Automated Facilities Management Systems: The Future of Campus Operations:

Use Cases, Benefits and Opportunities

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Introduction

- Automated facility management uses software, Artificial Intelligence (AI), IoT sensors, and robotics to manage building operations—like HVAC, lighting, security, and maintenance—with minimal manual intervention.
- It can be achieved by linking and integrating digital systems together
- It boosts efficiency by analysing real-time data to predict equipment failures, automate workflows, reduce energy costs, and optimise space usage
- It transforms traditional reactive maintenance into a proactive, data-driven strategy

Key components and benefits

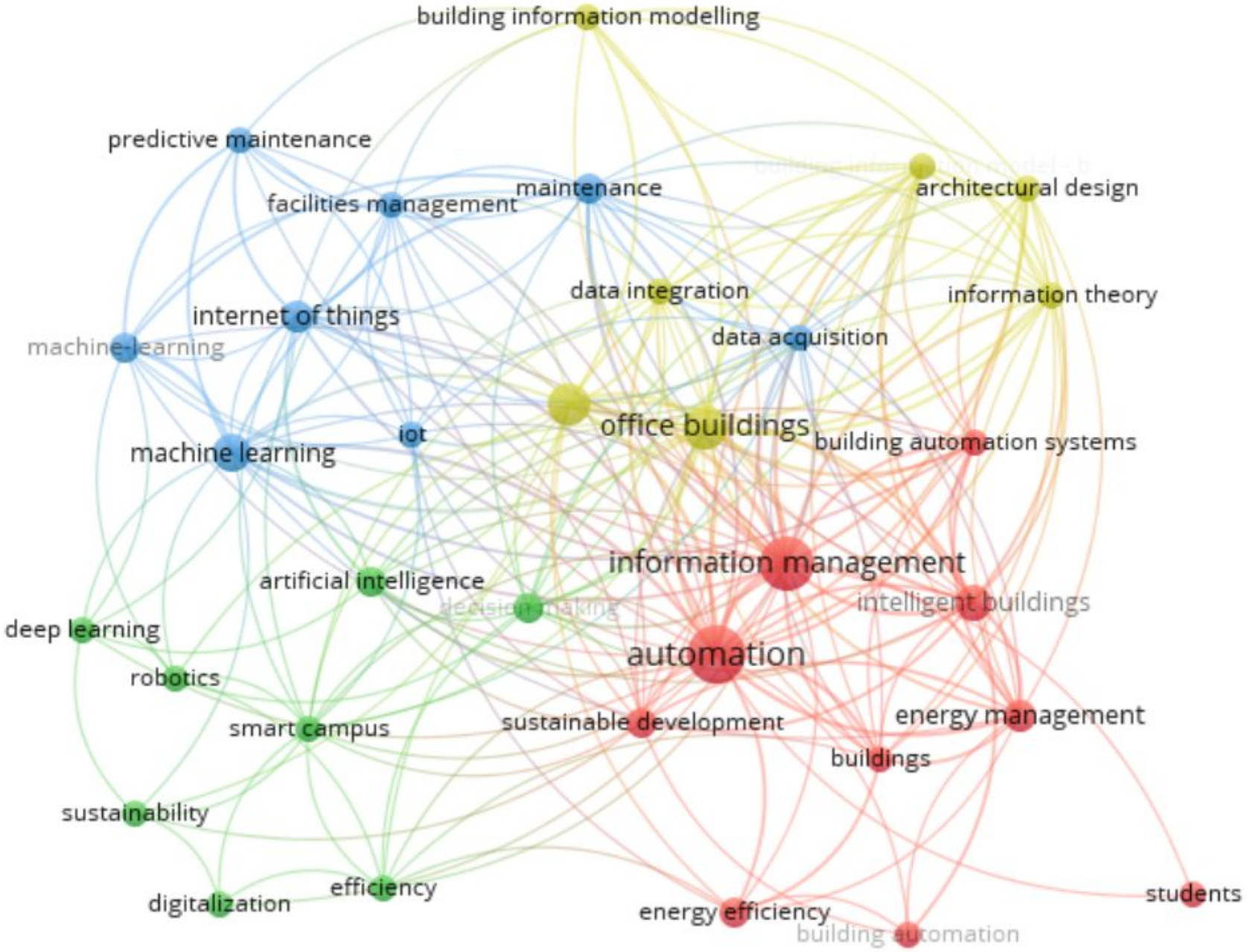
- Predictive Maintenance: Sensors identify potential equipment issues before they cause failures, reducing downtime.
- Energy Management: Smart lighting and HVAC, optimise usage, reduce waste and operating costs.
- Operational Efficiency: Centralised platforms (e.g., CMMS) handle work orders and tracking, reducing manual, paper-based tasks.
- Safety and Security: Autonomous robots and smart systems provide 24/7 surveillance and maintenance monitoring.
- Improved Accuracy: Minimising human error in reporting, scheduling, and routine tasks.

The Study

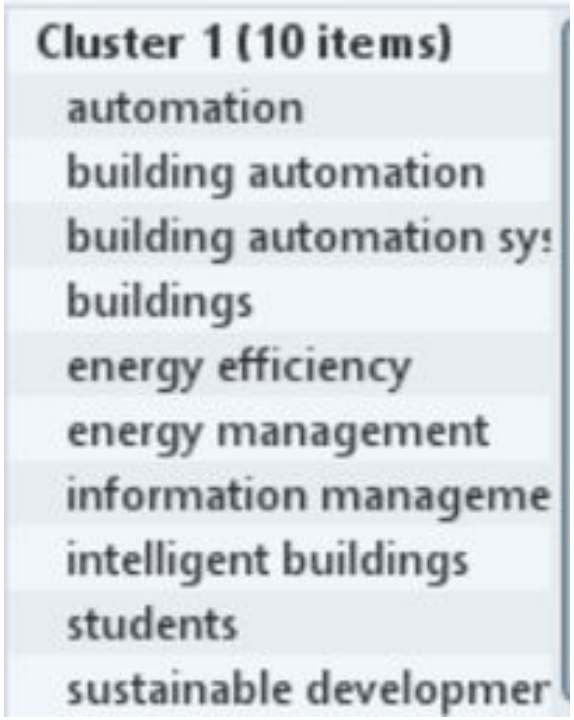
- Scoping review - Identify use cases, benefits and challenges of integrating automation systems in FM in university/campus operations
- Database – Scopus
- Keywords – Automation facilities management university
- Sources - Journal articles, conference papers, reviews
- Period - All time and then restricted to 10 years (2016 – 2025)
- Visualisation – VosViewer
- Content analysis

Findings

- 179 publications over the years
- 44 papers – 2016 to 2025
- Countries – United States, United Kingdom, Italy, Nigeria, South Africa (1)
- Focus – Strategies and Benefits
- Visualisation of keywords - 33 keywords - Four groups


building information modelling
predictive maintenance
maintenance
facilities management
architectural design
data integration
information theory
internet of things
machine-learning
data acquisition
office buildings
iot
machine learning
building automation systems
information management
artificial intelligence
intelligent buildings
deep learning
automation
robotics
smart campus
sustainable development
energy management
buildings
sustainability
efficiency
digitalization
energy efficiency
students
building automation

Findings – Keywords (1)



Energy efficiency in an intelligent building

AI for decision-making

Findings – Keywords (2)

Cluster 3 (8 items)
data acquisition
facilities management
internet of things
iot
machine learning
machine-learning
maintenance
predictive maintenance

IoT in data collection for predictive maintenance

Cluster 4 (7 items)
architectural design
building information m
building information m
data integration
facility management
information theory
office buildings

Integration of the data

Keyword	Occurrences	Total link strength
information management	13	62
automation	15	61
office buildings	9	51
facility management	8	39
intelligent buildings	6	32
machine learning	7	29
architectural design	3	26
building information model - bim	3	26
information theory	3	26
maintenance	4	25
data acquisition	3	24
energy management	5	24
internet of things	5	22
building automation systems	3	21
decision making	4	19
buildings	3	18
data integration	3	18
sustainable development	4	17
facilities management	3	16
machine-learning	4	16

Source	Tools	Use cases and benefits	Opportunities
Mohamed, B et al. (2021).	Mobile phones - crowdsourcing	Information sourcing; Real-time data on occupant feedback	Management's willingness to engage
Rey-Hernández (2019)	Supervisory Control and Data Acquisition (SCADA), in combination with different ventilation systems as free-cooling, heat recovery and geothermal energy of an Earth Air Heat eXchanger (EAHX),	Smart energy management and control; Energy efficiency in ventilation; climate change reduction; optimum system operation in cooling and heating mode	The use of new renewable energy technologies integrated in buildings, with the aim of reducing the consumption of the facilities
Stojkic et al.	Internet of Things and Big Data Analysis	Predictive maintenance; Processing data from many sensors; integration of automated systems with IT systems, to better control and management	Sustainable management
Weber et al (2025)	Data dictionaries	Data collation and text-mining on specific terms; To enhance simulation and management	Implementing IoT-based automation

Marín-Rodriguez, et al (2021)	Inmotics and IoTs for labs	To optimize resources to reduce costs, save energy and offer security; Energy savings	Design of smart buildings; using digital sensors, electronic controllers, devices and communication systems, creating the lucidity required for digitalization; needs integration into institution's technology infrastructure, together, cloud computing services and Artificial Intelligence platform
Ekanayake, B (2022)	Deep leaning algorithms (machine learning)	Detection of defects; real-time, accurate and efficient defects detection; monitoring	Sustainability of buildings with real-time detection of defects
Fialho, B. C. (2022).	BIM and IoT; maintenance system prototype for universities	Smart lighting systems; Improves user experience, helps to reduce costs	Effective reactive maintenance
Mendoza & Zeleda (2023).	IoT system infrastructure design	Data collection and storage, management of a specialised lab	Integral management system

Accardo	IoT devices, Digital twins	Creation of a Digital shadow for Indoor Air Quality (IAQ); Connecting data streams to building models for identifying criticalities and improving indoor environmental quality and users' comfort, as well as learning performance	Building automation
Mahariya Smart Campus 4.0: Digitalization of University Campus with Assimilation of Industry 4.0 for Innovation and Sustainability	Cloud computing, artificial intelligence (AI), Internet of things (IoT), edge/fog computing, blockchain, robot process automation (RPA), drones, augmented reality (AR), virtual reality (VR), big data, digital twin, and metaverse	IoT-Based Drone system - ground patrolling, and AI - campus placement prediction model	A cloud server to develop a smart campus energy monitoring system. Cloud and Edge computing architecture to build an intelligent air-quality monitoring system
Pacifico et al (2024)	Artificial Intelligence (AI) and Internet of Things (IoT) systems	Optimize maintenance processes, enabling knowledge automation; Predictive maintenance	ICT systems for managing and monitoring new buildings; Predictive maintenance

Erdogan, A. M. (2024).	Robotic Process Automation (RPA	Automating repetitive tasks; streamline administrative processes, improve operational efficiency, and free up staff resources	Process complexity, ROI, and strategic importance
Yahaya et al (2025).	A regularized Bayesian Neural Network (BNN)	Building energy prediction and management	Occupancy detection accuracy. Environmental sensor data (temperature, humidity, light, CO_2) Engineered features such as heating degree days (HDD)
Elias, et al. (2025)	Digital twins	Simulation and analyses of physical spaces Anomaly detention Decision making	Actionable and dynamic virtual models and enhance facilities and asset management (FAM) functions.

Bremer et al. (2025)	Motion sensors, IoTs, energy information systems	Increased energy efficiency/savings, increased comfort	Digital solutions to increase energy efficiency Human building interaction. linking and integrating digital systems together; Occupancy data
Fitri and Hasanah	IoT, smart campuses		Compliance with the systems Availability, Scalability, Security, Serviceability, and Manageability
Marteneh et al. Automated and interconnected facility management system: An open IFC cloud-based BIM solution.	cloud-based BIM	Enables data collection, retrieval and transfer	Interconnected systems

Studies in Africa

- Awosode et al. (2024) - The Relevance of Automation in the Facility Management of Selected High-Rise Buildings in Lagos, Nigeria

- Kibwami & Moyo (2021). Management of Facilities at Public Universities in Africa: Current Challenges and the Way Forward

- Nngidi 2023). An assessment of risk management in digitalisation of facilities Management in South Africa

- Mohammed & Amoah (2025). Integration of technology in decision-making in university facilities management: a literature review [Found research in the US, UK, and China; none from Africa]

Challenges

- Data supply issues – incomplete data and systems degrade
- Funding – available for detailed, advanced plans; difficult to balance between the initial capital investment cost versus the cost in use and energy saving cost over the lifecycle.
- Occupant and user behaviour – The more complex the system, the fewer people who are willing to interact with it; they may also want to prioritise their comfort and productivity
- Increasing amounts of collected data require a lot of storage

Challenges

- Technical complexities – Unreliable data logging, missing data; delivering what is intended
- Data storage – Storage, visualisation and accessibility of data and the associated costs
- Complex task of modelling real-world systems – Digital Twins
- Cost of maintenance – with automation; costly to resource; the costs for maintenance and repair rise

Future research directions

- Limited research from Africa
- Challenges and strategies to use the systems
- The downsides of smart systems
- Occupant or end-user behaviour
- Human-robot interaction – 5IR
- Smart campuses – combining BIM with IoT for real-time monitoring of energy consumption, lighting, and HVAC systems.
- Standardised Requirements: Standards (ISO) and guidelines; compliance

Thank you