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INNOVATIVE STRATEGIES FOR SUSTAINABLE MAINTENANCE OF EDUCATIONAL FACILITIES IN NIGERIAN TERTIARY INSTITUTIONS

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ABSTRACT

The sustainability of educational facilities is fundamental to the effectiveness, safety, and global competitiveness of tertiary institutions. In Nigeria, persistent infrastructural deterioration continues to undermine teaching, learning, research, and institutional performance. This paper examines the key challenges confronting sustainable maintenance of educational facilities in Nigerian tertiary institutions and proposes innovative strategies for addressing these challenges. Drawing on relevant literature and contextual analysis, the study identifies chronic underfunding, rapid student enrolment without proportional infrastructure expansion, poor maintenance culture, weak governance and accountability structures, shortage of skilled facility management personnel, substandard construction practices, bureaucratic procurement delays, vandalism, unstable electricity and water supply, and limited adoption of digital maintenance technologies as major constraints. The paper argues that the reactive and emergency-driven maintenance approaches prevalent in most institutions are economically inefficient and structurally unsustainable. To reverse this trend, the study advances innovative strategies such as the professionalization of facility management units, adoption of preventive and predictive maintenance systems, integration of ICT-based facility management tools, diversification of funding sources through public–private partnerships and alumni support, continuous capacity building for maintenance personnel, transparent

procurement practices, and the implementation of green and sustainable campus initiatives. The paper concludes that sustainable facility maintenance is not merely a technical obligation but a strategic imperative for higher education reform and national development in Nigeria.

KEYWORDS: Sustainable facility maintenance; Educational infrastructure; Facility management; Infrastructure sustainability.

INTRODUCTION

The physical environment of any educational institution is more than a backdrop for learning, it is an active contributor to academic success, student well-being, staff productivity, and institutional reputation. Around the world, tertiary institutions invest heavily in the construction, preservation, and modernization of their facilities because they understand that quality infrastructure is essential for quality education. In Nigeria, however, the reality is often different. Many public universities, polytechnics, and colleges of education operate in environments marked by deteriorating buildings, outdated laboratories, overcrowded classrooms, unreliable electricity, insufficient water supply, and aging equipment (Ajayi, 2024). These conditions not only limit the effectiveness of teaching and research but also send a broader message about national priorities and the value placed on education.

Tertiary education is the engine room of national development. It produces the skilled manpower, innovators, researchers, and problem-solvers upon whose expertise national progress depends. Yet, the ability of tertiary institutions to fulfill this mandate is significantly influenced by the quality of the facilities they possess. Studies consistently demonstrate that students learn better, are more motivated, and achieve higher outcomes when classrooms are conducive, equipment is functional, and campuses are safe and well-maintained (Ogunode & Galadima, 2023). Likewise, lecturers perform better, innovate more, and engage more deeply in research when they have access to reliable infrastructure and supportive working environments (Atobauka & Jacob, 2023).

Despite this reality, the Nigerian higher education system continues to grapple with chronic underfunding, rapid population growth, inflation, and governance challenges that make sustainable facility maintenance a recurring problem. In many institutions, maintenance is reactive, repairs are undertaken only after major breakdowns occur, often at a higher cost and with greater disruption to academic activities. Poor maintenance culture, bureaucratic delays, use of substandard materials, weak accountability mechanisms, and a shortage of qualified

facility management professionals have further deepened the infrastructural crisis (Ayokunle et al., 2024; Chimdi et al., 2024).

The situation is exacerbated by rising student enrollment without proportional expansion in infrastructure. Many universities admit far more students than their facilities were designed for, resulting in overcrowded lecture halls and hostels, overstretched water and electricity systems, and rapid deterioration of buildings and equipment. As a result, even newly constructed facilities quickly fall into disrepair, perpetuating a cycle of infrastructural decay (Ige & Asaju, 2024). This has serious implications for accreditation, national competitiveness, safety, and the employability of graduates.

As opined by Bassey (2025), the effective stewardship of educational facilities is paramount, necessitating the strategic acquisition of optimal provisions. This endeavor is fundamental to elevating pedagogical efficacy, enriching the student learning experience, and ultimately propelling the institution's enduring advancement and strategic growth. Therefore, sustainable maintenance of educational facilities is therefore not merely a technical issue, it is a strategic, economic, and ethical responsibility. Sustaining infrastructure ensures that resources invested in education yield long-term benefits, minimizes health and safety risks, reduces wasteful spending, and preserves the institutional heritage for future generations. More importantly, sustainable maintenance contributes to the creation of learning environments that inspire creativity, support research breakthroughs, foster innovation, and strengthen global competitiveness.

As the demands on Nigerian tertiary institutions evolve due to technological advancements, global educational trends, and societal expectations, there is an urgent need to rethink and redesign the systems that govern facility maintenance. This includes embracing modern facility management practices, incorporating digital technologies, mobilizing diverse funding sources, enforcing accountability, and involving the entire academic community in the culture of preservation. This article therefore examines the current challenges and presents innovative, forward-thinking strategies that Nigerian tertiary institutions can adopt to ensure sustainable maintenance of their educational facilities. The goal is to provide practical insights that support policy formulation, institutional reform, and long-term infrastructural development across the higher education system.

Why Sustainable Maintenance Matters

Sustainable maintenance of educational facilities is central to the success, stability, and long-term viability of tertiary institutions. It goes far beyond fixing broken structures; it encompasses the continuous planning, monitoring, upgrading, and preservation of facilities to ensure that they support teaching, learning, research, and community service for generations to come. In the context of Nigerian tertiary institutions, where infrastructural decline has become a recurring feature, understanding the significance of sustainable maintenance is essential for reversing years of deterioration and repositioning the sector for global competitiveness.

First, sustainable facility maintenance directly impacts academic quality and student outcomes. Research has shown that the physical condition of learning environments strongly influences students' concentration, engagement, motivation, and overall performance (Ogunode & Galadima, 2023). When classrooms are well-ventilated, lecture spaces are comfortable, laboratories are equipped and functional, and libraries are digitally connected, students are more likely to participate actively and develop a positive attitude towards learning. On the contrary, dilapidated buildings, overcrowded lecture halls, broken furniture, and outdated equipment create environments of frustration and disengagement that hinder effective learning.

Second, sustainable maintenance is crucial for enhancing staff productivity and professional satisfaction. Lecturers and researchers depend on reliable infrastructure, such as stable electricity, functional laboratories, modern ICT facilities, and safe office spaces, to deliver quality academic services. According to Atobauka and Jacob (2023), staff morale declines significantly when they are forced to teach in poor environments, which reduces creativity, research output, and job commitment. A well-maintained institution, therefore, becomes a catalyst for academic excellence and innovation.

Third, sustainable maintenance ensures cost efficiency and long-term financial savings. Deferred maintenance often results in more costly repairs or complete infrastructural failure. Buildings with minor leaks become structural hazards; outdated electrical systems become fire risks; and poorly maintained hostels degrade into unsafe living environments. Preventive and proactive maintenance reduces the frequency of emergency breakdowns, lowers energy waste, extends the lifespan of buildings, and helps institutions avoid enormous replacement costs.

Moreover, sustainable facility maintenance enhances institutional reputation and competitiveness. Globally, universities are evaluated not just by academic achievements but also by the quality of their physical environment. Prospective students, researchers, donors, and international partners are increasingly drawn to institutions with modern, functional, and aesthetically appealing infrastructures. For Nigerian institutions aspiring to attract foreign collaborations, research grants, and international students, infrastructural sustainability is non-negotiable.

From a different standpoint, sustainable maintenance also contributes to safety and health. Poorly maintained buildings, malfunctioning laboratory equipment, inadequate water supply, and faulty electrical systems pose serious health threats to campus communities. Ensuring that facilities meet safety standards minimizes accidents, reduces liability risks, and creates a secure environment conducive to academic pursuits.

Finally, sustainable maintenance aligns with the global movement toward environmental stewardship and green campus development. Proper waste management, water conservation, energy-efficient building designs, renewable energy solutions, and climate-resilient construction are increasingly becoming markers of forward-thinking institutions. Adopting sustainable practices positions Nigerian institutions to join global conversations on climate action and environmental preservation.

In essence, sustainable maintenance is about building a future of resilience, excellence, and continuous improvement. It ensures that Nigerian tertiary institutions not only survive but thrive, delivering education that meets international standards and preparing learners for a rapidly evolving world.

Key Challenges to Effective Facility Maintenance in Nigerian Tertiary Institutions

Although the importance of sustainable facility maintenance is widely acknowledged, Nigerian tertiary institutions continue to operate under conditions that make effective upkeep extremely difficult. These challenges are systemic, interconnected, and deeply rooted in long-standing socio-economic and administrative realities. Recent studies affirm that infrastructure decay persists because maintenance has not been prioritized as a strategic component of institutional governance (Ogunode & Musa, 2023; Ihuoma & Nwachukwu, 2022). Understanding these challenges is essential for designing reforms that are realistic, sustainable, and transformative.

1. Chronic Underfunding and Financial Instability

Perhaps the most pervasive challenge facing tertiary institutions is chronic underfunding. For years, the education sector has received budgetary allocations far below global benchmarks, leaving universities and polytechnics unable to sustain regular maintenance (Ofor-Douglas, 2024; Ajayi, 2023). Underfunding forces institutions into a crisis-response mode where urgent repairs overshadow planned maintenance. Research shows that deferred maintenance leads to accelerated deterioration, equipment obsolescence, and repeated breakdown of utilities (Mohammed, 2024). In some institutions, buildings go decades without renovation because capital funding is insufficient to cover basic operational needs.

2. Rapid Enrolment Growth without Corresponding Infrastructure Expansion

Student enrolment in Nigerian tertiary institutions has increased steadily in response to population growth and national development pressures. However, infrastructure has not expanded proportionately. Lecture halls meant for 150 students now accommodate over 400, while hostels designed for four residents house eight or more (Atobauka & Jacob, 2023). This mismatch creates overcrowding, accelerates wear and tear, and overwhelms utilities such as electricity and water. Studies confirm that facilities deteriorate faster when enrolment expansions are not matched with investments in new buildings and equipment (Nwankwo & Ede, 2023).

3. Poor Maintenance Culture

A deeply rooted poor maintenance culture affects most public tertiary institutions in Nigeria. Instead of adopting preventive or predictive maintenance approaches, many institutions rely on reactive repairs only after damage becomes severe (Ekanem & Bassey, 2024). This culture is fueled by inadequate planning, leadership neglect, and the perception that maintenance is optional rather than essential. Scholars note that this reactive approach creates cycles of

emergency repairs, escalating costs, and shortened infrastructure lifespan (Adewale & Ojo, 2023).

4. Weak Leadership, Governance, and Accountability Structures

Effective facility management requires strategic leadership, transparent processes, and strong governance structures. However, bureaucratic bottlenecks, weak accountability, and politicized decision-making hinder timely maintenance interventions (Iwerebor et al., 2024). Maintenance requests may take months before approval, causing minor challenges to escalate. Evidence indicates that institutions with weak governance structures struggle to translate maintenance policies into measurable outcomes (Ogunode, 2023). Leadership failure therefore remains a central obstacle to infrastructure sustainability.

5. Lack of Skilled Facility Management Personnel

Facility management has become a specialized profession globally, but many Nigerian institutions lack trained facility managers, engineers, and technicians. Maintenance units are often staffed by personnel with outdated skills or limited technical competence, making it difficult to manage modern systems such as ICT labs, smart classrooms, and advanced laboratory equipment (Aghimien, Aigbavboa & Thwala, 2022). This skills gap leads to misdiagnosed faults, poor-quality repairs, and inefficient service delivery (Uduak & Musa, 2023). Without professional capacity, even well-funded maintenance plans fail.

6. Use of Substandard Materials and Poor-Quality Construction

The pervasive problem of substandard construction materials significantly contributes to infrastructure decay. Contractors may cut corners to reduce costs, and weak institutional oversight allows inferior materials to pass through procurement processes (Olatunji & Ajayi, 2022). Studies show that buildings constructed with low-quality materials are more susceptible to cracking, leakage, and repeated electrical failures within short periods (Ogunyemi & Falana, 2023). This not only increases maintenance frequency but also poses safety risks to campus occupants.

7. Bureaucratic Delays and Ineffective Procurement Processes

Public tertiary institutions are often constrained by slow, cumbersome administrative procedures. Maintenance requests and procurement processes can take months due to bureaucratic layers, political interference, and compliance delays (Nwosu & Eme, 2023). As a result, minor issues evolve into complex infrastructural failures. Research highlights that ineffective procurement systems discourage timely interventions, reduce transparency, and contribute to infrastructure decay (Iwerebor et al., 2024). This inefficiency frustrates staff and students who rely on functional facilities.

8. Vandalism, Misuse of Facilities, and Poor User Behavior

Vandalism and poor handling of facilities remain major but often underreported challenges. Students and sometimes staff engage in destructive behaviors such as breaking furniture, damaging fittings, tampering with electrical systems, or mishandling laboratory equipment (Okeke & Ibiam, 2020). Weak enforcement of facility-use rules and insufficient user education compound this issue. As recent studies show, irresponsible facility use significantly increases maintenance costs and shortens asset durability (Adebanjo & Alamu, 2023).

9. Energy and Water Supply Challenges

Unstable electricity supply and water scarcity complicate infrastructure maintenance across Nigerian campuses. Heavy reliance on diesel generators inflates operational costs and accelerates wear on electrical systems, while power fluctuations frequently damage sensitive ICT and laboratory equipment (Ofor-Douglas, 2024). Water shortages affect sanitation, laboratories, hostels, and landscaping. Utility instability therefore strains maintenance budgets and disrupts campus operations (Mohammed, 2024).

10. Absence of Modern Technology in Facility Management

Globally, institutions rely on digital tools such as Computerized Maintenance Management Systems (CMMS)**,** Building Information Modeling (BIM), and smart monitoring technologies to enhance facility management. However, many Nigerian tertiary institutions still rely on manual logs and paper-based methods (Oloruntoba & Thomas, 2022). Without digital systems, it becomes difficult to track equipment life cycles, schedule routine servicing, forecast maintenance costs, or monitor asset performance. Studies indicate that lack of digital adoption leads to inefficiency, delayed interventions, and poor documentation (Adebanjo & Alamu, 2023).

Innovative Strategies for Sustainable Facility Maintenance

Ensuring sustainable facility maintenance in Nigerian tertiary institutions requires a multipronged approach that integrates professional expertise, technology, financial innovation, and participatory governance. Modern research increasingly emphasizes that sustainable facility management is most effective when institutions adopt systemic, proactive, and data-driven strategies (Adeboye & Ogunbiyi, 2022; Nwankwo & Ede, 2023). Below are key innovative strategies and their detailed explanations.

1. Professionalization of Facility Management Structures

The first step toward sustainability is the professionalization of facility management units. Studies show that institutions with trained facility managers, engineers, safety officers, and planners experience significantly lower rates of infrastructural deterioration (Umar & Ibrahim, 2021; Aghimien et al. 2022). Professionalized units bring technical competence, improve workflow coordination, and ensure that maintenance responsibilities are clearly defined. Professional facility management improves accountability by establishing reporting systems, maintenance schedules, and performance benchmarks. It also aligns institutional practice with global standards where facility management is recognized as a specialized discipline contributing to operational efficiency and resource optimization (Ayodele & Ismaila, 2023). Without this professional framework, institutions fall back into the ineffective cycle of emergency repairs and fragmented maintenance practices.

2. Preventive and Predictive Maintenance Culture

Moving from reactive to preventive and predictive maintenance is widely acknowledged as one of the most cost-effective innovations in facility management. Preventive maintenance involves regular inspections, servicing, and minor repairs that prevent major breakdowns (Adewale & Ojo, 2023). Predictive maintenance goes further by using digital sensors and diagnostic tools to detect potential failures before they occur (Okolie & Oke, 2022). This shift reduces long-term maintenance costs, extends the lifespan of buildings, and minimizes disruptions to academic activities. Research also shows that institutions practicing preventive maintenance achieve higher user satisfaction and lower operational risks (Ekanem & Bassey, 2024). By embedding these practices into routine operations, Nigerian tertiary institutions can significantly slow the rate of infrastructural decay.

3. Adoption of ICT and Digital Facility-Management Tools

ICT-driven facility management is now central to efficient, modern campus operations. Tools such as Computerized Maintenance Management Systems (CMMS)**,** Building Management Systems (BMS)**,** and asset-tracking software enhance transparency, accuracy, and accountability (Oloruntoba & Thomas, 2022). These systems enable institutions to automate maintenance requests, monitor equipment life cycles, track utility consumption, and generate reports for decision-making. Digital systems reduce human error, accelerate response times, and provide real-time data for strategic planning (Adebanjo & Alamu, 2023). The adoption of ICT is especially critical for managing large campuses where manual tracking is unreliable and inefficient. Furthermore, sustainability studies highlight that digital monitoring contributes significantly to energy conservation and risk mitigation (Okafor & Nwosu, 2022).

4. Diversification of Funding Sources and Creative Financing Models

Given chronic underfunding in the Nigerian education sector, institutions must adopt creative and diversified financing strategies. Recent analyses indicate that public–private partnerships (PPPs), alumni contributions, donor support, and income-generating ventures can drastically improve funding availability for infrastructural maintenance (Ogunleye & Aluko, 2021; Nwosu & Eme, 2023). PPP models allow private investors to build hostels, ICT centres, or solar plants in return for concessionary rights. Alumni endowments have proven effective in several African universities, helping to renovate libraries, laboratories, and hostels (Adewumi & Oyetunji, 2022). These diverse funding mechanisms reduce reliance on government allocations and promote financial resilience.

5. Capacity Building and Training for Maintenance Personnel

Sustainable maintenance depends heavily on the competence of technicians, artisans, cleaners, and engineers responsible for daily operations. Continuous training enhances technical proficiency, safety compliance, and the proper use of modern equipment (Ihuoma & Nwachukwu, 2021). Training also helps personnel adapt to emerging maintenance technologies such as smart meters, energy-management systems, and ICT-enabled diagnostic tools. Scholars argue that institutions with strong capacity-development programmes experience significantly fewer maintenance backlogs and achieve better budgeting accuracy (Uduak & Musa, 2023). Routine workshops, certification courses, and collaborations with professional bodies like IFMA, COREN, and NIMechE are therefore essential for strengthening institutional capacity.

6. Transparency and Accountability in Procurement

Procurement corruption and lack of accountability significantly undermine facility sustainability. Transparent procurement practices, such as open bidding, digital monitoring, and third-party oversight, lead to higher-quality construction and reduced maintenance burdens (Olatunji & Ajayi, 2022). When substandard materials are eliminated through proper regulation and monitoring, institutions save long-term costs and enhance infrastructure durability. Accountability also ensures that funds allocated for maintenance are used appropriately. Evidence shows that institutions with transparent procurement systems report fewer abandoned projects and lower rates of facility failure (Ogunyemi & Falana, 2023). As such, institutional leadership must enforce strict compliance with procurement guidelines.

7. Green and Sustainable Campus Practices

Green campus initiatives offer environmental and economic benefits. Strategies such as solar-powered streetlights, rainwater harvesting, recycling systems, and energy-efficient lighting

reduce operational costs and improve environmental health (Aderonmu & Omole, 2023). Green building materials and sustainable landscaping enhance both durability and aesthetics. Globally, sustainable campuses are associated with lower carbon emissions, improved student well-being, and long-term cost savings (Zubairu & Danjuma, 2021). For Nigerian tertiary institutions, integrating green practices is both a development necessity and a cost-saving innovation.

8. Strengthening Stakeholder Engagement and Shared Ownership

Effective facility management requires collaborative participation from students, staff, alumni, and host communities. Research demonstrates that institutions with strong stakeholder engagement experience reduced vandalism, improved reporting of facility failures, and a stronger culture of custodianship (Okeke & Ibiam, 2020). Engagement strategies may include maintenance-awareness campaigns, campus-clean-up activities, reporting hotlines, and alumni-sponsored improvement projects. A shared sense of ownership fosters respect for facilities and minimizes misuse.

9. Routine Facility Audits and Data-Driven Planning

Regular facility audits enable institutions to assess building conditions, equipment performance, safety compliance, and space utilization. These audits form the basis for realistic, evidence-based maintenance planning (Amoo & Lawal, 2023). Data-driven planning ensures that limited resources are allocated efficiently and that critical areas receive urgent attention. Incorporating facility-condition assessments into annual budget cycles also enhances transparency and allows institutions to track progress in infrastructure sustainability (Adegbile & Yusuf, 2022).

10. Incorporating Modern Architectural and Engineering Designs

Finally, adopting modern architectural principles is essential for sustainable infrastructure. Future construction projects should incorporate universal design, natural ventilation, ICT-readiness, energy-efficient layouts, and climate-responsive materials (Ogunbiyi & Ahmed, 2021). Well-designed buildings reduce long-term maintenance costs and adapt more easily to changing academic needs. Modern design thinking emphasizes flexibility, sustainability, and user comfort, qualities that directly support institutional performance and student experience (Abubakar & Gana, 2022).

CONCLUSION

The sustainable maintenance of educational facilities in Nigerian tertiary institutions is not merely a technical requirement; it is a strategic imperative for national development. As the

challenges confronting higher education continue to evolve, ranging from chronic underfunding and infrastructural decay to population growth and technological disruption, effective facility management becomes central to the mission of teaching, research, and community service. Well-maintained facilities enhance student academic performance, support staff productivity, and strengthen the institutional reputation necessary for global competitiveness (Ofor-Douglas, 2024; Nwankwo & Ede, 2023).

The analysis of key challenges reveals that infrastructural deterioration in Nigerian tertiary institutions is driven by systemic issues such as poor maintenance culture, weak governance, bureaucratic delays, lack of skilled personnel, and insufficient adoption of technology. These problems are compounded by unstable electricity supply, limited water infrastructure, substandard construction practices, and irresponsible facility use (Adewale & Ojo, 2023; Mohammed, 2024). Over time, these constraints have created an environment in which teaching and learning are disrupted, research output is diminished, and institutional effectiveness is undermined.

However, with the right strategies, professionalized facility management structures, preventive maintenance, digital tools, diversified funding, and inclusive stakeholder engagement, institutions can reverse decades of infrastructural decay. Building a sustainable maintenance system requires strong leadership commitment, strict accountability, and collaborative effort across all stakeholders (Iwerebor et al., 2024). Ultimately, transforming facility maintenance is integral to transforming the higher education system itself. A modern, resilient, and functional infrastructure is the foundation upon which Nigeria can build a globally competitive tertiary education sector.

RECOMMENDATIONS

To address the systemic challenges identified and ensure sustainable facility maintenance in Nigerian tertiary institutions, the following actionable recommendations are proposed:

1. The Federal and State Governments should raise budgetary allocations to tertiary institutions, specifically earmarking funds for facility maintenance. Dedicated maintenance subvotes and strict compliance monitoring can prevent diversion of funds.
2. Institutions should create well-structured facility management departments staffed by certified facility managers, engineers, technicians, and health-and-safety officers. Capacity-building programs and partnerships with professional bodies.

3. Tertiary institutions must transition from emergency, reactive repairs to proactive systems involving routine inspections, scheduled servicing, and predictive diagnostics using smart sensors.

4. The adoption of CMMS, Building Information Modelling (BIM), automated inventory systems, and real-time energy-monitoring devices will improve decision-making and operational efficiency.

5. Institutions should explore public–private partnerships (PPPs), alumni endowments, donor-funded projects, revenue-generating ventures, and CSR collaborations to supplement government funding.

6. Institutions should enforce open bidding, digital procurement tracking, third-party oversight, and strict penalties for contract fraud or use of substandard materials.

7. Continuous professional development and periodic training should be mandatory for maintenance staff to ensure they can operate modern systems and equipment effectively.

8. Students and staff should be sensitized through orientation programs, awareness campaigns, and enforcement of facility-use policies to minimize vandalism and misuse of infrastructure.

9. Institutions should invest in solar energy systems, water harvesting technologies, and mini-grid solutions to reduce reliance on unstable national utilities and lower long-term operational costs.

10. Annual infrastructural audits and condition assessments should guide budgeting, planning, and prioritization of maintenance projects.

11. Campuses should integrate energy-efficient designs, eco-friendly building materials, recycling programs, and green landscaping to promote environmental sustainability and reduce maintenance expenses.

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