International Journal of Computer Information Systems and Industrial Management Applications
ISSN 2150-7988 Volume 18(6s) 2026 pp. 689-703
https://doi.org/10.70917/ijcisim-2026-2601
Article

Leadership Perspectives on AI and IoT Integration in Smart Campuses: A Systems-Level Review

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Abstract: The proliferation of AI and IoT technology throughout higher education has led to the creation of "smart campuses," which are digitally-enabled environments that aim to improve both the efficiency of campus infrastructure, and both academic engagements, and the overall wellness of students. Although there is an abundance of literature exploring the technological advancements being implemented on campuses, there is an overwhelming lack of exploration surrounding the leadership roles that exist to guide, govern and sustain those same implementations. This literature review will examine the perspective of leaders regarding the implementation of AI and IoT technologies into smart campus ecosystems through an examination of decision making related to institutional level decisions, digital governance and framework for implementing strategically. This literature review will draw upon several case studies from around the world, including MIT, NTU, UCL, and IITs, to highlight the diverse leadership models used to facilitate campus innovation - including institutional, operational, and distributed leadership, and the impact each model has had on the campus. Additionally, this literature review will outline emergent collaborative methods that involve academic, industry, and governmental partners in developing smart campuses. The analysis will identify areas of significant literature gaps - including limited longitudinal studies, underrepresented low- and middle-income countries, and the need for comparative, multi-campus research. Finally, this literature review will propose directions for future research to enable effective, contextually relevant, and ethically responsible leadership in the development of smart campuses.
Keywords: Smart Campus, Artificial Intelligence, Internet of Things, Digital Leadership, Institutional Governance, AI Analytics, Higher Education Transformation, Data Governance, Adaptive Leadership, Campus Sustainability.

1. INTRODUCTION

Over the last 20 years, there has been a trend towards digitalization of university campus operations (infrastructure) and student services; this trend began with a series of disconnected information technology systems (e.g., learning management platforms, automated library catalogs, institutional portals); over time, the various systems have become increasingly integrated, forming a complex and interconnected ecosystem; when developed and implemented from both structural and integrated perspectives, these interconnected ecosystems will be referred to as smart campus; the term "smart campus" represents the use of advanced technologies to improve the operational efficiency of universities, facilitate more informed decision-making and provide more effective experiences for all users of the institution (students, faculty and staff), while extending beyond digital access to encompass the data driven management of physical space, energy systems, learning environments and institutional services (Jia & Hou, 2024).

Smart campuses are formed by the intersection of at least two different layers of technological development including, but not limited to, IoT, sensors, data analytic software, cloud-based infrastructures and AI systems. These components enable continuous collection of data, real-time analysis and automated decision making across campus domains including resource management, safety and security, transportation and student support. As these systems become more embedded into everyday institutional functions, they create new expectations with respect to transparency of operational processes, responsiveness to varying demands and scalability (Kelder et al., 2025).

1.1 Role of AI and IOT in transforming campus operations

Besides many other technologies used in the design of infrastructure in smart campuses, IOT and AI play specifically central roles. Iot technologies provide the sensory interface between the physical campus and its digital systems. They allow for the automatic collection of data about the state of environmental conditions, energy consumption, occupancy levels and user interactions with physical infrastructure. AI allows the analysis of this data to generate insightful analyses, forecast behaviours, detect anomalies and support automated responses. Together, these technologies allow institutions to monitor but also optimise their systems through adaptive feedback loops (Oliveira & Proença, 2025).

For example, AI models can analyse classroom occupancy data collected by iot sensors to recommend room allocations that reduce resource waste. Predictive analytics can be used to identify maintenance needs before system failure or to detect changes in student engagement based on behavioural data. In Student Services, AI can assist Early Alert Systems by identifying students-at-risk through use of Real-Time Data Inputs from IoT Enabled Applications. As such, there is an increasing emphasis on Cross-Domain Integration as Building System Data, Student Portal Data and Academic Platform Data are being utilized to Inform Decisions and Interventions collectively (Zeng et al., 2025).

However, the success of such Systems, although largely dependent upon Technical Factors; also depends on Institutional Leadership's Decisions related to Infrastructure Investments, Data Governance, Ethical Responsibility and Organizational Change. All of these decisions are made by Institutional Leaders.

1.2 Rationale for Focus on Leadership Perspectives

Literature regarding smart campuses has placed a significant amount of emphasis on technological potential, system design and user experience. comparably less attention has been given to the institutional leadership structures that enable or restrict these transformations. Without effective institutional leadership, even well-designed technological systems may face limited adoption, limited scalability and long-term disinvestment. conversely, strong institutional leadership can mobilize institutional resources, build cross-departmental coalitions and sustain commitment to system-wide change.

Specifically, the integration of ai & iot present challenges beyond the capabilities of individual technical departments. Decision-making in this case typically requires collaboration among academic leadership, it services, facilities management, student affairs and legal offices (zeng et al., 2025). The review does not focus soley on the functionality of the technical features of AI and IOT systems but rather on the institutional contexts in which these systems are adopted and scaled.

2. LITERATURE REVIEW

In early smart campus literature, the main focus was on technical aspects of smart campus, i.e. infrastructure such as sensor networks, learning management systems and automated energy control systems. Recent studies have extended their scope to social and organizational aspects, including the implications of smart systems for privacy, equity, accessibility and user agency (Sposato, 2025).

AI and IoT are two of the leading-edge technologies now in place for campus-wide operation through digital means. Increasingly, AI has been used in several areas of a university campus, including learning analytics, personalized feedback systems, predictive facility maintenance, and student service systems. IoT systems provide the capability to monitor in real time space utilization, energy consumption, and environmental parameters, using sensor data from interconnected devices. Research by Arrooqi & Alruqi, (2025), have shown that combining AI and IoT technologies can improve both the operational outcomes of an institution as well as improve the educational environment of a campus and campus security.

However, the processes of integrating AI and IoT technologies are not standardized among institutions. There are four major factors affecting the success of the integration process: (1) the degree of infrastructural readiness, (2) regulatory issues, (3) stakeholder acceptance, and (4) funding. Generally, it is the leadership within an institution that determines how to address these challenges. Although many studies evaluate the performance of the systems, few study the strategic and managerial processes that either foster or hinder the integration process (Arrooqi & Alruqi, 2025).

Research on leadership in higher education traditionally focuses on academic leadership, change management, and strategic planning. Due to the emergence of digital infrastructure, new models of leadership are proposed. They include distributed leadership, where power is distributed over several teams, and adaptive leadership, where the focus lies on responsiveness, learning, and problem-solving in unstable environments (Bakar, 2025).

Institutes which have been successful in their digital transformation are developing Hybrid Leadership Models as they offer the central strategic direction while also providing the local operational flexibility (Bevilacqua et al., 2025). These hybrid models will be represented by CIO's, Chief Digital Officers and Deans of Digital Learning; however, there is limited empirical evidence available regarding whether or not the hybrid model represents an effective strategy within Smart Campus environments. One major area of concern in the literature is the difference between the technology ambitions and the readiness of the organization to implement those technologies. Literature has identified several obstacles for leaders who want to implement AI/IoT technologies: senior administrators' lack of understanding of technology, inadequate coordination between departments, employee/student resistance and budget constraints (Bevilacqua et al., 2025).

3. SMART CAMPUS ECOSYSTEMS

Creating a "Smart Campus" refers to creating an integrated, digitally-enabled university environment through information communication technologies (ICT), sensors and data systems to enhance institutional performance, improve student learning and teaching, improve campus safety and improve the quality of experience of students. The model was developed as part of larger Smart Cities initiatives, however adapted to meet the specific needs of higher education. A Smart Campus does not rely on one technology; rather a suite of interrelated digital systems work together to increase process efficiency, responsiveness and decision-making speed (Adamakis & Rachiotis, 2025).

A Smart Campus can be made up of the following elements:

1. Embedded physical infrastructure, including IoT sensors and devices (such as smart meters, occupancy sensors, lighting systems and access control systems).

2. A Data Platform (including Wi-Fi, 5G, Cloud Storage) for collecting and integrating sensor and user data.

3. Analysis Engines (run by AI and ML algorithms) to analyze large datasets to generate insights for both tactical and strategic decision-making.

When a well-designed smart campus system operates effectively, both administrative efficiency and user-level personalized experiences will be achieved (Li, Palaoag, Du, et al., 2023).

The infrastructure area covers energy management, water usage, building automation and physical security. In this area, IoT and AI are used to track and analyze consumption, predict system failures and optimize resource usage. For example, a university could apply predictive maintenance to its Heating Ventilation Air Conditioning (HVAC) systems or use occupancy data to turn off lights and adjust heating and cooling systems automatically (Hassan & Ahmad, 2025).

Services include academic scheduling, transportation management, and library services. AI-enabled chatbots, intelligent timetabling systems, and campus navigation systems using location awareness are examples of common tools. These tools are used to reduce administrative burden, and to improve the experience of both students and faculty (Kesuma et al., 2024). Sustainability has become a prominent functional area due to growing pressure on institutions to achieve environmental objectives.

Figure 1 presents a systems-level representation of the smart campus ecosystem. This model is in the form of a vertically integrated architecture. It begins at the bottom with the data generation layer which includes IoT sensor technology, mobile device users, and Wi-Fi technologies. These elements serve to provide the physical-digital interface for the campus environment; therefore, they are able to collect data continuously from all areas of the campus including; infrastructure, mobility, and user interactions. The next level, the data aggregation layer, combines the many different sources of data collected in the previous step into one location.

At the apex of the model, institutional decision-makers interpret system outputs and implement strategic, operational, and governance decisions. The figure illustrates the sequential flow from sensing to governance, emphasizing that technological infrastructure is embedded within leadership and institutional oversight structures.

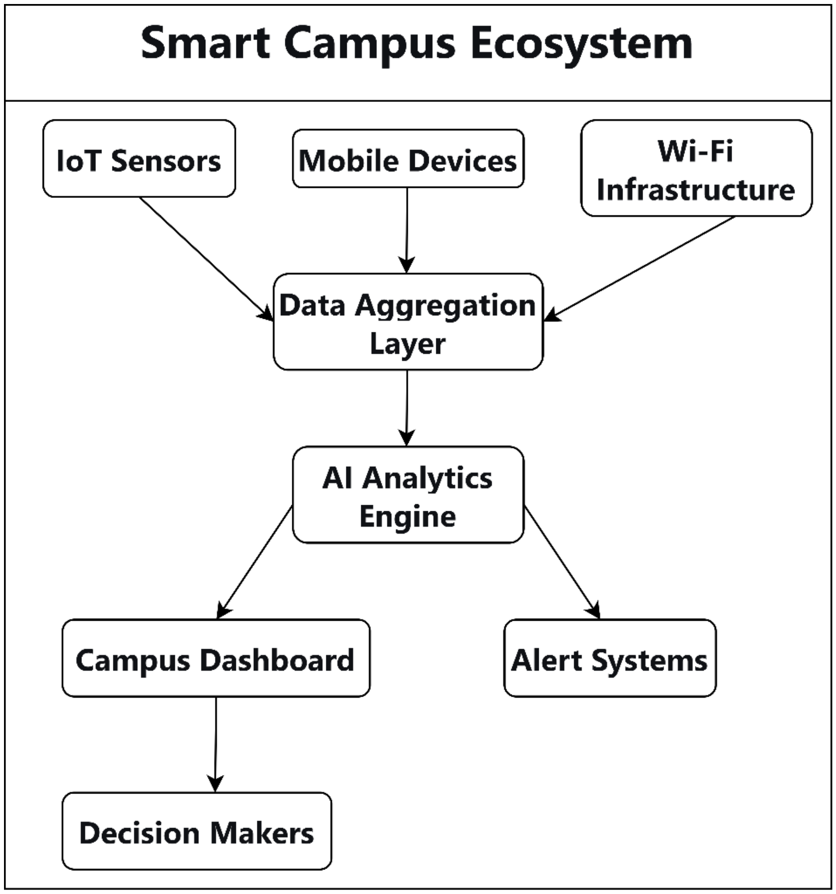

Figure 1. Layered Architecture of the Smart Campus Ecosystem Integrating IoT Infrastructure, Data Aggregation, AI Analytics, and Institutional Decision-Making

4. AI AND IOT INTEGRATION IN SMART CAMPUSES

Data Platform

Once data is sent to the data platform, the data is analysed and processed through data aggregation. The data is both structured and unstructured; for example, access logs are structured while video feeds are unstructured. In order to process and analyse the different types of data, the data needs to be placed into a data lake, which is a type of repository that stores large amounts of raw data. Middleware systems are also required to process and store the different forms of data. Data can be processed in real-time (Edge Computing) or processed for batch analysis (Cloud Computing). Depending on the urgency and need of each individual application, data will be processed in real-time or stored until later to be processed in batches (Khairullah et al., 2025).

Application Layer

After the data has been processed and analysed, AI algorithms are then applied to the data to find meaningful patterns in the data. Machine learning is primarily used to extract meaningful patterns in the data. Classification and Prediction are the most common supervised learning tasks, such as identifying students who are at risk of failing, or predicting energy consumption. Anomalies can be identified, and behavioural clusters can be identified with unsupervised learning, or changes in space utilization can be monitored. Natural Language Processing (NLP) can be used to perform sentiment analysis on feedback systems or chatbots (Khairullah et al., 2025).

Combined layers of IoT devices, robust data platforms, and AI models allow for real-time decision making and real-time responsive actions, and therefore form the operational backbone of smart campus ecosystems.

4.1 Use Cases: Energy Optimization, Learning Analytics, Security, and Student Mental Health

The combination of AI and IoT has allowed campuses to utilize these technologies in many different areas of campus life. **Energy Optimization through Predictive Models** Predictive models based on real-time data from smart meters and occupancy sensors are used to optimize lighting, heating, and cooling systems. An example would be if the campus knew that a particular classroom was going to be unused at a particular time, then the HVAC could be adjusted to waste less energy. Over time, the system would develop what are considered to be "optimal" energy patterns and make suggestions as to how to optimize the use of energy either by making changes to the physical infrastructure of the building or to the class schedule (Gordienko & Багратиони, 2024). **Use of Learning Analytics** Data from virtual learning environments, attendance tracking, and device usage are used by AI models to identify student's engagement and learning behaviours. The models can identify trends in student behavior such as a decline in engagement, inconsistent performance, etc. and notify academic advisors. Some platforms will also provide students with real-time feedback so they can better understand how to study and stay on top of coursework (Mahade et al., 2025). **Security Utilizing Video Analytics and Access Control Systems** AI enabled video analytics and access control systems utilizing IoT sensors and cameras can monitor movement, unauthorized access, and crowd formations. Facial recognition and heat mapping technologies are being increasingly used in large institutions to secure high traffic areas, but there is significant concern about the ethics and legality of deploying these technologies (Gordienko & Багратиони, 2024). **Student Mental Health Monitoring Through Wearable Sensors and Smartphone Apps** Wearable sensors and smartphone apps can collect behavioural and physiological data (sleep duration, activity level, frequency of communication, etc.) that AI models can identify patterns of psychological distress. These systems can integrate this type of data with academic and social participation data to provide early warning signals to allow counsellors to intervene automatically, or to provide self-help recommendations (Michopoulou & Gan, 2025). Together, each of these use cases demonstrates the capability of AI and IoT to create a more efficient and personalized campus environment.

Figure 2 illustrates the principal functional domains in which AI and IoT technologies are deployed within the smart campus ecosystem. In addition to a technology map, the model is an institutional map. The technology map can be used to identify how different types of technological applications will affect various institutional stakeholders. For example, within administrative departments, Smart Security Systems supported by Artificial Intelligence (AI) and Internet of Things (IoT) provide better Risk Monitoring; improve Resource Optimization; and better enable Sustainability Performance. Learning Analytics Systems enabled with AI help Faculty monitor Student Engagement; identify Students who are at Risk; and make Pedagogical Adjustments.

At the Student Level, AI-enabled monitoring systems can help identify and implement Early Intervention Mechanisms for Mental Health issues.

The figure illustrates how this smart campus technologies operate across several levels of organization and affect Administrative Governance; Academic Practice; and Student Well-Being. The figure also illustrates the distributed nature of the technological impacts on the institution and emphasizes the need for Coordinated Leadership; Ethical Oversight; and Stakeholder Engagement when integrating AI and IoT into an educational setting.

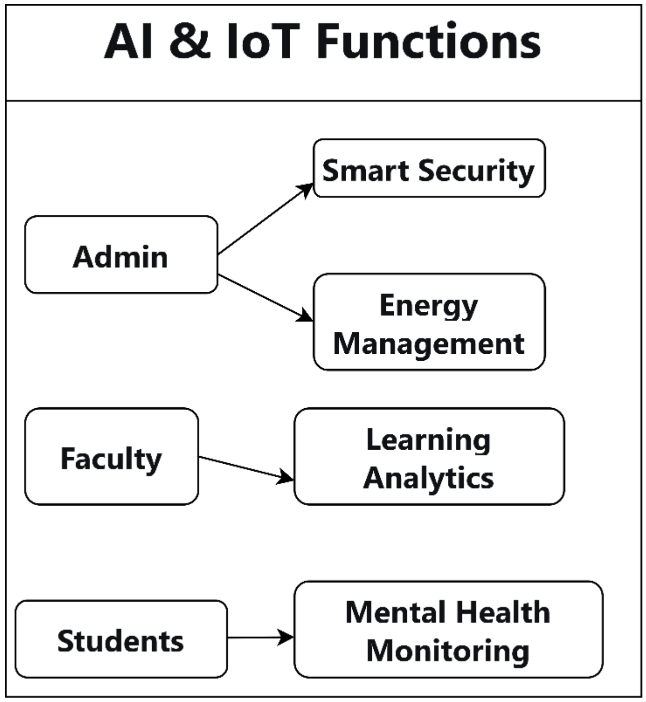

Figure 2. Functional Deployment of AI and IoT Applications Across Administrative, Academic, and Student Domains

5. LEADERSHIP ROLES IN SMART CAMPUS TRANSFORMATION

Institutional leaders define an organisations' culture. when institutional leaders visibly support experimentation, when they support collaboration with other departments, when they visibly commit to changing the organisation, it provides an environment where people will feel safe to try new things, collaborate with their colleagues, and embrace change. on the other hand, when institutional leaders do not provide visible support, the experimentations may occur in different parts of the organisation which creates duplicated efforts, confusion for both the employees and the students (Khan et al., 2025).

5.1 Operational Leadership

operational leadership is the term used to describe those who lead the day-to-day operation of a smart campus. operational leadership would include the leaders of facilities management, information technology services, academic administration, and student services. operational leadership is responsible for ensuring that the technical infrastructure required for a smart campus is working properly; including managing the integration of multiple systems, ensuring the security of all campus data, ensuring the reliability of the campus network, and ensuring that the systems that are being implemented are compatible with each other (Neelakantan et al., 2025). to effectively implement smart campus technologies, there needs to be collaboration between departments; because if a single department is solely responsible for implementing the smart campus technologies then those same technologies will not have the opportunity to operate at the system-wide level. therefore, effective implementation of smart campus technologies is typically dependent upon a combination of shared planning, frequent communications, and clearly defined roles and responsibilities between departments.

5.2 Distributed Leadership

students also contribute to leadership through informal means; as the users of smart campus systems, students influence whether or not smart campus systems are relevant, legitimate, and useful to them. additionally, student representatives may be involved in discussions surrounding how data is being used, what measures are being taken to protect the students' privacy, and what applications are being developed that relate to well-being when AI-driven monitoring tools are being implemented. students' experiential knowledge helps identify potential barriers to smart campus implementations and potential areas of development that were not apparent during the design phase. distributed leadership such as this is essential to providing an environment for bottom-up innovation to flourish and for sustaining smart campus technologies over time (Silva & Hämäläinen, 2024). collectively, the forms of leadership described above indicate that smart campus transformation is a collaborative effort and not simply a top-down implementation of technology. the successful integration of AI and IoT technologies into a smart campus is dependent upon creating harmony between the strategic vision of the smart campus, the operational execution of the smart campus, and the daily work practices of its users (Titareva & Mabrey, 2025).

Tables 1 and 2 together provide a structured overview of leadership roles and responsibilities involved in the integration of AI and IoT technologies within smart campus environments.

Table 1: Leadership Levels and Their Key Responsibilities in Smart Campus Transformation

Leadership Level	Primary Responsibilities	Domains of Influence
Institutional Leadership	Set strategic direction, approve funding, establish governance structures	University-wide digital strategy, risk governance
Operational Leadership	Manage deployment, ensure interoperability, oversee day-to-day system performance	Facilities, IT services, academic operations
Distributed Leadership	Promote adoption, support implementation, contribute user-level insights and feedback	Classrooms, student life, administrative workflows

Table 2: Examples of Leadership Roles Across Functions

Role	Leadership Type	Example Functions in Smart Campus Projects
Vice-Chancellor / President	Institutional Leadership	Endorse smart campus initiatives, ensure alignment with institutional vision
CIO / CTO	Institutional Leadership	Oversee IT infrastructure planning, procurement, and cybersecurity policies
Facilities Director	Operational Leadership	Coordinate sensor deployment, manage building automation integration
Academic Dean	Operational Leadership	Facilitate adoption of learning analytics, coordinate with teaching staff
Faculty Member	Distributed Leadership	Integrate smart tools into pedagogy, give feedback on usability and classroom impact
Student Union Leader	Distributed Leadership	Advocate for data ethics, represent student concerns in governance discussions

6. STRATEGIC DECISION-MAKING AND DIGITAL GOVERNANCE

Structured approaches to decision making for the deployment of AI and IoT systems are required so that decisions reflect the intentions of the institution and can be held accountable. Decisions regarding the introduction of AI and IoT systems are technological in nature but are also organizational and therefore reflect the values of the institution, increase the level of operational risk, and the legal responsibility of the institution. Therefore, any efforts to digitally transform HE environments must be guided by a structured decision-making process for the introduction of new technology, robust ethical governance, and compliance with external regulatory bodies (Titareva & Mabrey, 2025).

Higher Education institutions that have successfully introduced and implemented smart campus initiatives have employed formalised decision-making processes that link technological innovation to the missions of the institution, the needs of the various stakeholders and the resource availability. Formalised decision-making processes provide structure and guidance for project identification, stakeholder engagement, risk analysis and mitigation, and scheduling of the implementation of AI and IoT systems.

The formalised decision-making process for the adoption of AI and IoT systems is usually commenced with a needs assessment. In this stage, institutional priorities (for example, reducing energy consumption, improving student support, and updating facilities) are determined. After the needs assessment, the feasibility study follows, and this includes: cost-benefit analyses, assessments of the technical capability of the institution, and potential barriers to successful implementation. A pilot project is normally then undertaken to assess: the functionality of the AI and IoT systems, user acceptance, and integration with existing systems. Pilot projects are used to ascertain whether the AI and IoT systems can be scaled for widespread adoption within the institution ("Generative AI in Higher Education," 2025).

Strategic decision making also involves establishing and implementing governance structures to oversee the development and implementation of AI and IoT systems. The establishment of formalised decision-making processes helps to avoid disjointed implementations, duplicate work, and ensures that AI and IoT systems are scalable, secure and meet the academic objectives of the institution ("International Journal of Evaluation and Research in Education (IJERE)," 2025).

One of the most sensitive aspects of the integration of AI and IoT systems is the handling of data collected through campus systems, whether this is personal data or behavioural data. These data streams may contain: an individual's location; an individual's movement patterns; details of the devices an individual uses; details of how frequently an individual communicates; or physiological signals.

7. BARRIERS TO IMPLEMENTATION

The smart campus challenges can be categorized into four groups: Technology Challenges, Financial Challenges, Organizational Challenges, and Leadership Challenges. Each group presents challenges to every smart campus implementation, but they also relate to one another in some way.

Technology Challenges:

One of the most significant barriers to the development of smart campus systems is the incompatibility of new technologies with existing legacy systems. Legacy systems are systems and infrastructures that have existed for decades and were never designed to integrate with modern systems. Therefore, incorporating newer technologies into these legacy systems is difficult, if not impossible. For example, legacy systems can include:

- Building Management Systems (BMS)
- Learning Platforms
- Administrative databases

To allow for the incorporation of AI & IoT technologies, legacy systems would need to be updated and retrofitted with new sensors and network capabilities. smart campus systems depend upon standardization of data format and communication protocol. Lack of standardization prevents collecting data from multiple sources and creating large enough data sets that can be used to train adequate machine learning models. smart campuses systems are also susceptible to cyber-attacks because of their reliance on wireless connections and open access points. Establishing and maintaining the necessary infrastructure for the reliable operation of smart campus systems (e.g. reliable power, continuous internet connectivity, etc.) can be challenging for institutions in remote or under-resourced locations (Polin et al., 2024).

Financial Challenges:

Implementation of smart campus systems is very costly. There are additional costs other than hardware and software costs including integration, data storage, security, training, and continued support. Many times, institutions lack sufficient budgetary resources to justify the expense of smart campus systems, and therefore must choose between competing priorities (e.g. recruiting faculty members, providing student scholarship funds, repairing aging infrastructure).

Traditional purchasing procedures used by institutions of higher education are designed to promote efficiency and regulatory compliance. They are not conducive to evaluating the merits of new, emerging technologies. Traditional purchasing models tend to favor generic product offerings from vendors over interoperable, customizable, or ethically aligned products. Without interdisciplinary procurement experts in areas such as data governance and algorithmic accountability, institutions will select vendors that fail to deliver a return on investment for their smart campus projects (Toader et al., 2023).

Funding opportunities through national or regional programs to support digital innovation in universities are limited, further reducing the opportunities available for smaller or less financially resourced institutions to experiment with or expand the reach of pilot projects. Thus, the differences in funding between well-funded universities and those with fewer financial or geographical resources will increase (Tarisayi, 2023).

Organizational Challenges:

Cultural influences play just as important a role in the acceptance of technology as does the design of the technology itself. Probably the greatest challenge to the adoption of new technology is the reluctance to change, particularly among departments within academia that place high value on autonomy and long-standing ways of conducting business. Faculty and staff may express concern about the added surveillance, diminished authority and/or disruption to their workflow resulting from the introduction of AI and IoT technologies (Vu et al., 2025).

Digital literacy levels vary significantly across stakeholders. Some students and employees will quickly adopt new technologies, while others will need additional education/training and/or confidence in using the new tools before they can participate effectively. A lack of training, unclear communication, and failure to involve users in the design process all lower the probability of successful technology adoption (Cahyani & Musslifah, 2025).

Past experiences with poorly-designed/implemented technologies can create skepticism around new initiatives. If previous technologies failed to perform as expected (reliable, transparent, unobtrusive), then subsequent proposals may be viewed with suspicion – even when the new initiative was better designed. Therefore, to develop digital readiness, institutions need to address technical preparedness, as well as, develop institutional strategies to promote engagement, build organizational capacity, and communicate clearly (McIntire et al., 2025).

Leadership Challenges:

To successfully deploy AI & IoT technologies in smart campus systems, institutions require leaders who are able to make informed, forward-looking decisions regarding technology. Institutional leaders typically do not have enough technical experience to assess potential technologies, analyse data security issues, or determine whether vendors' claims about products can be trusted. The absence of this technical expertise results in over-reliance on outside consulting services; a lack of adequate control during the implementation of new technologies; and the loss of an opportunity to strategically utilize multiple technology systems (Cahyani & Musslifah, 2025).

In addition to possessing the required technical skills, institutional leaders also need to possess the ability to drive change within the organization, work effectively with other departmental areas (cross-functional), and ensure that the use of technology is consistent with the strategic objectives of the institution. These competencies are not always evident at every level of the institution's management structure. For example, many institutions have the responsibility for facilitating digital transformation shared among the departments of Academic Affairs, Information Technology (IT), Facilities Management, and Legal Affairs with very little coordination occurring among these departments (Cahyani & Musslifah, 2025).

Institutional leaders who fail to develop their digital leadership abilities through leadership development programs, succession planning, and governance structures that incorporate digital literacy as part of their overall institutional strategy will be unable to address the needs of digital transformation.

8. LEADERSHIP NARRATIVES FROM GLOBAL CASE STUDIES

The use of artificial intelligence (AI) and internet-of-things (IoT) technologies in the campus systems of universities all around the globe has taken many different forms. Each of these implementations depends on both the availability of the technological tools and the leadership paradigms that enable the creation, governance and scaling of these systems. Through case studies such as the Massachusetts Institute of Technology (MIT), Nanyang Technological University (NTU), University College London (UCL), and the selected Indian Institutes of Technology (IITs), several models of strategic decision making, cross-functional coordination, and lessons learned from the actual implementation of AI and IoT technologies will be discussed in detail (Aung & Hallinger, 2022).

8.1. MIT: Strategic Autonomy and Data-Driven Innovation

Massachusetts Institute of Technology: a leader in digital transformation both education and campus operations. The Smart Campus project serves as an illustration of how the Massachusetts Institute of Technology (MIT) is at the forefront of digital transformation, both in regards to education innovation and campus operations. The Smart Campus project uses Internet of Things (IoT) data gathered from campus systems such as buildings, student movement and interactions with students to support the decision making process of how best to utilize available campus resources. Centralized governance at MIT enabled academic departments and research units to develop their own technology pilot projects. However, central it and facilities governance bodies at the institution provided institutional alignment for those projects (Ghimire & Edwards, 2024).

Leadership at Massachusetts Institute of Technology provided ethical oversight and funding for interdisciplinary research into student behaviour and mental health, while giving the research team the autonomy to design and test its own behavioural sensing systems. This is an example of how centralized governance can work together with departmental autonomy to promote innovation while ensuring accountability.

8.2. Distributed governance and ethics-based leadership

University college London (UCL) has chosen a much more distribute model to launch its smart campus initiatives and has emphasis on using ethics frameworks and stakeholder involvement. While technical systems such as energy optimization and campus wi-fi tracking are deployed centrally, leadership at UCL has highlighted the importance of co-designing with students and staff relating to learning analytics and behavioural data.

The data governance working group at UCL, which consists of academic leaders, legal specialist, it professionals and student representatives, develops and oversees policies related to data usage, consent and analytics in an educational context. Different than other universities, ucl has not centralized its governance structure and rather emphasized iterative and consultative approaches. As a result, UCL maintains high levels of institutional trust while enabling innovation in AI-enabled systems (Ghimire & Edwards, 2024).

The case study of UCL showcases the importance of legitimacy and transparency in leadership when developing AI systems that may impact student autonomy or evaluation of students.

8.3. Indian institutes of technology (IITs): resource-conscious innovation

Many of the Indian institutes of technology (IITs) effectively incorporated various aspects of smart campus initiatives with differing scope and integration. For example, IIT Hyderabad and IIT Delhi have explored the application of sensor-based energy management, intelligent lighting and digital identity systems for secure access to the campus. Generally, the implementation of these systems is led by interdisciplinary research teams with central facilities management and administrative leadership (Çavuş et al., 2022).

A key difference between leadership in the IITs and global institutions is the resource constraints experienced by the IITs. Therefore, leadership in the IITs has focused on developing modular and scalable architectures for systems. Many of the low cost, replicable prototype systems developed by faculty-led student teams were specifically designed to function within the resource constraints of the IITs (Ho, 2025).

While the formal governance structures in the IITs may be less centralized than in NTU, leadership in the IITs play a crucial role in promoting bottom-up innovation, providing internal seed funding for new ideas and assisting pathways for the incorporation of new ideas into existing campus systems. These examples demonstrate how distribute; research driven leadership can promote innovation in resource constrained environments (Kabanda, 2025).

8.4. Cross-Case Synthesis: Patterns and Lessons Learned

There are several leadership paradigms that are evident throughout the case studies above. First, institutions that successfully scale smart campus initiatives establish a multi-level leadership model that provides strategic vision at the senior-most levels of the organization while providing operational ownership of specific initiatives across various departments. Second, successful smart campus initiatives require coordination across functional areas namely, between IT services, facilities services, academic units and student services to avoid duplicating effort and to ensure system-wide efficiency (Koukaras et al., 2025).

Third, institutions that include end-users primarily students and faculty in the design of smart campus initiatives tend to realize higher rates of acceptance and sustainability. Fourth, the alignment of an institution's digital strategy with national policy frameworks or the access to public funding significantly enhances the feasibility of long-term investments in digital infrastructure.

Finally, there is no single "right" leadership style whether centralized or distributed and that depends on the cultural context, funding models and governance traditions of the individual institution. However, in every case, the lack of clearly defined leadership roles and communication mechanisms hinders progress.

9. EMERGING MODELS OF AI/IOT-DRIVEN CAMPUS LEADERSHIP

Technology has dramatically changed how we think about university administration; it will create new leadership opportunities and challenge existing models of institutional leadership. Smart campus technologies and systems using artificial intelligence (AI) and Internet-of-Things (IoT) technologies create new responsibilities that extend beyond simply developing physical space for technology to the creation of a new form of digital governance and the need for cross-sectoral collaboration and the need for cultural transformation. Therefore, there is an immediate need for new models of institutional leadership that are adaptable, inclusive, and can navigate uncertainty (Li et al., 2023).

9.1 Adaptive Leadership in Digital Transformation

Adaptive leadership is the process of organizational leaders navigating through an environment of complexity and constant change utilizing ongoing learning, collaborative problem-solving and iterative decision-making processes. Unlike the traditional hierarchical approach of command and control, the model of adaptive leadership recognizes that complete determination of solution(s) to technological problems, including those related to AI and IoT, cannot occur prior to their introduction into the environment; rather, the solution(s) evolve as a result of experimentation and iterative adjustment over time. As a result, adaptive leaders are expected to lead their organizations through increasingly unpredictable and changing technological environments (i.e., provide guidance and direction) through the identification and reframing of new challenges, the identification and mobilization of various forms of expertise, and the development of institutional priority and direction in response to emerging knowledge and evidence (Kafa, 2025). Smart campus project managers will need to demonstrate these characteristics when they lead their respective institutions through the many challenges that are inherent within the planning, design and operation of smart campuses, e.g., managing the risks associated with data ethics, balancing innovation with regulatory requirements, and developing strategic decisions using incomplete or conflicting information. Additionally, adaptive leaders will be willing to modify the institutional resource allocation, timelines and strategy in response to the expressed needs and experiences of their stakeholders and the operational experiences of their organization. Finally, adaptive leadership will enable the development of processes for continuously evaluating the effectiveness of digital initiatives allowing corrective action to be taken in a timely manner.

Through the use of iterative review mechanisms, institutions that adopt this model of leadership can develop and implement more agile project management models.

9.2 Collaborative Models – Academic Industry Government Partnerships

The complexities of integrating AI and IoT technologies frequently exceed the institutional capacity of individual universities, particularly with respect to the availability of technical expertise, financial support and regulatory guidance. For example, some universities have been involved in smart infrastructure pilot projects funded by national innovation agencies or higher education commissions.

To ensure the success of collaborative models, the partners must agree on governance arrangements such as memoranda of understanding (MOU), joint steering committees and intellectual property agreements. In addition, institutional leaders must be able to negotiate and manage these collaborative relationships while maintaining the academic freedom and public accountability of their institutions.

9.3 Change Management and Building Capacity

Transitioning to a smart campus will require significant change at the level of organizational structure, process and culture. Therefore, university leaders who are in the process of implementing a smart campus model should intentionally design and implement change management plans to support both the technological implementation of smart campus models and the changes needed by people to be successful in the implementation of smart campus models. This can include creating a clear picture of what the future of the institution looks like, developing trust among all stakeholders, and supporting individuals through the resistance to new technology and data collection practices.

Change Management is a critical element of the success of an organization. One of the critical elements of effective change management is stakeholder engagement. University leaders need to involve their students, faculty, and staff in conversations regarding the design and implementation of smart campus models and the digital governance structures that will be implemented to protect student, faculty, and staff data. Many universities have developed open communication channels, continue to consult with their stakeholders and provide accessible methods for feedback to help increase buy-in and decrease uncertainty when implementing smart campus models ("International Journal of Evaluation and Research in Education (IJERE)," 2025).

The other critical element of change management is the building capacity of the university to implement and sustain digital initiatives. Universities must create and implement digital skill training programs for faculty and staff to assist them in acquiring the necessary digital skills to develop, implement and adapt to AI and IoT Systems in their role as educators, researchers, administrators, etc. Many universities have created professional development programs, workshops and digital fluency frameworks to support the digital transformation of their institutions (Kumar et al., 2025).

Finally, institutional leaders must also consider succession planning and institutional memory to ensure that the momentum created by the digital initiative continues after the departure of current leaders. Establishing cross functional digital leadership teams and creating permanent digital positions such as Chief Digital Officer (CDO) or Digital Transformation Manager will help to ensure continued progress on digital initiatives even when individual leaders leave their posts.

10. RESEARCH GAPS AND FUTURE DIRECTIONS

It is imperative that longitudinal research be conducted to determine the trajectory of digital transformation efforts, and how leadership roles evolve, how institutions adapt to emerging technologies, and how institutions respond to change dynamics over time.

Longitudinal research design incorporating both quantitative (institutional analytic) and qualitative (leadership interview, governance document, staff/student feedback) data would provide a better understanding of cause-and-effect relationships and the effectiveness of leadership in long-term AI/IoT deployments (Ahmad et al., 2025).

10.1 Lack of Representation of Institutions in Low- and Middle-Income Countries

The vast majority of literature examining smart campus transformation and AI/IoT leadership has focused on institutions in developed countries specifically, those located in North America, Western Europe, and portions of East Asia. Due to the geographic location of this focus, the generalizability of findings from this body of literature is limited. Furthermore, literature documenting the specific challenges and innovation strategies of universities in low- and middle-income countries is almost non-existent.

In lower and upper-middle income countries, there is an absence of documentation and study on digital (frugal, modular, community) strategies employed by universities, and, more importantly, alternative models of leadership at the university level (informal networks, faculty-led initiatives, national policies incentivizing implementation), which could be seen as alternative models to the capital-intensive and vendor-dependent models commonly found in wealthier nation universities (Arora et al., 2025a) Therefore, in order to create inclusive theoretical models of digital leadership in higher education, there needs to be expansion of the empirical base to include representations of different institutional types, funding models, and policy environments. The development of comparative studies examining the institutional context's influence on leadership behaviour will also contribute to the creation of adaptive and global frameworks for digital leadership.

10.2 Need for Comparative, Multi-Campus Frameworks

While there have been a few comparative studies, most of the existing body of knowledge regarding the relationship between AI/IoT leadership and smart campus leadership has been based on single-campus case studies. Single-campus case studies allow for a detailed examination of an individual institution; however, this does not allow for the ability to generalize findings across institutions (Arora et al., 2025b). Therefore, there is a need for comparative, multi-campus research to determine similarities and differences in AI/IoT leadership strategies across campuses of various sizes, governance structures, and national contexts. A comparative, multi-campus research framework would allow researchers to determine which AI/IoT leadership strategies are more effective under specific conditions (e.g., decentralized governance, public-private partnerships, etc.) and to identify the structural enablers and constraints that influence AI/IoT leadership outcomes (e.g., procurement policies, institutional autonomy, funding availability).

In addition, comparative, multi-campus research would allow for the development of standardized frameworks and metrics to evaluate AI/IoT leadership strategies. Examples of indicators for evaluating AI/IoT leadership strategies include indicators related to stakeholder participation, data governance maturity, digital capacity-building, and alignment with the institutional mission. Multi-institutional consortia, cross-country collaborations, and policy-driven research networks can provide platforms to conduct comparative, multi-campus research studies.

11. CONCLUSION

The application of AI and IOT to higher education has led to the creation of smart campuses – spaces where data driven infrastructure enhances learning, operations and well-being. while there has been a great deal of focus on the technical and operational aspects of smart campuses; this literature review focuses on the leadership role which enables these transitions to take place. leadership is a critical element in enabling successful transition to the use of AI and IOT as the success of such technology is dependent upon many elements beyond the technology itself (e.g., the strategic decisions, governance models and institutional capacity) that leaders bring to the decision making process. Study identified that leadership is a complex construct, covering multiple levels of leadership within an institution. Institutional leaders have to balance innovation with ethical obligations; operational leaders have to implement and integrate the technology; while distributed leadership supports engagement and adoption by stakeholders at all levels.

Although there have been many successes, there still exist several challenges. budgetary restrictions; technical limitations; lack of skilled workers; cultural reluctance to change; are just some examples of impediments to continued development. Additionally, institutional leaders also have the responsibility to create an ethical, transparent, and rights-based framework for managing data privacy and surveillance issues while ensuring regulatory compliance with existing laws. Furthermore, institutions located in low- and middle-income countries face additional impediments that require flexible and context-specific responses from their leaders.

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