sustainability and climate adaptation objectives.

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7. IMPLEMENTATION CHALLENGES AND POLICY IMPLICATIONS

7.1 Data Availability and Quality Constraints

Effective deployment of artificial intelligence in project management depends on the availability of high-quality, reliable, and interoperable data [40]. In Nigeria, project data is often fragmented across institutions, inconsistently recorded, and poorly standardised, limiting the accuracy and reliability of AI-driven insights [41]. These data constraints undermine the predictive capacity of AI models and restrict their scalability across projects and sectors. Addressing data quality challenges requires systematic investment in data governance frameworks, standardised data collection protocols, and institutional coordination mechanisms that support data sharing and integration [42].

AI adoption is contingent on adequate digital infrastructure, including stable power supply, connectivity, and computing capacity [43]. In Nigeria, infrastructural deficits remain a significant barrier, particularly for public sector projects and operations in remote or underserved areas [40]. Limited access to cloud services and digital platforms further constrains the deployment of advanced AI tools. Policy interventions aimed at strengthening digital infrastructure and expanding access to reliable power and connectivity are therefore critical to enabling widespread AI integration in project management [41].

7.2 Regulatory and Institutional Frameworks

The absence of comprehensive regulatory frameworks governing AI deployment poses challenges related to accountability, transparency, and risk management [44]. Existing project governance structures in Nigeria are often ill-equipped to address issues such as algorithmic decision-making, data ownership, and liability [42]. Developing clear regulatory guidelines and institutional responsibilities for AI use in project management is essential to ensure alignment with public interest objectives and to mitigate systemic risks [45].

AI systems increase exposure to cybersecurity risks and data privacy concerns, particularly when handling sensitive project and stakeholder information [43]. Weak cybersecurity safeguards can compromise data integrity and undermine trust in AI-supported decision-making [44]. Establishing robust ethical governance frameworks, including data protection standards, audit mechanisms, and oversight institutions, is critical to responsible AI adoption in Nigerian projects [40]. These measures help ensure that AI contributes to sustainable and inclusive project outcomes rather than reinforcing existing vulnerabilities.

7.3 Policy and Strategic Recommendations for Nigeria

To maximise AI's contribution to the triple bottom line, Nigeria must adopt a coordinated policy approach that integrates technology, governance, and capacity development [45]. Strategic priorities include investing in digital infrastructure, strengthening data governance, embedding ethical standards, and supporting workforce up skilling initiatives [41]. Public–private collaboration can accelerate knowledge transfer and innovation, while targeted pilot projects can demonstrate AI's value in diverse project contexts [42]. By aligning AI deployment with national development and sustainability objectives, policymakers can ensure that innovation translates into measurable and inclusive project impact [43].

8. CONCLUSION

This paper has examined the transition of artificial intelligence from a technological innovation to a practical enabler of sustainable project management in Nigeria's public and private sectors. By applying the triple bottom line framework, the study demonstrates that AI has the potential to generate integrated economic, social, and environmental value when strategically embedded within project management practices. Across planning, execution, and monitoring phases, AI-enabled tools support improved cost control, schedule reliability, and resource optimisation, contributing to stronger financial performance and long-term project viability.

From a social perspective, the findings highlight AI's capacity to enhance workforce productivity, decision transparency, and stakeholder engagement, while also underscoring the importance of addressing skills gaps, ethical risks, and governance challenges. Environmentally, AI offers practical mechanisms for emissions monitoring, waste reduction, and energy efficiency, enabling projects to align more closely with sustainability objectives and responsible resource use. These contributions are particularly significant in Nigeria, where large-scale projects have far-reaching economic, social, and ecological implications.

However, the paper also demonstrates that AI's impact is not automatic. Realising its full potential depends on the quality of underlying data, the adequacy of digital infrastructure, and the presence of clear regulatory and ethical frameworks. Without targeted capacity building and inclusive policy interventions, AI adoption risks reinforcing existing institutional and socio-economic disparities.

Overall, the study contributes to project management and sustainability scholarship by providing a context-specific evaluation of AI's role in advancing the triple bottom line in a developing economy. It offers practical insights for policymakers, project practitioners, and private sector actors seeking to harness AI for sustainable

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project delivery in Nigeria, while also laying the foundation for future empirical research on AI-driven project transformation.

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