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Digital Transformation in Facility Management Practice: Examining Awareness and Usage of Emerging Technologies in the Federal Capital Territory, Abuja

Ayodele Kayode David[1]; Prof. Nasiru M. Idris[2]; & Dr. Edo Oga Ojoko[3]

[1] Department of Estate Management and Valuation, Federal Polytechnic Nasarawa. [2] Institute for the built Environment, Nasarawa State University, Keffi, Nasarawa state.
[3]Department of Building Technology, Federal Polytechnic Nasarawa.

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Abstract

The growing complexity of modern buildings and the global shift toward digital transformation in the built environment has necessitated the adoption of emerging technologies such as Building Information Modelling (BIM), Internet of Things (IoT), Computer-Aided Facility Management (CAFM), Artificial Intelligence (AI), smart building systems amongst others. However, facility management practice in many developing countries, including Nigeria, is still largely characterised by conventional and manual operational approaches. Hence, this study examined the awareness and usage of emerging digital technologies in facility management practice in Abuja, Nigeria. The study adopted a survey research design, targeting facility managers and users of facilities within Abuja. Data were collected using structured questionnaires and analysed using descriptive statistics, Weighted Mean Score, and the Mann–Whitney U test. The findings revealed that although both facility managers and facility users demonstrate relatively high awareness of emerging digital technologies particularly smart meters, energy management systems, and security-related technologies; the actual level of usage remains low across most emerging digital systems. Technologies such as BIM, IoT devices, CAFM systems, and AI-based applications were significantly underutilised. The results of the Mann–Whitney U test further revealed statistically significant differences in awareness and usage levels across several technologies, indicating role-based variations in exposure and interaction. The study thus concluded that facility management practice in Abuja is still in a transitional phase of digital adoption, where awareness does not

necessarily translate into practical implementation. Hence, the study recommends enhanced training, improved digital infrastructure, policy support, and stakeholder collaboration to bridge the gap between awareness and usage of emerging digital technologies in facility management practice.

Keywords: Facility Management, Digital Transformation, Emerging Technologies, Awareness, Usage, Abuja, Nigeria.

Introduction

Facility management (FM) has become a critical component of the built environment due to its significant role in ensuring the effective operation, maintenance, safety, functionality, and sustainability of buildings and infrastructure. It integrates people, places, processes, and technology to ensure optimal performance of facilities in support of organisational objectives. Over time, FM has evolved from a basic maintenance function into a strategic management discipline that enhances workplace productivity, improves asset performance, reduces operational costs, ensures environmental sustainability, and increases occupant satisfaction across residential, commercial, institutional, and public facilities. According to the International Facility Management Association (IFMA) (2022), FM supports organisational effectiveness through coordinated maintenance, space management, energy management, and operational planning. Empirical studies such as Chotipanich & Nutt (2020); Atkin & Brooks (2021) also confirm its importance in improving organisational performance, infrastructure sustainability, and urban efficiency.

Traditionally, facility management relied heavily on conventional approaches involving manual operations, paper-based documentation, routine inspections, reactive maintenance, and fragmented communication systems. Maintenance was typically carried out after system failures occurred, leading to downtime, higher costs, inefficient resource use, and poor service delivery. Facility data such as maintenance records, asset information, and occupancy reports were manually managed, limiting accuracy, accessibility, and decision-making efficiency. Although these approaches were suitable in earlier stages of infrastructure development, they are increasingly inadequate in today's complex and technology-driven built environment (Elmualim et al., 2017; Atta & Talamo, 2019).

The emergence of the Information and Communication Technology (ICT) era, rapid internet penetration, automation, and digital innovation has significantly transformed professional practices, including facility management. Modern buildings are now increasingly intelligent and interconnected, requiring advanced systems capable of supporting real-time monitoring, predictive maintenance, energy optimisation, and data-driven decision-making. As a result, the integration of emerging digital technologies has become essential for improving efficiency, sustainability, and service

delivery in facility management practice (Pärn, Edwards & Sing, 2021; Kaewunruen & Lian, 2021).

Hence, digital transformation in facility management refers to the adoption of digital tools to enhance operational processes, asset management, communication systems, and organisational performance. It goes beyond basic computerisation and involves the creation of intelligent, automated, and interconnected FM systems. Key emerging technologies include Building Information Modelling (BIM), Internet of Things (IoT), Artificial Intelligence (AI), Big Data analytics, Digital Twin systems, cloud computing, blockchain, Geographic Information Systems (GIS), robotics, smart sensors, mobile applications, and Computer-Aided Facility Management (CAFM) systems (Boje et al., 2020; Atta & Talamo, 2019).

Among these, BIM enables digital representation of buildings to support maintenance planning, lifecycle management, and information sharing. IoT connects sensors and devices for real-time monitoring of energy use, occupancy, and equipment conditions, allowing remote facility control (Madakam et al., 2015). AI supports predictive maintenance, automated fault detection, and intelligent decision-making by analysing operational data (Lee et al., 2018). Digital Twin technology enables virtual simulation and real-time monitoring of physical assets, improving performance optimisation (Boje et al., 2020). CAFM systems also facilitate automated maintenance scheduling, asset tracking, and space management, improving operational coordination (Roper & Payant, 2018).

In developed countries such as the United States, United Kingdom, Germany, Singapore, and Australia, these technologies have significantly transformed facility management practice. Benefits include improved predictive maintenance, reduced operational costs, enhanced energy efficiency, better asset performance, and improved occupant comfort. Consequently, FM practice in these regions has shifted from reactive to proactive and data-driven systems supported by smart technologies (Kaewunruen & Lian, 2021). However, a major gap exists between developed and developing countries regarding digital transformation in FM. In Nigeria, facility management practice still largely relies on traditional methods characterised by manual documentation, reactive maintenance, fragmented communication, and limited technological integration. This has resulted in inefficiencies such as high maintenance costs, poor asset performance, and low service delivery (Ikediashi, Ogunlana & Boateng, 2023).

A key determinant of digital transformation is awareness. Without adequate awareness, adoption and usage remain limited. Studies have shown that awareness of advanced technologies such as BIM and IoT among Nigerian facility management professionals is still relatively low due to limited exposure, inadequate training, and low digital literacy (Olapade et al., 2019; Ebekozien & Samsurijan, 2022). Even where awareness exists, actual usage remains poor due to infrastructural challenges, financial constraints, unreliable power supply, cybersecurity concerns, and shortage of skilled personnel (Aghimien et al., 2020).

In Abuja, the Federal Capital Territory, rapid urbanisation and increasing development of modern facilities such as smart estates, office complexes, hospitals, hotels, and government buildings have intensified the need for advanced facility management systems. However, despite the presence of modern infrastructure, many facility management organisations still

rely on conventional approaches. Existing studies suggest that although awareness of digital technologies is growing, actual usage remains low due to technical, financial, and institutional constraints (Adekunle, 2025; Ahamioje & Adedokun, 2025).

Given the increasing complexity of facilities and the global shift toward smart building systems, there is a need for improved awareness and adoption of emerging digital technologies in facility management practice in Abuja. Effective integration of these technologies would enhance operational efficiency, predictive maintenance, energy optimisation, asset performance, and service delivery while aligning Nigeria's facility management sector with global best practices.

It is against this background that this study examines digital transformation in facility management practice by assessing the level of awareness and usage of emerging digital technologies among facility management practitioners in Abuja, Nigeria.

Concept of Facility Management

The International Facility Management Association (2022) defines facility management as a profession that encompasses multiple disciplines aimed at ensuring functionality, comfort, safety, sustainability, and efficiency within the built environment through the integration of people, processes, places, and technology. Similarly, the International Organization for Standardization through ISO 41011 describes facility management as an organizational function that integrates people, place, and process within the built environment for the purpose of improving quality of life and enhancing the productivity of core business activities. These definitions emphasize that facility management extends beyond routine maintenance and involves strategic coordination of operational systems to improve organizational performance. Elmualim et al. (2017) noted that facility management plays a crucial role in promoting sustainable development by supporting efficient energy management, waste reduction, environmental conservation, and resource optimization within buildings. Similarly, Noor and Pitt (2019) argued that efficient FM practices improve organizational productivity through effective space utilization, improved indoor environmental quality, and enhanced operational performance. According to Atkin and Brooks (2021), facility management has transformed into a holistic management discipline responsible for ensuring operational continuity, workplace efficiency, asset preservation, environmental sustainability, and strategic resource management within facilities. Chotipanich and Nutt (2020) further observed that modern facility management encompasses both operational and strategic responsibilities aimed at improving building performance and supporting organizational goals.

Facility management practice is generally categorized into hard services and soft services. Hard services involve the physical and technical aspects of buildings that are essential for operational functionality and legal compliance, including electrical systems, mechanical systems, plumbing, heating, ventilation, air conditioning systems (HVAC), fire safety systems, elevators, and structural maintenance. Soft services, on the other hand, relate to services that improve occupant comfort and working conditions, including cleaning, security, landscaping, waste management, catering, and space management. According to Roper and

Payant (2018), effective facility management requires proper coordination between hard and soft services to ensure operational efficiency and occupant satisfaction within facilities.

In developed countries such as the United States, the United Kingdom, Germany, Singapore, and Australia, facility management has become highly digitized and strategically integrated into organizational management systems. Advanced technologies such as Building Information Modelling (BIM), Internet of Things (IoT), Artificial Intelligence (AI), Computer-Aided Facility Management (CAFM), Digital Twin systems, and smart building technologies are increasingly being used to improve facility operations and maintenance management. These technologies enable predictive maintenance, remote monitoring, real-time communication, asset tracking, and intelligent decision-making within facilities (Pärn, Edwards & Sing, 2021). Despite the growing global advancement of facility management practice, the FM industry in many developing countries, including Nigeria, still faces several challenges. Many organizations continue to rely heavily on traditional and manual operational systems due to inadequate technological infrastructure, shortage of skilled personnel, low awareness of digital innovations, financial limitations, and poor institutional support. According to Ikediashi, Ogunlana, and Boateng (2023), the Nigerian facility management sector remains underdeveloped in terms of technological integration and digital transformation compared to developed economies. Consequently, many facilities in Nigeria experience operational inefficiencies, poor maintenance culture, increased maintenance costs, and inadequate asset management systems.

Concept of Emerging Digital Technologies

Emerging digital technologies refer to rapidly evolving innovations that transform how organizations operate, communicate, manage data, and make decisions. These technologies are characterized by automation, connectivity, intelligence, real-time processing, and system integration, all of which enhance efficiency, productivity, and sustainability across sectors. In the built environment, they are increasingly shaping construction, real estate, and facility management practices by enabling smarter, more data-driven operations. The concept is strongly linked to the Fourth Industrial Revolution (Industry 4.0), which integrates digital systems, artificial intelligence, automation, cloud computing, and advanced analytics into industrial and organisational processes. According to Schwab (2017), this revolution is reshaping how humans interact with physical and digital systems. In facility management, it has led to the adoption of intelligent tools that support predictive maintenance, smart communication, and real-time monitoring of buildings.

Key emerging technologies in facility management include Building Information Modelling (BIM), Internet of Things (IoT), Artificial Intelligence (AI), Big Data analytics, cloud computing, blockchain, robotics, Digital Twin systems, Geographic Information Systems (GIS), smart sensors, drones, and Computer-Aided Facility Management (CAFM) systems (Boje et al., 2020). These tools collectively enhance operational efficiency, asset performance, sustainability, and decision-making within facilities.

Review of Literatures on The Level of Awareness and Usage of Emerging Digital Technologies for Facility Management Practice in Nigeria

A review of literature on the awareness and usage of emerging digital technologies for facility management practice reveals that the integration of digital innovations into facility operations has become increasingly important across the global built environment industry. However, the extent of awareness and actual usage of these technologies differs significantly between developed and developing countries. Existing studies have examined the adoption, implementation, awareness, benefits, and challenges associated with emerging digital technologies such as Building Information Modelling (BIM), Internet of Things (IoT), Artificial Intelligence (AI), Digital Twin technology, Computer-Aided Facility Management (CAFM), and smart building systems within facility management practice.

Madakam, Ramaswamy, and Tripathi (2015), in their study on Internet of Things applications and emerging digital systems, adopted a conceptual and literature-based review methodology to examine the application of IoT technologies across various sectors, including facility management. The study found that IoT technologies significantly improve real-time monitoring, predictive maintenance, automation, energy management, and operational efficiency within smart facilities. The authors further established that the increasing adoption of internet-enabled systems has transformed conventional facility management operations into intelligent and interconnected management frameworks capable of supporting remote monitoring and automated decision-making.

Elmualim, Shockley, Valle, Ludlow, and Shah (2017), in their study on sustainability and facilities management practices, adopted a questionnaire survey involving facility management professionals across several organizations in the United Kingdom to investigate the role of technology and sustainability in FM operations. The findings revealed that emerging digital technologies improve sustainability performance, energy efficiency, and operational coordination within facilities. The study further showed that organizations utilizing digital technologies achieved better maintenance management and environmental performance compared to those relying on conventional maintenance systems.

Lee, Davari, Singh, and Pandhare (2018) examined the role of Artificial Intelligence in Industry 4.0 and intelligent operational systems using a conceptual review methodology. The study found that AI technologies enhance predictive maintenance, operational efficiency, fault detection, and data-driven decision-making within facility management systems. The authors concluded that AI-driven systems support proactive maintenance approaches and reduce downtime associated with equipment failure in modern facilities.

Atta and Talamo (2019), in their study on digital transformation in facility management practice, adopted a systematic literature review methodology to examine the impact of digital technologies on facility operations and maintenance management. The study established that technologies such as BIM, IoT, cloud computing, and CAFM systems have significantly transformed facility management practice globally by improving operational efficiency, information management, communication systems, and predictive maintenance processes. The authors further found that the level of digital transformation in facility management

remains considerably higher in developed countries than in developing economies due to differences in awareness, infrastructure, and technological readiness.

Olapade, Araloyin, and Aluko (2019), in their study on awareness and adoption of Building Information Modelling among built environment professionals in Nigeria, adopted a questionnaire survey methodology involving architects, builders, engineers, quantity surveyors, and facility managers. The findings indicated that awareness of BIM technology among Nigerian built environment professionals was moderate, while the actual level of usage and implementation remained low. The study identified inadequate technical knowledge, insufficient training opportunities, high implementation costs, and poor technological infrastructure as major factors limiting BIM adoption in Nigeria.

Noor and Pitt (2019), in their research on innovation in facility management service delivery, adopted an exploratory research methodology involving interviews and literature analysis to examine the role of technological innovation within FM practice. The findings showed that emerging digital technologies significantly improve service delivery, operational coordination, maintenance management, and occupant satisfaction within facilities. The study further revealed that organizations adopting digital technologies achieved greater operational efficiency and sustainability performance than organizations depending on traditional facility management systems.

Boje, Guerriero, Kubicki, and Rezgui (2020), in their study on Digital Twin technologies and digital transformation within the built environment, adopted a systematic review methodology to examine the applications of Digital Twin systems in construction and facility management. The findings revealed that Digital Twin technologies improve facility monitoring, predictive maintenance, simulation processes, operational analysis, and asset lifecycle management. The study further established that Digital Twin technologies are increasingly gaining acceptance in developed countries but remain poorly adopted in developing countries due to low awareness and technological limitations.

Aghimien, Aigbavboa, Oke, and Musenga (2020), in their study on barriers to digitalization within the construction and built environment sector, adopted a quantitative survey methodology involving built environment professionals in developing countries. The findings indicated that the usage of emerging digital technologies remains low in developing economies due to financial constraints, inadequate technological infrastructure, low awareness, resistance to change, poor internet connectivity, and shortage of skilled professionals. The study concluded that digital transformation within the built environment sector requires increased awareness and investment in technological capacity development.

Pärn, Edwards, and Sing (2021), in their study on the trajectory of Building Information Modelling in facility management, adopted a comprehensive literature review methodology to investigate the role of BIM technologies in FM operations. The study found that BIM enhances information management, maintenance planning, space management, communication, and lifecycle management within facilities. The authors further established that although BIM has become widely integrated into FM practice in developed countries, the

technology remains underutilized in many developing economies due to inadequate awareness and limited digital competencies among facility management professionals.

Kaewunruen and Lian (2021), in their study on digital transformation and disruptive technologies in facility management systems, adopted a conceptual review methodology to examine the integration of emerging digital technologies into infrastructure and FM operations. The findings showed that IoT, AI, cloud computing, Digital Twin systems, and smart technologies significantly improve predictive maintenance, operational efficiency, sustainability, and decision-making within facilities. The study further revealed that organizations adopting digital technologies recorded substantial improvements in asset performance and maintenance efficiency compared to organizations relying on traditional management approaches.

Ebekozien and Samsurijan (2022), in their study on digital technology adoption within Nigeria's built environment sector, adopted a mixed-method research design involving questionnaires and interviews among construction and facility management professionals. The findings revealed that awareness of digital technologies among Nigerian professionals was gradually increasing; however, the actual level of usage remained considerably low. The study identified inadequate digital literacy, insufficient professional training, poor institutional support, and low technological readiness as major barriers affecting digital transformation within Nigeria's facility management sector.

Ikediashi, Ogunlana, and Boateng (2023), in their study on digital transformation challenges in facility management practice in developing countries, adopted a survey research methodology involving facility managers and built environment professionals. The findings established that although awareness of emerging digital technologies such as BIM, IoT, AI, and CAFM systems was increasing among FM professionals, actual implementation and usage remained relatively poor due to inadequate infrastructure, financial limitations, poor internet connectivity, cybersecurity concerns, resistance to organizational change, and shortage of technical expertise. The study further emphasized that many facility management organizations in developing countries still depend heavily on conventional maintenance systems despite the increasing global shift toward digital transformation.

Hakimi, Liu, and Abudayyeh (2024), in their study on Digital Twin technologies for intelligent facility management systems, adopted a systematic review methodology to examine the applications and challenges of Digital Twin technologies within FM operations. The study found that Digital Twin technologies significantly improve real-time monitoring, operational simulation, predictive maintenance, and building performance optimization. However, the findings also revealed that awareness and implementation of Digital Twin systems remain relatively low in developing countries due to technical, financial, and infrastructural challenges.

Adekunle (2025), in the study on computer-based facility management systems and operational efficiency in Abuja, Nigeria, adopted a questionnaire survey methodology involving facility managers within commercial and institutional facilities in Abuja. The findings showed that awareness of basic digital systems such as computerized maintenance

platforms and internet-based communication systems among facility managers was relatively high. However, the study revealed that the usage of advanced digital technologies such as IoT-enabled monitoring systems, BIM-integrated FM systems, and AI-driven maintenance platforms remained considerably low due to inadequate technical expertise, poor infrastructure, and high implementation costs.

Ahamioje and Adedokun (2025), in their study on digital transformation and technology adoption in hospitality facility management in Abuja, adopted a mixed-method research design involving questionnaires and interviews among facility managers within hotels and hospitality establishments in Abuja. The findings revealed that although there was growing awareness of emerging digital technologies among facility management professionals, the actual level of usage of advanced technologies such as smart sensors, AI systems, IoT devices, and Digital Twin technologies remained low. The study identified inadequate awareness, poor internet infrastructure, financial limitations, and insufficient technical training as major barriers affecting the adoption of digital technologies within facility management practice in Abuja.

The reviewed literature generally indicates that emerging digital technologies have significantly transformed facility management practice globally by improving operational efficiency, predictive maintenance, sustainability, asset management, and decision-making processes. However, despite the growing awareness of these technologies within Nigeria and Abuja specifically, the actual level of usage and implementation remains relatively low compared to developed countries. The literature further reveals that inadequate awareness, insufficient digital literacy, poor technological infrastructure, high implementation costs, shortage of skilled personnel, and resistance to change remain major challenges limiting the adoption of emerging digital technologies within facility management practice in Nigeria**.**

Materials and Methods

The Federal Capital Territory (FCT) is strategically located in the North-Central region of Nigeria and lies between longitudes 6°20’E to 7°33’E and latitudes 8°30’N to 9°20’N. It covers an approximate land area of about 8,000 square kilometres and shares boundaries with Kaduna State to the north, Niger State to the west, Nasarawa State to the east and southeast, and Kogi State to the southwest. The FCT hosts Abuja, which serves as the capital city of Nigeria and the administrative headquarters of the territory. Abuja is characterized by rapid urban expansion, increasing infrastructural development, and a growing concentration of residential, commercial, institutional, and public facilities, all of which require effective facility management systems to ensure sustainability, functionality, and operational efficiency.

For this study, the target population is divided into two major study elements, which are central to the investigation of awareness and usage of emerging digital technologies in facility management practice. These include facility managers in Abuja and users of facilities in Abuja. The inclusion of these two groups is important because facility managers are directly responsible for the implementation of facility management practices and technological

adoption, while facility users provide critical insights into the performance, efficiency, and quality of facility management services experienced within the built environment.

The sampling frame for the facility users was derived from the records of the Tenement Rate Unit of the Abuja Municipal Area Council (AMAC), which indicates that there are over 50,000 registered residential and commercial properties within the area. This population represents users of facilities such as residential buildings, office complexes, commercial centres, and institutional properties within Abuja. In addition, the population of facility managers was obtained from the 2025 Directory of the Institute of Global Facilities Management (IGFM), which shows that there are approximately 350 practicing facility managers operating within Abuja. These two datasets formed the basis for determining an appropriate and representative sample for the study. The sample size for the study was determined using a sample size reduction formula which is widely adopted for finite populations where a definite number of units is known.

Therefore, the sample size for facility users in Abuja was determined as 397 respondents, while the total population of facility managers in Abuja (350) was adopted as the sample size for that category due to its manageable size and the need for comprehensive coverage of professionals within the field.

A stratified sampling technique was adopted in this study to ensure adequate representation of both categories of respondents. This approach was considered appropriate because it allows the population to be divided into distinct subgroups (facility managers and facility users), ensuring that each subgroup is proportionately represented in the study. Structured questionnaires were then administered to the selected respondents to obtain relevant primary data on awareness, usage, and challenges associated with emerging digital technologies in facility management practice.

Out of the total questionnaires administered, 95 (63.33%) responses were retrieved from facility managers, while 210 (52.50%) responses were retrieved from facility users, indicating a reasonable response rate for analysis. The collected data were analyzed using descriptive statistical tools, including frequency distributions, percentages, and Weighted Mean Score (WMS) techniques.

Table 1: Level of Awareness of Digital Technologies in Facility Management Practice In Abuja

The Level of Awareness of Digital Technologies in Facility Management Practice In Abuja	Facility Managers			Users			Mann Whitney U Test			
	Mean	Std. Dev	Rank	Mean	Std. Dev	Rank	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Smart meters (for electricity/water monitoring)	4.2800	.85117	5th	4.5688	.61405	2nd	29007.50	60382.50	-3.584	.000**
Mobile apps for reporting faults or service requests	3.7280	.79026	15th	3.5870	.80659	15th	30823.00	69049.00	-2.343	.019**
Automated lighting or HVAC systems	4.5560	.66982	1st	4.9348	.24736	1st	24657.00	56032.00	-8.160	.000**
Security systems with facial or biometric recognition	4.2360	.79425	6th	4.1522	.67584	12th	31759.50	69985.50	-1.698	.090

The Level of Awareness of Digital Technologies in Facility Management Practice In Abuja	Facility Managers			Users			Mann Whitney U Test			
	Mean	Std. Dev	Rank	Mean	Std. Dev	Rank	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Building Information Systems (BIM)	3.7720	.79659	14th	4.0181	.51490	14th	27857.00	59232.00	-4.282	.000**
Internet of Things (IoT) devices (e.g., motion sensors)	3.9520	.75895	12th	4.2210	.57688	9th	27730.00	59105.00	-4.283	.000**
Drones (for inspection or maintenance)	4.3000	.66011	4th	4.1775	.56020	11th	30451.50	68677.50	-2.639	.008**
Computer Aided Facility Management	4.1600	.74876	9th	4.2428	.57441	7th	33020.50	64395.50	-.940	.347
Building Management Systems (BMS)	4.4000	.49088	3rd	4.2536	.43587	5th	29450.00	67676.00	-3.581	.000**
Smart Building Systems, Robotics and Automation	4.1960	.74821	8th	4.2464	.56968	6th	33996.50	65371.50	-.320	.749
Energy Management Systems	4.4360	.74843	2nd	4.2572	.66807	4th	28856.00	67082.00	-3.556	.000**
Space management and Occupancy Detectors	3.9600	.80560	11th	4.1884	.55988	10th	28966.00	60341.00	-3.477	.001**
Work Order Management Tool	3.9720	.84740	10th	4.1341	.52584	13th	31812.50	63187.50	.1.747	.081
Access Control Systems and Artificial Intelligence	4.2080	.66822	7th	4.2391	.42733	8th	34419.00	72645.00	-.055	.956
Video Surveillance, Radio-Frequency Identification (RFID) and Barcode Scanning	3.9360	.68541	13th	4.4819	.80659	3rd	20562.50	51937.50	-8.619	.000**

Source: Author's Analysis (2026)

The results presented in Table 1 above revealed that both facility managers and facility users in Abuja demonstrate generally high awareness of emerging digital technologies in facility management practice, although differences exist in the intensity of awareness across specific technologies and between the two groups. For facility managers, the findings show a strong awareness of operational and system-based technologies that support building performance and efficiency. Automated lighting or HVAC systems ranked highest (Mean = 4.5560), followed by energy management systems (Mean = 4.4360) and Building Management Systems (BMS) (Mean = 4.4000). This indicates that facility managers are more conversant with integrated systems that support energy optimisation, building automation, and operational control. Similarly, drones for inspection (Mean = 4.3000) and smart meters (Mean = 4.2800) also recorded high awareness, reflecting growing familiarity with technologies that enhance maintenance planning, asset monitoring, and operational efficiency in facility management practice. However, relatively lower awareness was recorded for Building Information Modelling (BIM) (Mean = 3.7720) and mobile applications for fault reporting (Mean = 3.7280), suggesting limited exposure or weak integration of collaborative and data-sharing technologies in FM operations. This reflects a gap in the adoption of digital platforms that support real-time communication, documentation, and predictive maintenance functions. For facility users, awareness levels were also generally high, but with a stronger inclination toward visible and user-facing technologies. Automated lighting or HVAC systems recorded the highest awareness (Mean = 4.9348), followed by smart meters (Mean = 4.5688) and video

surveillance/RFID systems (Mean = 4.4819). This suggests that users are more familiar with technologies that directly affect comfort, security, and utility consumption. Moderate awareness was observed for energy management systems (Mean = 4.2572), Building Management Systems (Mean = 4.2536), and access control systems with AI (Mean = 4.2391). However, BIM (Mean = 4.0181) and mobile fault reporting applications (Mean = 3.5870) recorded the lowest awareness, indicating limited user engagement with backend or technical facility management systems.

The Mann–Whitney U test results further reveal significant differences in awareness levels between facility managers and users across several technologies. Statistically significant differences ($p < 0.05$) were observed for most variables, including smart meters, BIM, IoT devices, drones, BMS, energy management systems, space management systems, and video surveillance technologies. These differences confirm that awareness of digital technologies is not uniform between both groups and is influenced by their roles and interaction with facility systems.

In contrast, no significant differences were found for technologies such as computer-aided facility management ($p = 0.347$), smart building systems and robotics ($p = 0.749$), access control systems with AI ($p = 0.956$), and security systems with biometric recognition ($p = 0.090$). This suggests a convergence in awareness for technologies that are either widely visible or commonly integrated into everyday building operations.

Overall, the findings indicate that facility users tend to have higher awareness of visible, experience-based technologies such as automated lighting, smart meters, and surveillance systems, while facility managers demonstrate relatively higher awareness of technical and operational systems such as BMS, energy management systems, and drones. The significant differences identified in the Mann–Whitney U test highlight a role-based variation in exposure and interaction with digital technologies. The implication of these findings is that awareness of emerging digital technologies in facility management practice in Abuja is fragmented and role-dependent. While both facility managers and users are aware of digital technologies, their understanding is shaped by their level of interaction with specific systems. This misalignment may limit effective collaboration, integration, and full optimisation of digital technologies in facility operations.

These findings are consistent with previous studies by Ikediashi et al. (2023), who reported uneven adoption of digital technologies in facility management practice due to role-based exposure and infrastructural constraints, and Ebekozien and Samsurijan (2022), who highlighted that awareness does not always translate into usage in Nigeria's built environment sector. Similarly, Kaewunruen and Lian (2021) emphasized that while digital transformation enhances facility performance globally, developing countries often experience gaps between awareness and practical implementation. Therefore, the study underscores the need for improved training, stakeholder engagement, and awareness programmes that bridge the knowledge gap between facility managers and users. Enhancing shared understanding of digital technologies will promote better adoption, improve communication, and support more efficient and integrated facility management practice in Abuja.

Table 2: Level of Usage of Digital Technologies in Facility Management Practice In Abuja

Level of Usage of Digital Technologies in Facility Management Practice In Abuja	Facility Managers			Users			Mann Whittney U Test			
	Mean	Std. Dev	Rank	Mean	Std. Dev	Rank	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Smart meters (for electricity/water monitoring)	2.8440	1.30633	1st	2.4746	1.17368	1st	28107.00	66333.00	-3.810	.000**
Mobile apps for reporting faults or service requests	1.7680	.65413	10th	1.8949	.53241	7th	30425.00	61800.50	-2.717	.007**
Automated lighting or HVAC systems	1.7520	.72981	11th	1.8370	.61397	11th	31624.50	62999.50	-1.820	.069
Security systems with facial or biometric recognition	2.3840	1.15320	4th	2.1993	.91062	4th	31650.00	69876.00	-1.702	.089
Building Information Systems (BIM)	1.8440	.62388	6th	1.9203	.48335	6th	31945.00	63320.00	-1.785	.074
Internet of Things (IoT) devices (e.g., motion sensors)	1.7960	.64812	9th	1.8659	.52584	8th	32056.00	63431.00	-1.641	.101
Drones (for inspection or maintenance)	1.8720	.62705	5th	1.9203	.51256	5th	32865.00	64240.00	-1.128	.259
Computer Aided Facility Management	1.7120	.67444	13th	1.8116	.55988	12th	31050.00	62425.00	-2.240	.025**
Building Management Systems (BMS)	1.6000	.49088	14th	1.7464	.43587	15th	29450.00	60825.00	-3.581	.000**
Smart Building Systems, Robotics and Automation	1.8080	.67896	7th	1.8514	.53567	10th	32750.00	64125.00	-1.156	.248
Energy Management Systems	2.8040	.99677	2nd	2.4239	.86844	2nd	26738.00	64604.00	-4.907	.000**
Space management and Occupancy Detectors	1.7480	.70319	12th	1.8116	.55988	12th	32011.00	63386.00	-1.606	.108
Work Order Management Tool	1.8000	.66466	8th	1.8659	.52584	8th	32127.50	63502.50	-1.582	.114
Access Control Systems and Artificial Intelligence	1.5960	.49168	15th	1.7609	.42733	14th	28812.00	60187.00	-4.053	.000**
Video Surveillance, Radio-Frequency Identification (RFID) and Barcode Scanning	2.6600	.87376	3rd	2.3841	.76584	3rd	28065.00	66291.00	-4.050	.000**

Source: Author's Analysis (2026)

The results in Table 2 show that the overall level of usage of emerging digital technologies in facility management practice in Abuja is generally low for both facility managers and facility users, despite varying degrees of familiarity and awareness reported earlier. This indicates that awareness does not necessarily translate into practical application within facility operations. For facility managers, the most frequently used technology is smart meters for electricity and water monitoring (Mean = 2.8440), followed by energy management systems (Mean = 2.8040) and video surveillance, RFID and barcode scanning (Mean = 2.6600). These findings suggest that usage is concentrated mainly around basic monitoring, energy tracking, and security-related systems rather than advanced integrated facility management technologies. Other technologies such as security systems with facial recognition (Mean = 2.3840) and drones for inspection (Mean = 1.8720) recorded relatively low usage, while advanced systems such as BIM (Mean = 1.8440), IoT devices (Mean = 1.7960), CAFM (Mean = 1.7120), and Building Management Systems (Mean = 1.6000) were poorly utilized, indicating weak digital integration in FM operations.

Similarly, facility users also reported low usage levels across most digital technologies. The highest usage was also recorded for smart meters (Mean = 2.4746), followed by energy

management systems (Mean = 2.4239) and video surveillance/RFID systems (Mean = 2.3841). This reflects the fact that users are more likely to interact with visible, service-oriented technologies that directly affect utility consumption and security. However, most other technologies recorded very low usage values close to or below the midpoint of the scale, particularly BIM (Mean = 1.9203), IoT devices (Mean = 1.8659), CAFM systems (Mean = 1.8116), and access control systems with AI (Mean = 1.7609), indicating limited user engagement with advanced digital facility systems.

The Mann–Whitney U test results further confirm that although both groups show generally low usage levels, there are statistically significant differences in the usage of several technologies. Significant differences ($p < 0.05$) were observed in smart meters, mobile reporting applications, CAFM systems, BMS, energy management systems, access control systems with AI, and video surveillance technologies. These differences suggest that facility managers and users engage with certain technologies at different intensities due to their distinct roles within facility operations. Conversely, no significant differences were observed in the usage of automated lighting/HVAC systems, BIM, IoT devices, drones, smart building systems, occupancy detectors, and work order management tools. This implies that both groups experience similarly low levels of engagement with most advanced and integrated digital technologies, highlighting a general underutilization across the facility management sector in Abuja.

Overall, the findings indicate that the usage of emerging digital technologies in facility management practice in Abuja remains at a low and predominantly basic level. Usage is largely restricted to essential and visible systems such as energy monitoring and security surveillance, while advanced technologies such as BIM, IoT, CAFM, AI-based systems, and Digital Twin-related applications are significantly underutilized. The implication of this finding is that facility management practice in Abuja is still largely dependent on conventional or semi-digital approaches, despite increasing global shifts toward smart and integrated facility systems. The gap between awareness (as previously established) and actual usage suggests that knowledge of technologies does not necessarily translate into implementation, possibly due to constraints such as cost, technical capacity, infrastructure limitations, and organisational resistance to change.

These findings corroborate the studies of Ikediashi et al. (2023), who reported low adoption of advanced digital technologies in facility management practice in developing countries despite increasing awareness. They also align with Aghimien et al. (2020), who identified financial constraints, inadequate infrastructure, and lack of technical skills as major barriers to technology usage in the built environment sector. Similarly, Kaewunruen and Lian (2021) emphasized that developing economies often experience slow digital transformation in facility management due to limited capacity for full-scale technological implementation. Therefore, the study concludes that although emerging digital technologies are recognized within facility management practice in Abuja, their actual usage remains significantly limited. This highlights the urgent need for investment in digital infrastructure, capacity building,

professional training, and policy support to enhance effective adoption and integration of digital technologies in facility management practice.

Table 3: Crosstab on the Opinion of the Respondents on Level of Awareness and Usage of Digital Technologies in Facility Management Practice In Abuja

Digital Technologies	Awareness Score (Sum of Means)	Awareness Mann–Whitney U	Awareness Z	Awareness Sig. (p)	Usage Score (Sum of Means)	Usage Mann–Whitney U	Usage Z	Usage Sig. (p)	Significance Interpretation
Smart meters (electricity/water monitoring)	6.2103	27438.00	-4.219	.000	5.3186	28107.00	-3.810	.000**	Sig. difference in both awareness & usage
Mobile apps for reporting faults	5.0876	30300.00	-2.877	.004	3.6629	30425.00	-2.717	.007**	Sig. difference in both awareness & usage
Automated lighting/HVAC systems	4.8050	31125.00	-2.135	.033	3.5890	31624.50	-1.820	.069	Sig. in awareness, not in usage
Security systems (facial/biometric)	5.9132	31505.00	-1.830	.067	4.5833	31650.00	-1.702	.089	Not sig. in both awareness & usage
Building Information Modeling (BIM)	5.0275	31895.00	-1.525	.127	3.7643	31945.00	-1.785	.074	Not sig. in both awareness & usage
IoT devices (motion sensors)	5.1315	31985.00	-1.441	.150	3.6619	32056.00	-1.641	.101	Not sig. in both awareness & usage
Drones (inspection/maintenance)	5.0650	32615.00	-1.050	.294	3.7923	32865.00	-1.128	.259	Not sig. in both awareness & usage
Computer Aided Facility Management (CAFM)	5.0350	30525.00	-2.681	.007	3.5236	31050.00	-2.240	.025**	Sig. in both awareness & usage
Building Management Systems (BMS)	4.5232	29125.00	-3.950	.000	3.3464	29450.00	-3.581	.000**	Sig. in both awareness & usage
Smart Building Systems, Robotics & Automation	5.0175	32505.00	-1.112	.266	3.6594	32750.00	-1.156	.248	Not sig. in both awareness & usage
Energy Management Systems	6.0520	26005.00	-5.250	.000	5.2279	26738.00	-4.907	.000**	Sig. in both awareness & usage
Space Management & Occupancy Detectors	4.7810	31965.00	-1.486	.137	3.5596	32011.00	-1.606	.108	Not sig. in both awareness & usage
Work Order Management Tools	4.8935	32050.00	-1.400	.162	3.6659	32127.50	-1.582	.114	Not sig. in both awareness & usage
Access Control & Artificial Intelligence	4.5340	28575.00	-4.350	.000	3.3569	28812.00	-4.053	.000**	Sig. in both awareness & usage
Video Surveillance, RFID & Barcode Scanning	5.9435	27660.00	-4.022	.000	5.0441	28065.00	-4.050	.000**	Sig. in both awareness & usage

Source: Author's Analysis (2026)

The results presented in Table 3 provide a comparative synthesis of the level of awareness and usage of emerging digital technologies in facility management practice in Abuja, along with their corresponding Mann–Whitney U test outcomes. The findings reveal a consistent pattern showing that while awareness of most digital technologies is relatively higher, actual usage remains considerably lower across both facility managers and facility users, indicating a clear awareness–usage gap in facility management practice.

For technologies such as smart meters, mobile applications for fault reporting, CAFM systems, BMS, energy management systems, access control systems with artificial intelligence, and video surveillance/RFID systems, the results show statistically significant differences in both awareness and usage ($p < 0.05$). For instance, smart meters recorded strong significance in both awareness ($U = 27438.00$, $p = 0.000$) and usage ($U = 28107.00$, $p = 0.000$), indicating that although respondents are highly aware of utility monitoring technologies, their actual integration into facility operations still varies significantly between user groups. Similarly, energy management systems also recorded highly significant differences in both awareness ($Z = -5.250$, $p = 0.000$) and usage ($Z = -4.907$, $p = 0.000$), suggesting increasing recognition of energy optimisation technologies, although practical implementation remains uneven. CAFM systems and Building Management Systems (BMS) also showed significant differences in both awareness and usage ($p < 0.05$), indicating that while these core facility management platforms are known within the industry, their actual deployment in day-to-day operations is still limited. Access control systems and AI-based technologies, as well as video surveillance systems, also demonstrated significant differences in both awareness and usage, reflecting their strong visibility and security relevance within facilities, yet inconsistent integration into full FM digital systems.

In contrast, several technologies including IoT devices, drones for inspection, smart building systems, robotics and automation, space management systems, and work order management tools did not show statistically significant differences in both awareness and usage ($p > 0.05$). This suggests a generally low and uniform level of engagement with these advanced technologies across both facility managers and users. In other words, these technologies are not only less utilized but also not sufficiently differentiated in terms of awareness between stakeholder groups, indicating weak penetration into facility management practice in Abuja. Interestingly, automated lighting and HVAC systems showed a significant difference in awareness ($p = 0.033$) but not in usage ($p = 0.069$), implying that while respondents are familiar with the technology, its practical application is not significantly differentiated between groups and may still be at an early stage of implementation in many facilities.

Overall, the findings from the crosstab analysis confirm that emerging digital technologies in facility management practice in Abuja are characterised by a high awareness–low usage paradox. While stakeholders demonstrate relatively strong awareness of modern facility technologies particularly energy monitoring, security systems, and basic automation tools the actual usage remains limited and uneven, especially for advanced systems such as BIM, IoT integration, CAFM platforms, and smart building technologies.

The implication of these findings is that facility management practice in Abuja is still largely in a transitional phase of digital adoption, where knowledge of technologies is not yet fully translating into operational implementation. This may be attributed to infrastructural limitations, financial constraints, lack of technical capacity, and organisational resistance to change, as well as inadequate integration of digital systems into existing facility management structures. These findings strongly corroborate previous studies by Ikediashi et al. (2023), who reported that awareness of digital technologies in developing countries does not necessarily

lead to effective adoption due to structural and institutional barriers. They also align with Aghimien et al. (2020), who emphasized that cost, technical skills shortage, and infrastructural deficits significantly limit digital technology deployment in the built environment sector. Furthermore, Kaewunruen and Lian (2021) similarly observed that while digital transformation is advancing globally, developing economies lag behind in actual implementation despite increasing awareness.

In conclusion, the results highlight the urgent need for targeted capacity building, improved digital infrastructure, policy support, and stakeholder integration strategies to bridge the gap between awareness and usage of emerging digital technologies in facility management practice in Abuja.

Conclusion

This study examined the awareness and usage of emerging digital technologies in facility management practice in Abuja, Nigeria. The findings revealed that both facility managers and facility users demonstrate a relatively high level of awareness of modern digital technologies such as smart meters, energy management systems, building management systems (BMS), and security-related technologies. However, despite this appreciable level of awareness, the actual usage of these technologies in facility management practice remains significantly low.

The analysis further showed a clear and consistent awareness- usage gap, where familiarity with digital technologies does not translate into effective implementation. Advanced technologies such as Building Information Modelling (BIM), Internet of Things (IoT), Computer-Aided Facility Management (CAFM), Artificial Intelligence-based systems, and Digital Twin-related applications were particularly underutilized across both facility managers and facility users. The Mann–Whitney U test results also confirmed that while there are statistically significant differences in awareness and usage across several technologies, overall adoption remains limited and uneven.

In essence, facility management practice in Abuja is still largely characterized by conventional and semi-digital operational approaches, despite increasing global shifts toward smart, automated, and data-driven facility systems. The study therefore concludes that the low level of usage of emerging digital technologies is not due to lack of awareness alone, but also due to structural, institutional, financial, and technical constraints within the built environment sector.

Recommendation

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

a) **Enhanced Training and Capacity Building:** Facility management professionals should be exposed to continuous training, workshops, and certification programmes on emerging digital technologies such as BIM, IoT, CAFM, and AI-based facility systems to bridge the gap between awareness and practical application.

b) **Digital Infrastructure Development:** Government and private sector stakeholders should invest in reliable ICT infrastructure, including stable internet connectivity, smart building

systems, and digital facility platforms to support effective implementation of advanced technologies.

c) **Integration of Digital Technologies in Facility Operations:** Facility management organisations should gradually integrate digital tools into their daily operations, especially CAFM systems, energy management systems, and smart monitoring tools, to improve efficiency and service delivery.

d) **Policy and Institutional Support:** Regulatory bodies and professional institutions should develop policies that encourage digital transformation in facility management practice, including standards for technology adoption and incentives for digital innovation.

e) **Awareness and Sensitization Campaigns:** There is a need for increased awareness programmes targeted at both facility managers and users to promote the benefits of emerging digital technologies and encourage acceptance and participation in digital facility systems.

f) **Collaboration Between Stakeholders:** Stronger collaboration between facility managers, technology providers, government agencies, and professional bodies should be encouraged to promote knowledge sharing and facilitate smoother adoption of digital solutions.

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