STRATEGIES FOR ENHANCING INNOVATIVE TECHNOLOGY ADOPTION IN UNIVERSITY FACILITIES MANAGEMENT

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Abstract. This study examines strategies that enhance the adoption of innovative technologies for university facilities management (FM) in Ghana. Grounded in a post-positivist philosophy, the study adopts a quantitative approach. Data were collected through structured questionnaires administered to FM personnel, academic and administrative staff, ICT personnel, and student leaders across five public universities in Ghana's Greater Accra Region. Using stratified random sampling based on Cochran and Neyman procedures, 385 valid responses were obtained. SPSS was used for descriptive and inferential analysis. The study finds that technology adoption in university FM is driven more by governance, stakeholder engagement, and human capacity than by financial or technical factors. Key strategies include clear policies, effective communication, staff training, and interdepartmental collaboration, which highlight adoption as a socio-organisational process. Training emerged as a critical enabler, indicating that usability rather than access is the main challenge. Financial incentives support implementation, but organisational readiness is more decisive. Adoption is a continuous, system-based process that requires institutional alignment and integrated strategies for sustainable outcomes, including ongoing training, stakeholder engagement, and practices to meet evolving needs. The study provides empirical evidence from Africa and offers practical, action-oriented guidance for policymakers and university managers seeking to implement technology-driven FM practices.

Keywords. *Facilities Management, Innovative Technologies, Public Universities, Strategies, Ghana*

1. Introduction

The International Facilities Management Association (2020) defines facilities management (FM) as the integration of people, place, process, and technology to ensure the functionality of the built environment. Key innovative technologies in FM include Building Information Modelling (BIM), Geographic Information System (GIS), Computer Maintenance Management System (CMMS), Computer-Aided Facilities Management (CAFM), Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR), Internet of Things (IoT), Building Energy Management Systems (BEMS), Building Automated Systems (BAS), and Big Data Analytics (BDA) (Marocco and Garofolo, 2021). The adoption of innovative technology represents a behavioural transformation, notably during the 2019 coronavirus pandemic (Chu, 2024). Planning strategic FM operational delivery, providing greater opportunities for sustainability and performance (Mannino et al., 2021).

FM is undergoing innovative transformation, shifting from reactive to predictive practices through IoT, data analytics, and automation (Osei Assibey Antwi et al., 2024).

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Signorini and Pomè (2025) demonstrate that BIM enhances FM functions, although Dixit et al. (2019) highlight that interoperability constraints can hinder the full integration of these innovative technologies into existing systems and processes. Ghansah (2024) argues that Artificial Intelligence (AI), cloud systems, and digital twins (DT) further enhance lifecycle performance, with DT enabling real-time monitoring and predictive decision-making. However, critical adoption barriers remain in African public institutions. Atta and Talamo (2020) highlight data and security challenges, while Lee and Lee (2021) emphasise interoperability limitations. Lovell et al. (2024) argue that a lack of standardisation constrains integration, whereas Sacks et al. (2020) and Tsaples et al. (2024) identify skill gaps and organisational resistance, and financial constraints further limit adoption.

Innovative technology integration, such as IoT, AI, AR/VR, and robotics in FM, enhances resource optimisation and serves as a key driver of data-informed decision-making and sustainability (Siripurapu et al., 2023). While Aripin et al. (2019) explain BIM's progression towards lifecycle asset management, Salem and Dragomir (2022) highlight digital twins for real-time monitoring. Also, Innovative tools such as radio frequency identification (RFID), sensor networks, and predictive analytics enable proactive asset management (Hou et al., 2024). Sampaio et al. (2023) observe rising demand for innovative FM systems; however, Aithal et al. (2024) argue that digitalisation remains underdeveloped in African universities, highlighting the need to integrate innovative technologies in African HEIs to improve teaching and administration, while Pampana et al. (2022) recommend context-specific maintenance strategies due to infrastructural diversity and funding constraints.

Yet, Mohammed and Amoah (2025) observe that traditional systems such as CMMS and CAFM are inadequate for modern FM demands in African universities. From a strategic perspective, Mohammed et al. (2025) affirm the role of FM in institutional performance in Africa. Frameworks such as the Pedagogy-Space-Technology model and Balanced Scorecard support performance evaluation in African universities (Mohammed and Amoah, 2025). UNESCO (2021) reports persistent infrastructure gaps limiting the adoption of innovative technology in Africa. Innovative tools such as AI-driven forecasting and decision intelligence remain underutilised due to skill and infrastructure deficits (Brandtner and Mates, 2021). Nevertheless, Ghufran et al. (2022) suggest that KPI-driven and sustainability-focused strategies can strengthen FM transformation.

Ghanaian higher education institutions (HEIs) are pressured to improve FM practices to meet students' needs (Mohammed et al., 2025). The physical learning environment significantly impacts students' academic engagement, satisfaction, and performance (Gadzekpo et al., 2022). However, many Ghanaian HEIs struggle with outdated infrastructure, inadequate maintenance, and limited integration of technology into FM. In Ghana, outdated maintenance systems, poor data management, and a reliance on reactive rather than predictive maintenance hinder FM practices in HEIs (Alhassan et al., 2025). Poor conditions in lavatories, air conditioning systems, lighting, and cleaning services are frequently observed across campuses, indicating a weak maintenance culture and inadequate adoption of innovative monitoring technologies (Gadzekpo et al., 2022). This issue raises questions about whether HEIs have the institutional and technological competence to teach a highly trained workforce for Ghana's industrial and economic transition. Moreover, in Ghana, colleges of education face rising infrastructure and energy demand that require innovative FM solutions (Mohammed et al., 2025). However, cultural, financial, and structural constraints hinder decision-making, with poor maintenance, outdated systems, and limited technological adoption. Despite this, integrating innovative technologies presents a significant opportunity to enhance efficiency, sustainability, and decision-making in Ghanaian HEIs.

Existing studies in Ghana have primarily focused on digital transformation in teaching, learning, and institutional administration, but have paid limited attention to how innovative technologies can enhance decision-making in FM within HEIs. For instance, Essel et al. (2021) and Kumi-Yeboah et al. (2023) examined digital transformation and strategies for bridging the digital divide in Ghanaian universities; however, their analyses focused on pedagogy and online learning, overlooking the operational management of physical infrastructure. Similarly, Loglo (2024) explored leadership enablers and challenges in the digital transformation of public universities but did not extend this investigation to FM functions, which remain critical to institutional sustainability. Despite increased discourse on higher education quality assurance and institutional management, empirical evidence on how innovative technologies can strengthen FM decision-making processes remains scarce. Consequently, there is a critical gap in understanding how Ghanaian HEIs can adopt and operationalise innovative technologies to enhance facility-related decisions, improve maintenance efficiency, and ensure sustainable campus management.

Considering the study problem above, this study aims to examine strategic interventions that can enhance the adoption of innovative technologies for decision-making in university FM in Ghana. Addressing this gap is vital given the ongoing deterioration of public university infrastructure and the urgent need to align FM practices with digital transformation agendas in Ghana's HEIs. The study contributes to the body of knowledge by providing empirical evidence on the impact of innovative technologies in university settings and guiding future policy, research, and practice in Ghana. The study aligns with key United Nations Sustainable Development Goals (UNSDGs). It supports Goal 4 (Quality Education) and Goal 7 (Affordable and Clean Energy). It also advances Goal 9 (Industry, Innovation, and Infrastructure) and Goal 11 (Sustainable Cities and Communities). In all, the study provides a roadmap for building smarter, sustainable, and technology-driven higher education facilities in Ghana.

2. Literature Review

2.1. FACILITIES MANAGEMENT CULTURE IN GHANAIAN TERTIARY INSTITUTIONS

FM plays a crucial role in the post-occupancy phase of buildings, with a primary focus on space management and maintenance (Tannor et al., 2024). Space management tools help optimise space usage, while maintenance applications automate preventive maintenance, work schedules, and repairs (Mohammed & Amoah, 2025). The goal of FM is to create a comfortable environment that enables staff to deliver high-quality services to students (Boison, 2025). However, in Ghana, FM is relatively underdeveloped, particularly in traditional and technical universities. The lack of local expertise and repair delays contributes to ineffective FM (Wuni et al., 2017). Despite the presence of established associations such as Architecture and Engineering Services Limited (AESL), the Ghana Institution of Surveyors (GhIS), the IFMA Ghana Chapter (Gh-IFMA), and the Ghana Institution of Architects (GIA), Ghana Institution of Engineers (GhIE), the quality of building management remains subpar, suggesting that the existence of these organisations alone is not enough to ensure improved service delivery. Additionally, Amos et al. (2020) view FM as a tool to support an organisation's sustainable and operational strategies by managing infrastructure, resources, and services over time. These functions are equally critical, as many public institutions in Ghana face challenges related to outdated mechanical systems, inefficient energy use, and limited adoption of CAFM tools (Opoku, 2023). Furthermore, FM in Ghanaian HEIs plays a vital role in technological advancement through teaching, learning, and research (Maia et al., 2021). A suitable learning environment is critical to these processes, as the condition of facilities directly impacts the achievement of educational objectives (Gadzekpo et al., 2022). However, traditional FM practices in these institutions tend to be reactive, characterised by inadequate budgeting, a lack of strategic planning, and minimal preventive maintenance. As public educational institutions in Ghana face rising operating costs and growing user expectations, improving FM efficiency becomes critical (Mohammed et al., 2025).

2.2. INNOVATIVE TECHNOLOGIES IN FACILITIES MANAGEMENT

According to Mahmoud et al. (2024), innovative technologies in HEIs can be conceptualised into three interrelated categories: digital modelling and simulation technologies such as BIM, smart and connected systems including the IoT and sensor-based technologies, as well as decision-support systems such as CAFM and AI-driven analytics. Empirically, Moreno et al. (2022) show that BIM enhances data integration and lifecycle management, while Atta and Talamo (2020) emphasise that IoT enables real-time monitoring and predictive maintenance. Similarly, Marzouk and Zaher (2020) demonstrate that AI-driven systems optimise resource allocations and improve decision-making efficiency. Collectively, these technologies underpin the transition to smart campus environments, enhancing operational performance and sustainability, particularly in developing nations such as Ghana.

2.3. DETERMINANTS OF TECHNOLOGY ADOPTION

The determinants of technology adoption consistently identify financial, technical, organisational, and environmental dimensions as critical factors. Financial constraints, particularly high initial investment and lifecycle costs, remain significant barriers (Fialho et al., 2023). In addition, limited technical expertise hinders the effective implementation of IoT and digital systems (Atta & Talamo, 2020). From an organisational perspective, institutional support and governance structures are key enablers, with strong leadership increasing the likelihood of adoption (Biancardi et al., 2023). Infrastructure readiness, especially the integration of digital and energy systems, further influences adoption outcomes (Hanum et al., 2024). Moreover, perceived benefits, such as improved operational efficiency, sustainability, and user satisfaction, are strong drivers of technology adoption (Roumi et al., 2023). Therefore, this study employs a structured, literature-informed framework to ensure theoretical grounding for all adoption variables. Beyond adoption factors, the performance impact of these technologies in HEIs demonstrates concerns. From a user and environmental perspective, advanced systems such as heating, ventilation, and air conditioning (HVAC) and indoor environmental quality (IEQ) technologies enhance occupant comfort, productivity, and academic performance (Roumi *et al.* 2023). Overall, the study demonstrates that integrating BIM, IoT, AI, CAFM, and BEMS enhances

operational efficiency, sustainability, and user experience in HEIs, reinforcing their strategic importance in advancing FM decision-making and institutional performance.

2.4. MEASURES TO IMPROVE FACILITY MANAGEMENT IN GHANA

Globally, the adoption of Industry 4.0 technologies has already proven to enhance FM through automation and data-driven processes (Odili et al., 2024). In Ghana, integrating AI for predictive maintenance, energy forecasting, and environmental monitoring could help optimise resource use in public universities and hospitals (Opoku, 2023). Other advanced tools, such as 3D printing (Bongomin et al., 2020), could assist Ghanaian FM units by locally producing spare parts for obsolete equipment, reducing their dependence on expensive imports. IoT-enabled monitoring and robotics (Javaid et al., 2022) can enhance campus safety and reliability of maintenance, while drones can provide cost-effective solutions for surveying and inspecting Ghana’s sprawling estates (Mustapha et al., 2024). Equally critical is addressing knowledge and skills gaps (Danso et al., 2024). Expanding FM programmes in Ghanaian universities and strengthening professional training (Gadafi et al., 2024), through Gh-IFMA and GhIS, would build capacity for modern FM practice. In addition, digital literacy among FM personnel must also be prioritised to ensure the smooth adoption of AI, IoT, and BIM tools (Chew et al., 2020). Investing in robust information and communication technology (ICT) infrastructure is crucial to overcoming Ghana's connectivity challenges, especially in rural areas with underserved public facilities (Ofosu-Asare, 2024). Strategic collaboration between government, HEIs, and private FM companies will also be necessary to finance and scale the adoption of digital FM solutions (Zabalawi et al., 2024). By integrating these measures, Ghana can modernise FM practices, making them more efficient, sustainable, and resilient, ensuring that the country keeps pace with global FM trends while addressing local realities (Mohammed et al., 2025).

2.5. THEORETICAL FOUNDATION

This study is theoretically grounded in the Technology Acceptance Model (TAM) and Innovation Diffusion Theory (IDT) to provide complementary explanations of technology adoption at individual and organisational levels within university FM. As Davis (1989) asserts, TAM explains user acceptance through two core constructs, perceived usefulness and perceived ease of use, which significantly influence behavioural intention and actual technology utilisation. Building on this foundation, Nnaji et al. (2023) demonstrate the relevance of TAM in FM, where user perceptions shape the adoption of smart building systems, IoT-enabled infrastructure, and energy management technologies. Similarly, Waymer and Heath (2023) emphasise that user experience remains a critical determinant of successful technology integration in FM practices. Alhammadi et al. (2023) discuss Rogers' Innovation Diffusion Theory, which explains how organisational systems communicate and adopt innovations. IDT identifies key attributes, relative advantage, compatibility, complexity, trialability, and observability, that influence adoption decisions

(Almaiah et al., 2022). In higher education FM, these attributes are essential for assessing the suitability and effectiveness of innovative technologies within existing institutional structures (Wu et al., 2021). Furthermore, Menzli et al. (2022) highlight that trialability and observability are particularly important in encouraging adoption, as facilities managers often require demonstrable evidence before committing to new technologies. Importantly, Joseph et al. (2021) conceptualise technology adoption as a multi-level process shaped by both individual perceptions and organisational dynamics. In this regard, TAM provides insight into user-level acceptance, while IDT explains institutional diffusion and scaling, thereby making their integration theoretically coherent and empirically robust. Additionally, contextual factors, such as organisational readiness, stakeholder involvement, and cultural influences, further shape adoption outcomes (Kolade et al., 2022), reinforcing the need for a comprehensive framework.

3. Research Methods

3.1. RESEARCH PARADIGM

This study is anchored in the positivist research paradigm, which assumes that social phenomena exist as objective realities independent of individual perceptions and can be measured through systematic observation and analysis (Bahari, 2010). Positivism emphasises objectivity, empirical measurement, and the use of structured methods to generate generalisable knowledge about observable phenomena (Siraz Chowdhury et al., 2023). Within this paradigm, reality is viewed as external and measurable, allowing researchers to identify patterns, relationships, and causal links through numerical data and statistical testing (Kalelioğlu, 2020). In line with this tradition, positivist research prioritises structured data collection, hypothesis testing, and statistical analysis to ensure reliability, validity, and replicability (Morrison & Saunders, 2025). This philosophical positioning is appropriate for examining strategic interventions to enhance the adoption of innovative technologies in university FM in Ghana, as these can be objectively measured while remaining shaped by institutional and operational contexts within public universities.

3.2. RESEARCH APPROACH

Also, consistent with this paradigm, the study adopted a quantitative research approach, which examines phenomena through the collection and statistical analysis of numerical data (Creswell, 2021). Quantitative research focuses on identifying relationships between measurable variables and testing objective theories using structured instruments and standardised procedures (Mohajan, 2020). This approach is particularly suitable for assessing strategic interventions that can enhance the adoption of innovative technologies. By prioritising objectivity, generalisability, and statistical rigour, quantitative research enables an undistorted examination of the extent and significance of these challenges (Saunders et al., 2018).

3.3. TARGET POPULATION

The target population comprised key stakeholders involved in the planning, implementation, and utilisation of innovative technologies in university FM across public universities in the Greater Accra Region. These included university management/administrators, facilities management personnel within the Works Directorate (e.g., directors of works, estate/facilities managers, maintenance officers), IT personnel, academic staff, and student leaders from the Students' Representative Council (SRC) and the Graduate Students' Association of Ghana (GRASAG). These groups were chosen because they are directly involved in decision-making, implementing systems, and interacting with end users. This gives a full picture of how technology is being used in university FM. The study focused on five out of the six public universities in the Greater Accra Region, namely Accra Technical University (ATU), University of Professional Studies, Accra (UPSA), Ghana Communication Technology University (GCTU), Ghana Institute of Management and Public Administration (GIMPA), and the University of Media, Arts and Communication (UNIMAC). One institution was excluded due to administrative and data accessibility constraints, including the inability to obtain institutional approval within the study timeline, which could have compromised the accuracy of proportional sampling. The selected institutions provided a representative, diverse institutional context, capturing variations in size, governance structures, and technological maturity.

3.4. SAMPLING STRATEGY

In addition, stratified random sampling was adopted because the population was heterogeneous but could be divided into internally homogeneous, non-overlapping groups (Lohr, 2021). Each university was treated as a distinct stratum, and respondents were selected in proportion to its population size. This approach ensured balanced representation, reduced selection bias, and improved the precision of estimates (Wu and Thompson, 2020). Furthermore, the combined application of Cochran's finite population formula and Neyman's proportional allocation yielded a statistically adequate and methodologically rigorous sample, thereby enhancing the generalisability of the findings across the case-study universities.

3.5. SAMPLE SIZE DETERMINATION

The total population across the five universities was 3,180, comprising staff and student leaders, as obtained from the respective human resource directorates. The sample size was determined using Cochran's (1977) formula for finite populations, which accounts for population size, confidence level, and margin of error. The initial sample size (n_0) was calculated to be 384.16 at a 95% confidence level and a 5% margin of error. Adjusting for the finite population yielded a minimum required sample of 343 respondents. To enhance robustness and account for potential non-response, a total of 420 questionnaires were distributed, yielding 385 valid responses, exceeding the minimum requirement and improving statistical reliability (See Table 1).

Table 1, The distribution of the sample across the five case study universities

Stratum (Universities)	Staff Population (N_h)	Student Leaders	Total Population	Allocated n_h (exact)	Total distributed	Total Received
ATU	728	22	750	81	96	91
UPSA	704	22	726	78	93	88
GCTU	689	22	711	77	92	86
GIMPA	476	22	498	54	70	60
UNIMAC	473	22	495	53	70	60

Total	**3,070**	**110**	**3,180**	**343**	**420**	**385**

Source: Own Construct (2025)
Compiled from the data received from Human Resource Directorates of the case study universities

After sample size determination, Neyman's (1934) proportional allocation method was used to allocate the sample across the five universities based on their respective population sizes. This ensured that each stratum contributed proportionately to the total sample, thereby enhancing representativeness and minimising sampling error. The final distribution reflected the relative sizes of the institutions, ensuring balanced inclusion of respondents across all participating universities. In addition to institutional stratification, the sample was further distributed across key stakeholder categories, including administrative staff, facilities management personnel, academic staff, IT personnel, and student leaders. This ensured that both strategic-level decision-makers and operational-level implementers, as well as end-users (students), were adequately represented. Each university contributed 22 student leaders, comprising 11 representatives from the SRC and 11 from GRASAG, covering key leadership roles, including president, general secretary, financial secretary, PRO, and welfare officers. This balanced inclusion ensured representation of both undergraduate and postgraduate perspectives. In all, the combined use of Cochran's sample size determination and Neyman's proportional allocation, together with stratified random sampling, provides a methodologically rigorous and statistically robust sampling framework. This approach enhances representativeness, reduces bias, and supports the generalisability of the findings across public universities in Ghana.

3.6. DATA COLLECTION INSTRUMENTS

Data were collected using a structured quantitative questionnaire designed to capture patterns, perceptions, and barriers related to the adoption of innovative technology in university FM. The survey approach enabled efficient data collection from a large and diverse population and supported robust statistical analysis. The instrument included categorical and Likert-scale items, allowing respondents to examine key dimensions such as awareness, perceived benefits, organisational readiness, and adoption constraints. The questionnaire was administered via Google Forms through official university WhatsApp platforms between June and August 2025. Out of 420 distributed questionnaires, 385 valid responses were obtained and used for analysis. Moreover, the questionnaire was developed using a theory-driven and literature-based approach, ensuring a clear rationale and alignment with the study objective. The design followed a structured process involving:(1) identification of constructs from established theories and empirical studies, (2) operationalisation of these constructs into measurable items, and (3) validation through pilot testing. The instrument was grounded in the TAM and IDT, which provide complementary explanations of technology adoption at individual and organisational levels. According to Davis (1989), TAM explains user acceptance through perceived usefulness and perceived ease of use, which influence behavioural intention and actual usage. These constructs are widely validated in FM and technology adoption (Fearnley & Amora, 2020; Nnaji *et al.,* 2023). At the organisational level, IDT identifies key attributes, relative advantage, compatibility, complexity, trialability, and observability as critical determinants of innovation adoption (Almaiah et al., 2022; Alhammadi et al., 2023). These dimensions are particularly relevant in higher education FM, where technology adoption must align with existing institutional systems and practices (Thangamani et al., 2020; Wu et al., 2021).

In addition, based on these foundations, the questionnaire was systematically operationalised from established constructs. TAM informed variables such as perceived usefulness, perceived ease of use, behavioural intention, and user acceptance (Davis, 1989; Nnaji et al., 2023), while IDT guided the inclusion of relative advantage, compatibility, complexity, trialability, and observability (Almaiah et al., 2022). In addition, context-specific factors, including organisational readiness, stakeholder involvement, awareness, adoption barriers, and cultural influence, were incorporated based on prior empirical studies (Kolade et al., 2022; Choi et al., 2020). This explicit and systematic identification of factors ensured that all questionnaire items were grounded in established scholarship. Again, the instrument was organised into four sections: Section A (demographics), Section B (awareness and current use), Section C (perceived benefits and relevance), and Section D (barriers and strategies for enhancing adoption). A five-point Likert scale (1 = strongly disagree to 5 = strongly agree) was used to measure perceptions. Measurement items were adapted from validated studies and refined for contextual relevance, ensuring both construct validity and applicability to Ghanaian HEIs.

Additionally, a pilot study involving 30 stakeholders was conducted to assess clarity, reliability, and structure. The pilot results informed targeted refinements, including rewording ambiguous items, simplifying technical terminology, aligning items with underlying constructs, removing redundant questions, and improving overall structure and flow. Reliability testing confirmed strong internal consistency (Cronbach's alpha > 0.70), and pilot responses were excluded from the final analysis. The strategy-related items in Section D were measured using Likert-scale indicators and correspond to the nine adoption strategies analysed in Table 3. These items formed the basis for reliability (Cronbach's alpha = 0.912) and sampling adequacy (KMO = 0.920) tests. Furthermore, the Friedman ranking test was applied to prioritise these strategies based on respondents' perceptions, thereby identifying the most critical measures for enhancing technology adoption. Overall, the questionnaire design demonstrates methodological rigour through a clear design process, strong theoretical grounding, systematic factor identification, and empirical validation through pilot testing. This ensures that the instrument is both reliable and valid and that it effectively captures the multi-dimensional drivers of innovative technology adoption in university FM.

3.7. DATA ANALYSIS

Finally, for data analysis, quantitative responses were coded, assigned numerical values, and entered into a cleaned dataset. A codebook was developed to ensure consistency in data handling. Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS), version 20. Descriptive statistics, including frequencies, percentages, and mean scores, were used to summarise respondents' demographic characteristics and to provide an overview of the strategies for innovative technology in university FM. Inferential statistical techniques were employed to explore deeper relationships within the data. The Friedman test, a non-parametric technique, was used to rank strategies improving technology integration. All statistical tests were conducted at a significance level of $p < 0.05$.

4. Results and Discussion

4.1 DEMOGRAPHIC PROFILE

The demographic profile in Table 2 shows that the sample is technically savvy and has a strong institutional background, which makes the proposed technology adoption strategies in university FM more credible. The mix of early-career and experienced respondents suggests that the strategies reflect both practical experience and openness to innovation, an essential balance in environments where legacy systems coexist with emerging technologies. Also, the strong representation from FM directorates, along with academic, administrative staff, and student leaders, underscores that technology adoption is a socio-organisational process that requires coordination across stakeholders. The high educational levels further suggest that adoption barriers are less about individual capacity and more about institutional, financial, and governance constraints, underscoring the need for policy-driven, leadership-backed strategies. Additionally, respondents' familiarity with technology indicates that the challenge lies not in awareness but in effective integration. This underscores the need for implementation-focused strategies, including targeted training, workflow integration, and ongoing technical support. Finally, the findings demonstrate that technology adoption at university FM is shaped by stakeholder roles, institutional structures, and system readiness, justifying the need for system-oriented interventions in HEIs in Ghana.

Table 2, Summary of Respondents' Demographic Characteristics (n = 385)

Variable	**Category**	**Frequency (n)**	**Percentage (%)**
Age Group	18–24 years	49	12.7
	25–34 years	109	28.3
	35–44 years	87	22.6
	45–54 years	106	27.5
	55 years and above	34	8.8
Gender	Male	240	62.3
	Female	145	37.7
Position / Role	Administrative Staff	75	19.5
	Facility Management Directorate	135	35.1
	Academic Staff	121	31.4
	Key Student Leaders	54	14.0
Education Level	Diploma/HND	25	6.5
	Bachelor's Degree	115	29.9
	Master's Degree	159	41.3
	PhD	86	22.3
Years of Experience	1–3 years	83	21.6
	4–7 years	114	29.6
	8–10 years	86	22.3
	Over 10 years	102	26.5
Technology Familiarity	Not Familiar	71	18.4
	Somewhat Familiar	164	42.6
	Very Familiar	150	39.0

Source: Field Data (2025)

4.2. STRATEGIC MEASURES FOR TECHNOLOGY ADOPTION

How can the adoption of innovative technologies enhance decision-making in university FM? The goal is to identify ways to improve how universities encourage, implement, and use innovative technologies so that facilities managers can make more effective, efficient, and data-driven decisions, ultimately improving campus operations and resource management. The findings in Table 3 reveal that technology adoption in university FM is primarily driven by institutional alignment and stakeholder integration rather than purely technical or financial inputs. While all identified strategies were rated highly, the pattern of responses suggests that respondents prioritised governance, communication, and human-centred approaches as the foundation for successful implementation. Foremost, the prominence of stakeholder engagement, clear policy guidelines, and effective communication indicates that technology adoption is perceived as a socio-organisational process rather than a technical upgrade. This implies that resistance to innovation in university FM is less about the technology itself and more about institutional buy-in, clarity of direction, and transparency in implementation. In practice, this means universities must actively involve key actors, facility managers, academic staff, administrators, and students in decision-making processes to build ownership and reduce resistance. Closely following this, staff training and interdepartmental collaboration highlight the operational dimension of adoption. The findings suggest that even when technologies are available, their effectiveness depends on users' competence and on departments' ability to work across traditional silos.

In real-world FM, this translates into continuous professional development and the creation of integrated workflows that connect maintenance, ICT units, and administrative systems. Without this alignment, technology investments risk underutilisation. Mid-ranked strategies, such as organisational needs assessment and incentives, reflect the importance of context-sensitive and motivational drivers. The relatively strong emphasis on needs assessment indicates that respondents recognise the risk of adopting technologies that do not align with institutional priorities or infrastructure realities, an issue relevant in Ghanaian universities where resource constraints are significant. Similarly, incentives serve as behavioural catalysts, encouraging staff to transition from conventional practices to technology-enabled systems.

Interestingly, financial-related measures, including increased budget allocation, were not ranked as the most critical. This suggests that financial investment alone is insufficient to guarantee adoption, reinforcing the argument that organisational readiness and strategic coordination are more decisive factors. Likewise, the lower emphasis on specialised task forces implies that mainstreaming technology adoption within existing institutional structures may be more effective than creating isolated units, which can sometimes lead to fragmentation. Taken together, these findings demonstrate that enhancing technology adoption in university FM requires a holistic, systems-oriented approach that integrates policy clarity, stakeholder engagement, capacity building, and institutional coordination. Rather than viewing technology adoption as a one-time investment, universities should frame it as a continuous organisational transformation process, tailored to specific operational and socio-cultural contexts.

Table 3, Descriptive Statistics on Strategic Measures for Technology Adoption (N = 385)

Strategic Measure	Mean	Standard Deviation	Rank
Stakeholder Engagement	4.33	0.78	1
Clear Policy Guidelines	4.32	0.74	2
Effective Communication	4.31	0.71	3
Staff Training Programs	4.27	0.86	4
Interdepartmental Collaboration	4.26	0.76	5
Organisational Needs Assessment	4.19	0.79	6
Incentives for Technology Adoption	4.18	0.86	7
Increased Budget Allocation	4.17	0.89	8
Creation of Specialised Task Forces	4.10	0.84	9

Source: Field Data (2025)

4.3 RELIABILITY, SAMPLING ADEQUACY AND NORMALITY TEST

The diagnostic tests confirm in Table 4 that the dataset is suitable for meaningful analysis, allowing greater emphasis on interpretation rather than statistical validation. The high internal consistency indicates that the items reliably capture the underlying dimensions of strategies for enhancing technology adoption, suggesting coherence in respondents' perceptions. Similarly, strong sampling adequacy and significant factorability indicate that the variables are sufficiently interrelated to warrant deeper analytical exploration of strategic constructs. Importantly, the normality results indicate no serious violations, supporting the use of parametric techniques and strengthening confidence in subsequent inferences. These tests do not merely validate the data; they establish a robust foundation for interpreting how and why specific strategies influence technology adoption in university FM. Building on this foundation, the findings are understood to reflect systemic and context-specific drivers rather than isolated, ranked factors. The emphasis, therefore, shifts to how institutional capacity, stakeholder engagement, policy alignment, and technological readiness interact to shape adoption outcomes. In practical terms, this implies that effective technology adoption in university FM is less about individual strategies in isolation and more about organizational structures, user readiness, and resource commitment within the university environment.

Table 4, Reliability, Sampling Adequacy, and Normality Test

Test	Statistic	Value	N of Items/df	Sig.
Reliability Statistics	Cronbach's Alpha	0.912	9 items	–
KMO and Bartlett's Test	KMO Measure of Sampling Adequacy	0.920	–	–
	Bartlett's Test of Sphericity – Approx. Chi-Square	1878.821	df = 36	0.000
Tests of Normality	Kolmogorov–Smirnov Statistic	0.108	df = 385	0.090
	Shapiro–Wilk Statistic	0.885	df = 385	0.095

Source: Field Data (2025)

4.4 FRIEDMAN RANKING TEST

The analysis demonstrates in Table 5 that differences in stakeholder perceptions are not merely indicative of varying preferences but reflect the underlying structural conditions required for effective technology adoption in university FM. Functioning as isolated interventions, the identified strategies operate as a coordinated system shaped by institutional constraints, technical complexity, and human capacity limitations. Training and capacity building emerge as the most critical enabler, indicating that the central barrier to technology adoption is not access to digital tools but the limited ability of facilities personnel to effectively utilise and integrate them into existing operational workflows. This underscores the importance of continuous professional development and aligns with technology adoption theories, which hold that user competence influences both perceived ease of use and actual utilisation. Also, financial incentives highlight the resource-constrained nature of university environments, where investment in innovation competes with other institutional priorities. The results show that it is easier to adopt new technology when dedicated funding structures are in place and investments are backed by long-term operational value, such as increased efficiency and better asset management. Again, collaboration with technology providers reflects the technical sophistication of contemporary FM systems and the limited in-house expertise within universities. This reinforces the role of external partnerships in facilitating implementation, enabling knowledge transfer, and ensuring system adaptability to institutional needs. Moreover, management policy support highlights the necessity of organisational alignment and governance. Embedding technology adoption within formal policies and strategic frameworks ensures institutional commitment, reduces resistance to change, and provides a clear direction for implementation. This highlights the importance of organisational readiness as a determinant of successful adoption. Finally, regular evaluation and feedback, although relatively less emphasised, remain essential for sustaining technological adoption. Their role is more pronounced at the post-implementation stage, where continuous monitoring supports system optimisation, accountability, and long-term value realisation, preventing underutilisation or technological obsolescence.

Collectively, the findings reveal that technological adoption in university FM is not a singular event, but a functionally interrelated process driven by human, financial, technical, and organisational factors. Effective adoption begins with strengthening staff capacity, is enabled by financial commitment, is facilitated through external collaboration, is institutionalised via policy support, and is sustained through continuous evaluation. This integrated perspective directly addresses the persistent challenge of low technology adoption in university FM in Ghana by demonstrating that successful implementation depends on aligning these interdependent elements within a coherent and context-sensitive framework, providing a more practical and theoretically grounded understanding of how universities can transition from limited adoption to effective and sustained use of innovative technologies in Ghana.

Table 5, Friedman Ranking Test

Strategy	**Mean Rank (Descriptive)**	**Mean Rank (Friedman)**	**χ^2 (Chi-square)**	**df**	**p-value**
Training and capacity building for staff	4.35	4.28	92.146	4	0.000
Financial incentives for technology adoption	4.12	4.15			

Collaboration with technology providers	4.05	3.98			
Management policy support	3.89	3.92			
Regular evaluation and feed-back	3.76	3.67			

Source: Field Data (2025)

4.5 DISCUSSION OF FINDINGS

4.5.1 Strategic Measures for Technology Adoption in University FM

The findings of this study redefine innovative technology adoption in university FM as a multi-dimensional organisational transformation process rather than a purely technical or resource-driven intervention. The prominence of stakeholder engagement, policy clarity, and effective communication indicates that technology adoption is fundamentally socio-organisational, aligning with prior studies that emphasise institutional support, governance structures, and user involvement as critical determinants of successful adoption (Atta & Talamo, 2020; Biancardi et al., 2023). This also reinforces the TAM, in which user perceptions of usefulness and ease of use are shaped by communication, training, and inclusive decision-making processes. Similarly, the findings support the IDT, particularly the role of compatibility and observability, by demonstrating that adoption is more likely when institutional actors are actively engaged, and organisational systems are aligned. The importance of staff training and interdepartmental collaboration further aligns with existing literature, which highlights technical skill gaps and organisational silos as major barriers to digital transformation in FM (Sacks et al., 2020; Danso et al., 2024). From a theoretical perspective, the result reflects the IDT construct of complexity and TAM's emphasis on perceived ease of use, suggesting that technology's usability is contingent on user competence and organisational learning. Additionally, the significance of organisational needs assessment supports Pampana et al. (2022) advocacy for context-specific strategies in resource-constrained environments, such as Ghanaian HEIs. The study's theoretical grounding and empirical validation of existing knowledge within the specific context of FM decision-making are evident in these convergences.

However, the study critically departs from the dominant literature that positions financial constraints as the primary barrier to technology adoption (Fialho et al., 2023; UNESCO, 2021). Although financial resources were recognised as important, they were not ranked as the most critical, with respondents prioritising governance, stakeholder engagement, and capacity building instead. This contradiction challenges the prevailing assumption that increased funding alone can drive digital transformation in FM. The findings suggest that, in the Ghanaian universities, institutional readiness and organisational alignment are more decisive than financial inputs. In practice, this implies that even well-funded initiatives may fail due to clear policies, stakeholder inclusion, and effective communication structures. This insight is particularly significant, given that policy discourse in many developing countries tends to overemphasise funding deficits while underestimating systemic organisational inefficiencies. A major contribution of this study lies in adopting technology as a governance-driven rather than technology-driven process in Ghanaian HEIs. While the literature focuses on specific technologies such as BIM, IoT, and AI, the findings demonstrate that institutional coordination mechanisms, including policy frameworks, communication systems, and stakeholder integration, are the primary enablers of adoption. This shifts the analytical focus from technological availability to organisational functionality. Furthermore, the study advances a systems-oriented perspective by showing that adoption strategies are interdependent and mutually reinforcing rather than discrete variables.

4.5.2 Integrated Interpretation of Adoption Strategies (Friedman Analysis)

The Friedman analysis further strengthens this interpretation by identifying training and capacity building as the most critical enablers of technology adoption. This finding aligns strongly with both TAM and IDT, as training enhances perceived ease of use and reduces the complexity of innovative technologies. It also supports prior studies that identify skills deficits as a central barrier to digital transformation in African institutions (Danso et al., 2024; Brandtner & Mates, 2021). The importance of financial incentives and external collaboration aligns with literature, which emphasises the role of resource mobilisation and partnerships in facilitating technological integration (Zabalawi et al., 2024; Hou et al., 2024). However, the findings simultaneously challenge studies that prioritise infrastructure deficits as the primary constraint (Aithal et al., 2024) by demonstrating that human capacity limitations are a more immediate and critical barrier. This shifts the discourse from “technology access” to “technology usability", offering a more nuanced understanding of adoption challenges in resource-constrained environments. Moreover, the relatively low ranking of evaluation and feedback mechanisms contrasts with studies that emphasise continuous monitoring as central to digital transformation (Ghufran et al., 2022). This discrepancy suggests that Ghanaian HEIs may still be at an early stage of technological adoption, with a focus on implementation rather than optimisation. This introduces a temporal dimension to technology adoption that is often overlooked in FM literature, highlighting the need to align strategies with institutional maturity levels. The findings contribute significantly to knowledge by proposing a process-based and contextually grounded model of technology adoption in university FM. Adoption is conceptualised as a continuous organisational process that begins with capacity building, is enabled by financial and institutional support, is facilitated through external collaboration, is institutionalised via policy frameworks, and is sustained through ongoing evaluation and learning. This integrated framework challenges reductionist approaches that prioritise singular factors and instead advances a holistic, system-based perspective.

5. Implications of the findings

The findings have important policy, social, economic, and practical implications for the adoption of innovative FM technologies in Ghanaian HEIs. From a policy perspective, inadequate budgets, weak strategic direction, and regulatory gaps call for cohesive governance frameworks that embed digital FM into routine operations rather than isolated pilot projects. Clear policies defining digital workflows, data standards, cybersecurity, and accountability are essential, particularly when aligned with institutional sustainability objectives. Socially speaking, the findings show that FM technology adoption is a people-centred process. Communication gaps, low awareness, and resistance to change suggest that participatory implementation, transparent communication, and role-specific digital literacy programs are critical for building acceptance and ownership among FM staff, students, and administrators.

Economically, while limited funding remains a key constraint, the endorsement of increased budgets and incentives indicates a need to shift toward long-term, value-based investment. Life-cycle costing and reinvestment of efficiency savings can help justify upfront costs and support sustainable financing of FM technologies. Practically, the study stresses prioritising role-based training, standardised workflows, and improved communication before scaling advanced technologies. Aligning adoption strategies with local capacity and infrastructure conditions can enhance the effectiveness and sustainability of FM technology integration.

6. Conclusion

This study provides a content-specific analysis of the challenges and strategies associated with the adoption of innovative technologies in FM decision-making within Ghanaian public universities. The study further confirms that stakeholder engagement, policy clarity, effective communication, leadership commitment, and continuous capacity building are critical enablers of adoption. The central contribution of this research lies in revealing a paradox within Ghanaian HEIs: resource constraints and institutional weaknesses limit adoption in the short term, but these same conditions create a strong case for strategically deployed technologies as catalysts for long-term efficiency and sustainability. Addressing this through coordinated and context-sensitive strategies would position FM as a proactive, data-driven, and sustainability-oriented function within HEIs.

6.1 LIMITATIONS OF THE STUDY

The reliance on self-reported perceptions may introduce response bias, as respondents' views may not fully reflect actual outcomes. The focus on public universities limits the generalisability of the results to private HEIs or other public-sector organisations.

6.2 AREAS FOR FURTHER STUDIES

Further studies could also focus on qualitative investigations into leadership behaviour, organisational culture, and governance structures, which would enrich understanding of the socio-institutional dynamics influencing technology adoption in FM in analogue institutions.

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