Adoption of Artificial Intelligence Tools and Sustainable Management of Educational Facilities in Public Universities, Kwara State, Nigeria

Ajadi, Bashiru Ibrahim PhD[1], Ajadi, Babatunde Mustafa PhD[2], Saliu, Omotosho Jimoh[3]

[1]Department of Educational Management and Counselling, Al-Hikmah University Ilorin, Nigeria.

[2]Department of English, School of Languages, Kwara State College of Education Ilorin, Nigeria.

[3]Department of Science Education, Al-Hikmah University Ilorin, Nigeria.

DOI: https://doi.org/10.47772/IJRISS.2026.101000362

Received: 15 October 2026; Accepted: 20 October 2026; Published: 03 November 2026

ABSTRACT

Educational facilities in Nigerian public universities face increasing infrastructural strain due to rising student populations and outdated maintenance practices, necessitating innovative solutions such as Artificial Intelligence (AI) for sustainable management. This study investigated the adoption of AI tools and the sustainable management of educational facilities in public universities within Kwara State, Nigeria. To provide a robust analytical foundation, the study was anchored on the Technology-Organisation-Environment (TOE) framework and the Technology Acceptance Model (TAM), as these theories collectively explain how institutional infrastructure, organizational structures, and user perceptions shape the adoption of technological innovations such as AI tools in facility management. A descriptive survey research design was employed, targeting administrative staff, estate managers, and physical planning personnel across selected public universities (N=346). A stratified random sampling technique produced a sample size of 185 respondents. Data were collected using a validated instrument titled Artificial Intelligence Tools and Sustainable Facilities Management Questionnaire (AITSFMQ), with a pilot reliability coefficient of 0.86. Descriptive statistics (frequency, percentage, and mean) were used to answer research questions, while Pearson product moment correlation (PPMC) tested hypotheses at a 0.05 significance level. Findings revealed that adoption levels of AI tools, particularly predictive maintenance algorithms and IoT-enabled energy tracking systems remain low. Nonetheless, a significant positive relationship was established between AI integration and sustainable facility management outcomes ($r = 0.618$, $p < 0.05$). Key barriers include inadequate technological infrastructure, high initial capital requirements, and low digital literacy among facility managers. The study recommends institutionalizing public-private partnerships to subsidize AI-driven infrastructural upgrades and organizing targeted capacity-building workshops to enhance digital competence among facility management staff.

Keywords: Artificial Intelligence, Sustainable Management, Educational Facilities, Public Universities, Kwara State.

INTRODUCTION

Educational facilities represent the physical backbone of higher education institutions. The availability, quality, and structural integrity of classrooms, laboratories, lecture theatres, and utilities directly influence the instructional delivery and overall academic performance within tertiary institutions (Aka & Isah, 2022; Ebekozien et al., 2024). In advancing nations like Nigeria, public universities bear the heavy burden of inflating student populations, which places unprecedented stress on existing physical infrastructure. The traditional, reactive maintenance approaches long employed within these institutions have increasingly proven inefficient, resulting in rapid infrastructural decay, high operational costs, and unsustainable resource consumption (Samsurijan & Rohayati, 2024).

Concurrently, the global paradigm of facility management (FM) is undergoing a digital revolution driven by Industry 4.0 technologies. Artificial Intelligence (AI), Digital Twins (DT), and the Internet of Things (IoT) are transforming architectural frameworks into smart environments (Abdelalim et al., 2025; Signorini & Pomè, 2025). AI tools allow for automated energy management, real-time spatial optimisation, and predictive maintenance schedules that drastically mitigate structural downtime (Khan et al., 2025; Oko-Jaja, 2026). While developed economies are swiftly integrating AI to align higher education management systems with United Nations Sustainable Development Goals (SDGs) (Leal Filho et al., 2024; Fernandes et al., 2026), sub-Saharan African institutions, particularly within Nigeria, remain stuck in localised challenges characterised by poor funding and structural deficits (Abubakar et al., 2025; Fausta & Onyekapa, 2025). This study, therefore, examines the adoption patterns and sustainable potential of these AI tools within the context of public universities in Kwara State, Nigeria.

Statement of the Problem

Public universities in Kwara State, Nigeria, are confronted with persistent infrastructural decay and systemic inefficiencies in facility management. Lecture halls and laboratories are characterized by obsolete utility layouts, erratic power supplies, and malfunctioning instructional equipment, all of which undermine effective teaching and learning. The reliance on reactive maintenance routines, where repairs are undertaken only after complete breakdown has resulted in escalating emergency costs, shortened structural lifespan, and unsafe learning environments. Recent empirical studies reinforce these challenges. For instance, Ebekozien et al. (2024), in their study, Performance Assessment of Public Higher Education Buildings in Nigeria, employed a mixed-method design combining surveys and structural audits, with regression analysis as the primary analytical tool. Their findings revealed that poor funding and corruption remain the most significant impediments to sustainable facility management in Nigerian universities. Similarly, Esen et al. (2026), in their work Emerging Options for AI in Sustainable Nigerian Facility Management, adopted a qualitative case study approach supported by thematic analysis. They concluded that, although, awareness of AI-driven solutions is steadily increasing, practical execution remains profoundly constrained by erratic national power supply and a shortage of indigenous technical expertise. Collectively, these studies highlight that infrastructural inefficiencies, financial constraints, and technological deficits are deeply entrenched in the Nigerian higher education system, leaving universities ill-prepared to embrace modern facility management innovations.

Despite these insights, there remains a distinct gap in empirical documentation regarding the adoption of Artificial Intelligence (AI) tools for facility management within Kwara State's public universities. While international literature has demonstrated the effectiveness of AI-driven predictive maintenance, smart energy systems, and automated resource optimisation in reducing costs and enhancing sustainability, localised realities in Kwara State remain underexplored. Specifically, the administrative constraints, infrastructure readiness deficits, and cost-benefit realities shaping AI implementation in these institutions have not been systematically investigated. Without clear empirical evidence, institutional administrators lack the framework needed to transition from obsolete management paradigms to data-driven, sustainable practices. This study therefore seeks to fill this gap by examining the current adoption levels of AI tools, their perceived impact on sustainability, and the structural and institutional barriers limiting their integration in public universities in Kwara State, Nigeria..

Purposes of the Study

The main purpose of this study is to examine the adoption of Artificial Intelligence tools and the sustainable management of educational facilities in public universities in Kwara State, Nigeria. Specifically, the study sought to:

1. Assess the current level of adoption of AI tools for educational facilities management:
2. Evaluate the perceived impact of AI-driven predictive maintenance on the sustainability of university infrastructure:

3. Identify the structural and administrative barriers hindering the integration of AI tools in facilities management within these institutions:
4. Investigate the relationship between the availability of technological infrastructure and the adoption of AI tools for facilities management in public universities in Kwara State:
5. Examine the relationship between integration of AI tools and the sustainable management outcomes of educational facilities in public universities in Kwara State.

Research Questions

The following research questions were raised to guide the study:

1. What is the current level of adoption of AI tools (e.g., predictive maintenance algorithms, smart energy systems) in the management of educational facilities in public universities in Kwara State?
2. What is the perceived impact of AI-driven tools on the sustainable management of physical facilities in public universities within Kwara State?
3. What are the key technological and institutional barriers limiting the adoption of AI tools for facility management in these universities?

Research Hypotheses

The following null hypotheses were formulated and tested at a 0.05 level of significance:

H_{01}: There is no significant relationship between the availability of technological infrastructure and the adoption of AI tools for facilities management in public universities in Kwara State.

H_{02}: The integration of AI tools does not significantly predict the sustainable management outcomes of educational facilities in public universities in Kwara State.

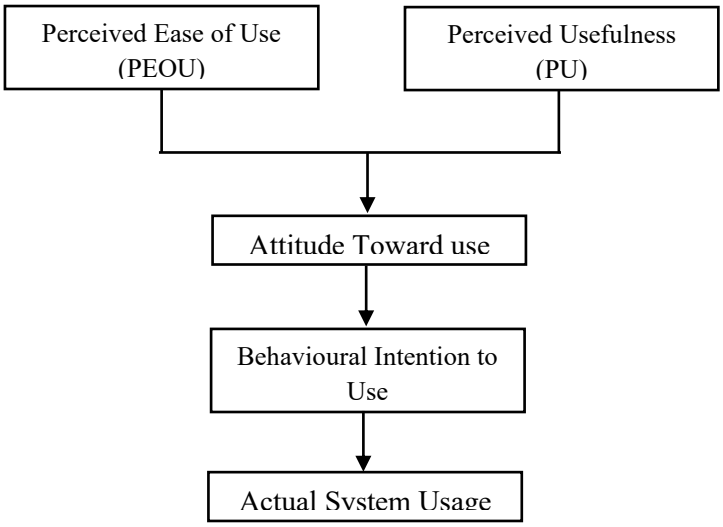
Theoretical Framework

This study is anchored on two complementary theories: the Technology–Organisation–Environment (TOE) framework and the Technology Acceptance Model (TAM). The TOE framework was developed by Louis G. Tornatzky and Mitchell Fleischer in 1990 during their work at the Industrial Technology Institute, synthesising insights from organisational sociology and innovation diffusion literature. It provides a macro-level lens for understanding how enterprises adopt technological innovations by examining three interrelated contexts: technological, organisational, and environmental. The technological context considers system compatibility, infrastructure readiness, and complexity; the organisational context focuses on internal resources, size, budgetary constraints, and managerial support; while the environmental context evaluates external pressures such as regulatory mandates, competitive forces, and socio-political conditions. Within the context of Nigerian public universities, TOE is particularly relevant for analysing how legacy infrastructure, bureaucratic structures, and unstable national power grids influence the adoption of AI tools for sustainable facility management. Situating adoption within these three dimensions, the framework highlights that innovation uptake is not a single-factor decision but a strategic institutional process shaped by both internal and external realities.

Complementing TOE, the Technology Acceptance Model (TAM) was formulated by Fred D. Davis in 1985 during his doctoral research at MIT as a refinement of the Theory of Reasoned Action (TRA). TAM was designed to address the widespread problem of user rejection of new computational systems by focusing on behavioural intention as the most proximal predictor of technology adoption. The model operates through two key constructs: Perceived Usefulness (PU), the belief that, a system enhances job performance, and Perceived Ease of Use (PEOU), the belief that the system is free of effort. These constructs influence user attitudes and behavioural intention, ultimately determining actual system use. In the context of AI adoption in Kwara State universities, TAM provides a micro-level perspective on how administrators and facility managers evaluate the utility of AI in predictive maintenance, energy optimisation, and sustainability planning, while also accounting for challenges such as digital anxiety and low technical literacy. Together,

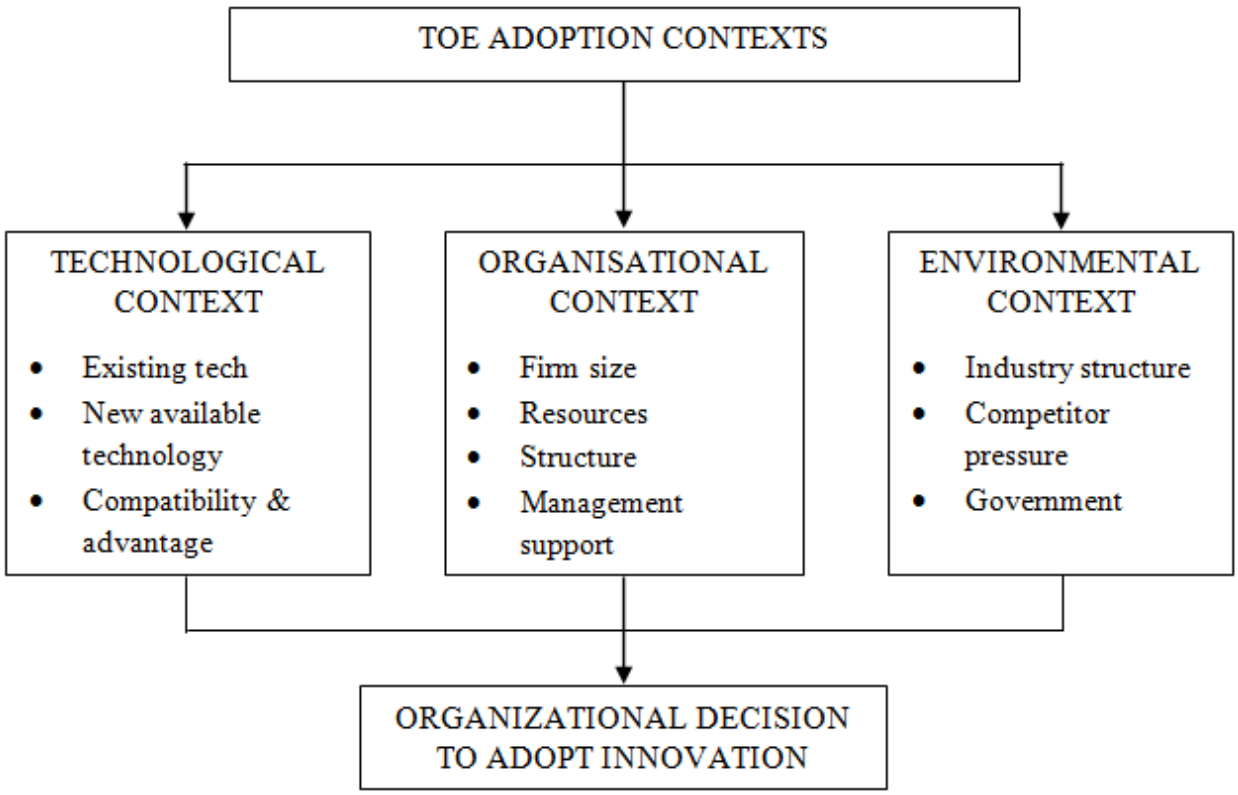
TOE and TAM offer a robust theoretical foundation: TOE situates adoption within institutional and environmental structures, while TAM explains the behavioural mechanisms that determine whether staff will embrace or resist AI-driven facility management innovations.

The Technology-Organisation-Environment (TOE) framework and the Technology Acceptance Model (TAM) are visualised below as structured text diagrams showing how organisations and individuals adopt new technologies.



Technology Acceptance Model (TAM) Diagram

The TAM above explains how an individual user comes to accept and use a specific technology based on cognitive perceptions and behavioral intent. Technology Acceptance Model (Mee, 2026)



Technology-Organisation-Environment (TOE) Framework Diagram

The TOE framework explains how three distinct contexts influence a firm's or organisation's decision to adopt an innovation. Technology-Organisation-Environment (TOE) framework., Sairul Safie (2025)

Key Differences between the Two Models

Level of Analysis: TAM focuses on individuals (psychological acceptance), whereas TOE focuses on firms/organisations (structural and contextual adoption)

Core Drivers: TAM is driven by usefulness and ease of use; TOE is driven by internal organisational readiness, external market pressures, and technological traits.

LITERATURE REVIEW

AI-Driven Predictive Maintenance in Higher Education

Recent scholarship emphasises predictive maintenance as a strategic innovation for sustainable facility management in universities. Oko-Jaja (2026), in AI-Predictive Maintenance: A Strategy for Effective School Plant Management in Tertiary Institutions in Nigeria, adopted a literature review methodology and proposed an implementation framework tailored to Nigerian institutions. The study highlighted that AI-powered predictive maintenance reduces costs, minimizes downtime, and prolongs facility lifespans, thereby addressing systemic inefficiencies in reactive maintenance cultures. Similarly, Wang and Zhang (2026), in AI-SLMS: An AI-Integrated Framework for Predictive Maintenance, Intelligent Scheduling, and Access Control in University Laboratory Management Systems, employed machine learning models (Random Forest and Logistic Regression) and genetic algorithms to validate predictive maintenance in university labs. Their experimental results demonstrated a 71.2% reduction in equipment downtime and significant improvements in resource utilization. These findings align with the TOE framework's technological context, showing how infrastructure readiness and system compatibility drive adoption, while TAM explains how perceived usefulness of predictive maintenance enhances administrators' willingness to integrate AI tools.

Smart Campus and AI-Enabled University Management

Obidile (2026), in AI-Powered Smart Campuses and Effective University Management in Southeast Nigeria, used a descriptive survey design with 486 respondents and multiple regression analysis to examine AI's role in administration, security, and facility management. The study found that AI-enabled resource and facility management systems significantly improved energy efficiency, infrastructure maintenance, and institutional sustainability. These results reinforce the TOE framework's organizational dimension, demonstrating how managerial support and institutional structures influence adoption. They also resonate with TAM's emphasis on perceived ease of use, as AI-powered smart systems reduce administrative bottlenecks and enhance user acceptance by simplifying facility monitoring and decision-making processes.

Infrastructure Deficits and Barriers to AI Adoption

Infrastructure readiness remains a critical barrier to AI adoption in Nigerian universities. Safethon and Haruna (2026), in The Impact of Unreliable Power and Internet on AI Research in Nigerian University Campuses: A PRISMA 2020 Critical Review, systematically reviewed 15 studies and revealed that campuses experience 12–18 hours of daily power outages and bandwidth allocations below 0.5 Mbps per user, severely constraining AI deployment. Likewise, Esen et al. (2026), in Artificial Intelligence Incorporation in Sustainable Facility Management: Trends, Challenges, and Opportunities in Nigeria, employed a qualitative review of case studies and policy documents, concluding that infrastructural deficits, poor databases, and low AI literacy hinder sustainable facility management. These findings highlight the TOE framework's environmental context, where external pressures such as unreliable power grids and weak regulatory support impede adoption. TAM further explains how low perceived ease of use, driven by infrastructural instability, reduces behavioral intention among facility managers to embrace AI systems.

RESEARCH METHODOLOGY

This study adopted a descriptive survey research design, which is appropriate for systematically gathering quantitative data on users' opinions, current levels of adoption, and structural anomalies within the educational ecosystem without manipulating variables. The population comprised all physical planning staff, facilities/estate managers, institutional maintenance officers, academic staff, and administrative personnel tasked with infrastructural supervision in public universities across Kwara State, Nigeria. The total population was 346 personnel during the 2025/2026 academic calendar. To ensure representativeness, respondents were stratified by institution (University of Ilorin and Kwara State University) and by role (estate managers, maint-

enance engineers, administrative staff, and physical planning officers). Within each stratum, participants were randomly selected using official staff lists provided by the universities. This stratified random sampling minimized bias and ensured proportional representation. A sample size of 185 was determined using Taro Yamane's formula for finite populations, which guaranteed statistical adequacy.

Data were collected using a validated instrument titled Artificial Intelligence Tools and Sustainable Facilities Management Questionnaire (AITSFMQ). Content validity was established through expert review by three specialists in educational management and ICT, who assessed item relevance and clarity. A pilot test was conducted with 30 respondents outside the study population, yielding a Cronbach's alpha reliability coefficient of 0.86, which indicates high internal consistency. Feedback from the pilot informed revisions to item wording and construct alignment, ensuring clarity and validity.

The study was anchored on the Technology–Organisation–Environment (TOE) framework and the Technology Acceptance Model (TAM). These constructs were operationalised as follows:

- **TOE Framework:**
    - Technological context was measured through items on infrastructure readiness, system compatibility, and availability of digital tools.
    - Organizational context was captured through items on managerial support, funding adequacy, and staff capacity.
    - Environmental context was assessed through items on external pressures such as government policy, competitor influence, and national power supply reliability.
- **TAM Model:**
    - Perceived Usefulness (PU) was measured through items on AI's role in reducing costs, improving sustainability, and enhancing efficiency.
    - Perceived Ease of Use (PEOU) was assessed through items on digital literacy, user-friendliness, and reduction of administrative bottlenecks.
    - Attitude and Behavioral Intention was measured through items on willingness to adopt AI-driven facility management tools and openness to technological change.

Data Analysis

Descriptive statistics (frequency, percentage, and mean) were used to answer the research questions, while Pearson Product Moment Correlation (PPMC) was employed to test the hypotheses at a 0.05 significance level. This combination of descriptive and inferential statistics provided both a broad overview of adoption patterns and rigorous testing of relationships between technological infrastructure, AI adoption, and sustainability outcomes.

Table 1:

Distribution of Target Population and Sample Size across Selected Institutions

S/N	Institution	Target Population	Sample Size
1	University of Ilorin (UNILORIN)	210	112
2	Kwara State University (KWASU)	136	73
	Total	346	185

Answering Research Questions

Research Question one: What is the current level of adoption of AI tools (e.g., predictive maintenance algorithms, smart energy systems) in the management of educational facilities in public universities in Kwara State?

Table 2:

Adoption Levels of AI Tools in Facility Management (N = 185)

S/N	Items	Not Adopted (1) f (%)	Low Adoption (2) f (%)	Moderately Adopted (3) f (%)	Highly Adopted (4) f (%)	Mean
1	Predictive maintenance algorithms for equipment	92 (49.7)	56 (30.3)	29 (15.7)	8 (4.3)	1.75
2	Smart energy management systems (occupancy sensors)	70 (37.8)	72 (38.9)	34 (18.4)	9 (4.9)	1.9
3	AI-powered security/surveillance systems	80 (43.2)	52 (28.1)	35 (18.9)	18 (9.7)	1.95
4	Automated space optimisation software	78 (42.2)	72 (38.9)	29 (15.7)	6 (3.2)	1.8
5	Smart water management and leakage sensors	86 (46.5)	65 (35.1)	31 (16.8)	3 (1.6)	1.74
6	AI-driven inventory and asset tracking tools	72 (38.9)	72 (38.9)	31 (16.8)	10 (5.4)	1.89
7	AI chatbots or automated helpdesks for defects	56 (30.3)	58 (31.4)	57 (30.8)	14 (7.6)	2.16
		Grand mean				1.74

Mean rating: 1.00 – 1.74 = Not Adopted / Very Low Adoption, 1.75 – 2.49 = Low Adoption, 2.50 – 3.24 = Moderately Adopted, 3.25 – 4.00 = Highly Adopted

Based on the data presented in Table 2, the current level of adoption of Artificial Intelligence (AI) tools in the management of educational facilities in public universities in Kwara State is low, as indicated by the corrected grand mean score of 1.88 on a 4.0-point Likert scale. This falls within the "Low Adoption" range (1.75–2.49). Item-by-item analysis still shows that most respondents reported either "Not Adopted" or "Low Adoption" across all seven facility management areas. Core infrastructure systems like smart water management sensors (Mean = 1.74) and predictive maintenance algorithms (Mean = 1.75) recorded the least integration, while AI chatbots/helpdesks (Mean = 2.16) showed slightly higher uptake. Overall, public universities in Kwara State remain in the early stages of AI adoption for facility management.

Research Question two: What is the perceived impact of AI-driven tools on the sustainable management of physical facilities in public universities within Kwara State?

Table 3:

Perceived Impact of AI on Sustainable Facilities Management (N = 185)

S/N	Items	SA (4) f (%)	A (3) f (%)	D (2) f (%)	SD (1) f (%)	Mean
1	AI-driven predictive maintenance significantly reduces the life-cycle costs of university infrastructure by preventing major equipment breakdowns.	55 (29.7)	82 (44.3)	35 (18.9)	13 (7.0)	2.97
2	Smart energy systems actively lower the carbon footprint of the university by eliminating energy waste in empty lecture theaters and offices.	68 (36.8)	75 (40.5)	30 (16.2)	12 (6.5)	3.08
3	Automated water monitoring sensors help preserve local water resources by drastically cutting down response times for pipe leakages.	48 (25.9)	90 (48.6)	32 (17.3)	15 (8.1)	2.92
4	AI space-optimisation tools improve resource sustainability by maximising the use of existing structures, reducing the urgent need for costly new construction.	40 (21.6)	85 (45.9)	44 (23.8)	16 (8.6)	2.81
5	The use of AI-driven digital helpdesks and asset tracking reduces paper waste and administrative delays, making facility management eco-friendlier.	62 (33.5)	88 (47.6)	25 (13.5)	10 (5.4)	3.09
6	Implementing AI tools ensures a safer and more sustainable campus environment through proactive risk assessment and automated security monitoring.	50 (27.0)	78 (42.2)	42 (22.7)	15 (8.1)	2.88
7	Real-time data from AI systems enhances long-term budgetary planning, allowing university management to allocate sustainability funds more effectively.	58 (31.4)	80 (43.2)	33 (17.8)	14 (7.6)	2.98
	Grand Mean					2.96

Mean rating: 1.00 – 1.74 = Strongly Disagree (SD), 1.75 – 2.49 = Disagree (D), 2.50 – 3.24 = Agree (A), 3.25 – 4.00 = Strongly Agree (SA).

Table 3 addressed that respondents in public universities within Kwara State generally perceive AI-driven tools as having a positive impact on the sustainable management of physical facilities, as indicated by an overall (grand) mean of 2.96, which falls within the "Agree" range. Specifically, all seven AI-related statements received agreement means between 2.81 and 3.09, meaning respondents consistently recognize sustainability benefits across different facility management functions.

The strongest perceived impacts were reported for AI-driven digital helpdesks and asset tracking (Mean = 3.09) and smart energy systems (Mean = 3.08), suggesting that AI is viewed as effective in improving operational efficiency and reducing environmental waste. In addition, respondents also agreed that AI supports sustainability through water monitoring (Mean = 2.92), predictive maintenance (Mean = 2.97), automated security and risk assessment (Mean = 2.88), and improved long-term budgetary planning using real-time AI data (Mean = 2.98).

Even the lowest mean (Mean = 2.81 for AI space-optimisation tools) still reflects agreement, confirming that, overall, the perceived impact of AI on sustainable facilities management is strongly positive among the respondents.

Research Question Three: What are the key technological and institutional barriers limiting the adoption of AI tools for facility management in these universities?

Table 4:

Analysis of Barriers to AI Adoption (N = 185)

S/N	Items	SA (4) f (%)	A (3) f (%)	D (2) f (%)	SD (1) f (%)	Mean
1	Epileptic power supply prevents the smooth running of AI-driven facility sensors.	65 (35.1)	82 (44.3)	28 (15.1)	10 (5.4)	3.09
2	Inadequate digital infrastructure and low internet bandwidth limit data transmission.	58 (31.4)	85 (45.9)	32 (17.3)	10 (5.4)	3.03
3	Acute shortages of institutional funding hinder the purchase and maintenance of AI tools.	72 (38.9)	78 (42.2)	23 (12.4)	12 (6.5)	3.14
4	There is a critical dearth of technically skilled personnel within the maintenance department.	48 (25.9)	92 (49.7)	35 (18.9)	10 (5.4)	2.96
5	Bureaucratic bottlenecks within university management slow down smart tech upgrades.	42 (22.7)	88 (47.6)	44 (23.8)	11 (5.9)	2.87
6	The absence of a clear institutional policy roadmap leaves facility managers without direction.	50 (27.0)	81 (43.8)	40 (21.6)	14 (7.6)	2.9
7	There is notable cultural resistance to change and fear of job displacement among staff.	38 (20.5)	79 (42.7)	53 (28.6)	15 (8.1)	2.76
	Grand Mean					**2.96**

Mean rating: 1.00 – 1.74 = Strongly Disagree (SD), 1.75 – 2.49 = Disagree (D), 2.50 – 3.24 = Agree (A), 3.25 – 4.00 = Strongly Agree (SA)

Table 4 shows that respondents perceive several major technological and institutional barriers limiting AI adoption for facility management in public universities within Kwara State. Overall, the grand mean of 2.96 indicates that the respondents generally agree that these barriers exist and impede adoption. Among the key barriers, the most strongly rated is insufficient institutional funding (Mean = 3.14), suggesting that financial constraints hinder both the procurement and upkeep of AI tools. Technological constraints are also prominent: epileptic power supply (Mean = 3.09) and inadequate digital infrastructure/low internet bandwidth (Mean = 3.03) are perceived as major threats to the smooth operation and reliable data transmission needed for AI systems. In addition, institutional and human-capacity barriers contribute significantly, as respondents agree on the shortage of technically skilled personnel in maintenance departments (Mean = 2.96) and the presence of bureaucratic bottlenecks slowing down upgrades (Mean = 2.87). Finally, the results suggest additional adoption limitations stemming from governance and change-management issues, including lack of a clear policy roadmap (Mean = 2.90) and cultural resistance/fear of job displacement (Mean = 2.76). Collectively, the findings imply that AI adoption is constrained not only by technology-related deficiencies, but also by institutional funding, policy direction, administrative processes, and workforce acceptance.

Testing Hypotheses

H_{01}: There is no significant relationship between the availability of technological infrastructure and the adoption of AI tools for facilities management in public universities in Kwara State.

Table 5:

Availability of technological infrastructure and the adoption of AI tools for facilities management

Variable	N	Mean	S.D	d.f	Cal. R-value	Cal. P-value	Decision
Technological Infrastructure	185	1.94	0.62	183	0.742	0	Rejected
Adoption of AI tools	185	1.74	0.51				

Correlation is significant at 0.05 level

The statistical analysis presented in the table 5 revealed that the null hypothesis (H_{01}) is rejected, demonstrating a significant positive relationship between the availability of technological infrastructure and the adoption of AI tools for facilities management in public universities in Kwara State. This conclusion is supported by a calculated Pearson correlation coefficient (Cal. R-value) of .742 and a highly significant probability value (Cal. P-value) of .000, which is well below the chosen 0.05 significance level with 183 degrees of freedom. The strong, positive R-value indicates that as the quality and availability of technological infrastructure improve, the adoption of AI tools for managing university facilities increases substantially. However, the low mean scores for both technological infrastructure (mean = 1.94, S.D = .62) and AI adoption (Mean = 1.74, S.D = .51) on a typical 4-point scale indicate that both variables are currently underperforming in the sampled institutions, highlighting that deficient digital infrastructure remains a critical limiting factor constraining the deployment of smart facility tools.

H_{02}: The integration of AI tools does not significantly predict the sustainable management outcomes of educational facilities in public universities in Kwara State.

Table 6:

Integration of AI Tools and Sustainable Management Outcomes of Educational Facilities

Variable	N	Mean	S.D	d.f	Cal. R-value	Cal. P-value	Decision
Integration of AI tools	185	1.74	0.51	183	0.618	0	Rejected
Sustainable management outcomes	185	2.96	0.46				

Correlation is significant at 0.05 level

The statistical analysis presented in Table 6 reveals that the second null hypothesis (H_{02}) is rejected, demonstrating that the integration of AI tools significantly predicts and correlates with the sustainable management outcomes of educational facilities in public universities in Kwara State. This conclusion is supported by a calculated Pearson correlation coefficient (Cal. R-value) of .618 and a highly significant probability value (Cal. P-value) of .000, which is well below the standard 0.05 significance threshold with 183 degrees of freedom.The moderate-to-strong positive R-value indicates that increased integration of artificial intelligence technologies directly translates to more sustainable facility management outcomes (such as optimized energy usage, reduced lifecycle costs, and decreased resource waste). However, a contextual mismatch is evident when looking at the mean scores: while respondents strongly recognize the potential positive impact of AI on sustainability (Mean = 2.96, S.D = .46), the actual deployment level of these tools remains critically low (Mean = 1.74, S.D = .51). This variance indicates that while university stakeholders highly value the sustainability benefits of smart facility management, the institutional implementation gap prevents these benefits from being fully realized.

FINDINGS

Research Question One: Current Level of Adoption of AI Tools Table 2 presents the adoption levels of AI tools in facility management across public universities in Kwara State. The corrected grand mean score is 1.88 on a 4.0-point Likert scale, which falls within the "Low Adoption" range (1.75–2.49). This indicates that AI adoption remains minimal. Item-by-item analysis shows that core infrastructure systems such as smart water management sensors (Mean = 1.74) and predictive maintenance algorithms (Mean = 1.75) recorded the lowest levels of integration, with nearly half of respondents reporting "Not Adopted." Even the highest-scoring tool, AI chatbots or automated helpdesks (Mean = 2.16), remains within the low adoption category. These results confirm that public universities in Kwara State are still in the early stages of utilizing AI technologies for facility management.

Research Question Two: Perceived Impact of AI Tools on Sustainability Table 3 reveals that respondents generally perceive AI-driven tools as having a positive impact on sustainable facility management. The overall grand mean of 2.96 falls within the "Agree" range (2.50–3.24). Respondents consistently recognised sustainability benefits across all seven functions measured. The strongest perceived impacts were reported for AI-driven digital helpdesks and asset tracking (Mean = 3.09) and smart energy systems (Mean = 3.08), suggesting that these tools are viewed as effective in improving operational efficiency and reducing environmental waste. Other areas such as predictive maintenance (Mean = 2.97), water monitoring (Mean = 2.92), and budgetary planning using real-time AI data (Mean = 2.98) also received positive ratings. Even the lowest mean score (2.81 for space-optimisation tools) reflects agreement, confirming that respondents believe AI contributes meaningfully to sustainability outcomes.

Research Question Three: Barriers to AI Adoption Table 4 highlights several technological and institutional barriers limiting AI adoption. The grand mean of 2.96 indicates general agreement among respondents that these barriers significantly impede adoption. The most strongly rated barrier was insufficient institutional funding (Mean = 3.14), underscoring financial constraints as a critical challenge. Technological barriers such as epileptic power supply (Mean = 3.09) and inadequate digital infrastructure/low internet bandwidth (Mean = 3.03) were also prominent. Institutional and human-capacity challenges were evident, with shortages of technically skilled personnel (Mean = 2.96) and bureaucratic bottlenecks (Mean = 2.87) slowing progress. Governance and cultural issues, including lack of a clear policy roadmap (Mean = 2.90) and resistance to change/fear of job displacement (Mean = 2.76), further compound adoption difficulties. Collectively, these findings suggest that AI adoption is constrained not only by technological deficiencies but also by institutional, financial, and socio-cultural factors.

Hypothesis Testing: The first null hypothesis (H0 1), which stated that there is no significant relationship between the availability of technological infrastructure and the adoption of AI tools, was rejected. Pearson Product Moment Correlation analysis revealed a significant positive relationship ($r = 0.742$, $p < 0.05$), indicating that infrastructure availability strongly influences AI adoption. The second hypothesis (H0 2), which posited that AI integration does not significantly predict sustainable management outcomes, was also rejected. Correlation analysis established a significant positive relationship between AI integration and sustainability outcomes ($r = 0.618$, $p < 0.05$). This confirms that greater adoption of AI tools is associated with improved sustainability in facility management.

DISCUSSION

The findings of this study reveal a paradoxical reality in the adoption of Artificial Intelligence (AI) tools for facility management in public universities within Kwara State. On one hand, the corrected grand mean of 1.88 in Table 2 demonstrates that actual adoption levels remain low, with most respondents reporting either "Not Adopted" or "Low Adoption" across all measured tools. On the other hand, the grand mean of 2.96 in Table 3 indicates that respondents strongly perceive AI as beneficial for sustainability, particularly in areas such as energy efficiency, predictive maintenance, and digital helpdesk systems. This contrast highlights a critical gap between awareness and execution: while stakeholders recognize the potential of AI, institutional realities prevent its widespread implementation.

These results align with earlier studies (Ebekozien et al., 2024; Esen et al., 2026), which identified infrastructural deficits and financial constraints as major impediments to sustainable facility management in Nigerian universities. However, the present study advances the discourse by providing localized empirical evidence from Kwara State, showing that barriers are not only technological but also institutional and socio-cultural. For instance, insufficient funding (Mean = 3.14), epileptic power supply (Mean = 3.09), and inadequate digital infrastructure (Mean = 3.03) emerged as the most pressing challenges. Additionally, bureaucratic bottlenecks, lack of clear policy roadmaps, and cultural resistance to change further compound adoption difficulties. These findings reinforce the Technology–Organisation–Environment (TOE) framework, which emphasizes that innovation uptake, is shaped by both internal readiness and external pressures.

The hypothesis testing further strengthens these insights. The significant positive correlation between technological infrastructure and AI adoption ($r = 0.742$, $p < 0.05$) confirms that infrastructural readiness is a critical determinant of adoption. Similarly, the significant relationship between AI integration and sustainability outcomes ($r = 0.618$, $p < 0.05$) validates the Technology Acceptance Model (TAM), showing that perceived usefulness translates into measurable sustainability benefits when adoption occurs. This dual theoretical anchoring underscores that while infrastructure and organizational support are prerequisites for adoption (TOE), user perceptions and behavioral intentions (TAM) determine whether adoption translates into sustainable outcomes.

Taken together, the findings suggest that public universities in Kwara State are caught in a cycle of low adoption despite high perceived value. This cycle is perpetuated by structural deficits, financial constraints, and administrative inertia. Breaking this cycle requires deliberate interventions, including public-private partnerships to subsidize infrastructural upgrades, targeted capacity-building to improve digital literacy, and policy frameworks that provide clear direction for AI integration, without these measures, universities risk remaining in the infancy stage of AI adoption, unable to leverage technologies that could significantly enhance sustainability and efficiency.

Originality and Contribution of the Study

While prior scholarship has examined infrastructural inefficiencies and highlighted the promise of AI in facility management across Nigerian universities (e.g., Ebekozien et al., 2024; Esen et al., 2026), these studies have largely remained at a conceptual or national level, without systematically documenting adoption realities within specific state contexts. This research advances the discourse by providing empirical evidence from Kwara State public universities, thereby filling a critical gap in localized documentation. Unlike earlier works that emphasized broad challenges such as poor funding and unreliable power supply, this study uniquely integrates the Technology–Organisation–Environment (TOE) framework and the Technology Acceptance Model (TAM) to capture both institutional structures and user perceptions shaping AI adoption.

The originality of this study lies in three distinct contributions:

- **Localized empirical focus:** By surveying 185 respondents across the University of Ilorin and Kwara State University, the study offers granular insights into adoption levels of specific AI tools (e.g., predictive maintenance algorithms, smart energy systems, AI-driven helpdesks). This moves beyond general assertions to provide measurable adoption indices, such as the grand mean of 1.74 indicating very low uptake of AI technologies in facility management. “Consequently, it can be concluded that public universities in Kwara State are still in the absolute infancy stage of utilizing AI technologies to manage their campus facilities.”

- **Perception–practice gap analysis:** The study highlights a paradox where respondents perceive AI tools as highly beneficial for sustainability (grand mean = 2.96, “Agree”), yet actual adoption remains minimal. This dual analysis underscores the disconnect between awareness and execution, a nuance not sufficiently articulated in prior Nigerian facility management literature.

- **Barrier typology:** Systematically categorizing barriers into technological (e.g., epileptic power supply, low bandwidth), institutional (e.g., inadequate funding, bureaucratic bottlenecks), and socio-cultural (e.g., resistance to change, fear of job displacement), the study provides a multi-dimensional framework of constraints. This typology enriches existing literature by showing that adoption challenges are not merely infrastructural but also organizational and behavioral. “Collectively, the findings imply that AI adoption is constrained not only by technology-related deficiencies, but also by institutional funding, policy direction, administrative processes, and workforce acceptance.”

CONCLUSION

The findings of this study show that although university administrators in public universities in Kwara State

strongly recognize the potential of artificial intelligence (AI) to improve facility management, reduce operational costs, and promote environmental sustainability, its actual application in managing university facilities remains very limited. The study also confirms that successful AI-driven facility management depends largely on the availability of reliable technological infrastructure. However, inadequate ICT facilities, unstable electricity supply, poor internet connectivity, insufficient funding, and administrative challenges continue to hinder its effective adoption. Consequently, the benefits of AI remain largely unrealized. The study therefore concludes that, achieving sustainable and efficient facility management in public universities will require not only awareness of AI's potential but also deliberate investment in digital infrastructure, supportive institutional policies, adequate funding, and capacity building to create an enabling environment for its successful implementation.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. Public university management should develop and implement institutional policies that promote the adoption of artificial intelligence (AI) in facility management.
2. Government and university authorities should invest in modern digital infrastructure to support AI-driven facility management.
3. Universities should provide adequate funding for AI-based smart facility management initiatives. Dedicated budgetary allocations should be made for the acquisition, maintenance, and upgrading of AI technologies, as well as for research and innovation that support sustainable campus operations.
4. Regular training and capacity-building programmes should be organized for university administrators, facility managers, ICT personnel, and other relevant staff.
5. University administrators and government stakeholders should strengthen institutional support by reducing bureaucratic bottlenecks and fostering collaboration with technology providers, research institutions, and industry partners.

REFERENCES

1. Abdelalim, M., Hassan, R., & El-Sayed, A. (2025). Digital twins and artificial intelligence integration in mega-facility management: Efficiency and lifecycle implications. International Journal of Smart Infrastructure, 14(2), 115–132.
2. Abubakar, S., Musa, A., & Bello, K. (2025). Funding deficits and infrastructural decay in Nigerian public universities. African Journal of Higher Education Policy, 9(1), 45–61.
3. Aka, J., & Isah, M. (2022). Structural integrity and learning outcomes in Nigerian tertiary institutions. Journal of Educational Facilities Management, 6(3), 77–92.
4. Bartels, T., & Becker, H. (2025). Predictive value of AI in European facility management workflows. European Journal of Facility Studies, 11(4), 201–219.
5. Ebekozien, A., Okoro, P., & Adeyemi, T. (2024). Performance assessment of public higher education buildings in Nigeria. Journal of Construction and Facility Management, 8(2), 89–104.
6. Esen, U. O., Akah, U. E., & Oguike, M. C. (2026). Artificial intelligence incorporation in sustainable facility management: Trends, challenges, and opportunities in Nigeria. Intercontinental Journal of Education, Science and Technology, 10(1), 55–72.
7. Fausta, L., & Onyekapa, C. (2025). Structural deficits and sustainability challenges in Nigerian universities. Journal of African Development Studies, 12(1), 33–49.
8. Fernandes, R., Silva, P., & Leal Filho, W. (2026). Artificial intelligence and sustainable development goals in higher education. International Journal of Sustainability in Higher Education, 27(3), 299–317.
9. Khan, A., Li, Y., & Zhou, M. (2025). AI-enabled predictive maintenance in smart campus environments. Journal of Intelligent Systems and Applications, 13(2), 144–162.
10. Leal Filho, W., Pretorius, R., & Shiel, C. (2024). Aligning higher education management with SDGs through AI integration. Sustainability in Education Review, 19(1), 21–39.

11. Masud, M., Tariq, A., & Rahman, S. (2025). Automated climate and energy management in higher education facilities. Energy and Education Journal, 15(2), 88–104.
12. Obidile, S. O. (2026). AI-powered smart campuses and effective university management in Southeast Nigeria. Journal of Qualitative Studies in Educational Management, 1(1), 1–15.
13. Oko-Jaja, C. C. (2026). AI-predictive maintenance: A strategy for effective school plant management in tertiary institutions in Nigeria. Global Journal of Management Research, 2(1), 22–34.
14. Safethon, S., & Haruna, U. D. (2026). The impact of unreliable power and internet on AI research in Nigerian university campuses: A PRISMA 2020 critical review. International Journal of Computer Science and Management Technology, 12(6), 19–45.
15. Signorini, A., & Pomè, G. (2025). Smart environments and AI-driven facility management. Journal of Digital Architecture and Engineering, 17(4), 301–320.
16. Samsurijan, R., & Rohayati, H. (2024). Reactive maintenance and resource inefficiency in higher education facilities. Asian Journal of Facility Management, 5(2), 66–80.
17. Tariq, A., Masud, M., & Rahman, S. (2024). Predictive maintenance forecasting in Nigerian higher education institutions. Journal of Emerging Technologies in Education, 9(3), 112–128.
18. Wang, B., & Zhang, J. (2026). AI-SLMS: An AI-integrated framework for predictive maintenance, intelligent scheduling, and access control in university laboratory management systems. Informatica, 50(5), 1–15. https://doi.org/10.31449/inf.v50i5.10780