

Emerging Smart University using various Technologies: A Survey Analysis

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Abstract

Higher education is one of the fundamental and essential factors which creates many educators across the globe. It promotes various areas in order to inflate the growth of the country. Higher education is delivering by universities these days. The university must provide a better atmosphere for educational practices to provide an excellent asset to the community. Unfortunately, there are several issues identified as an obstacle to delivering the best pedagogical accomplishments. This study's main objective is to seek better measures to overcome the university issues by smart campus and IoT. More than 50 papers were chosen to examine the architecture and current trends of universities. It can be inferred from this study that IoT, RFID, and mobile technologies are the best smart campus suites and delivers low-cost and user-friendly Pedagogical frameworks. Meanwhile, many studies missed improving the security features of the smart campus. However, this study recommends McFarlan Strategic, Grid analysis, and an IT pattern analysis to evaluate the IT infrastructure to provide an excellent solution for the smart campus without concerning security; furthermore, it discussed a security technique to ensure data privacy.

Keywords: Smart Campus, Internet of things, RFID, IT Analysis, Sensors, Security;

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1 Introduction

Higher education is one of the fundamental and essential nurseries which creates many educators in the world. Also, Higher education is a crucial feature that determines the country's literacy rate [1]. Even a nation's political, social, and economic disparities rely considerably on higher education. The higher education of any country around the globe contributes significant support to its nation in different identified areas such as; business [2], [3], healthcare [4]–[6], tourism [7], [8], marketing [9]–[12], leadership [13]–[21] and management [22]–[26]. Almost in all sectors, higher education supplies human resources in order to accomplish goals.

Higher education is started from the university level all around the globe. Higher education is an essential essence to the nation in order to uplift the country by various domains. It is identified to provide the best training activities to the students from the teachers to deliver valuable output to society. Thus, in universities, education nature, learning-understanding rate, technological infrastructure, flexible teaching-learning activities, and an impressive collaboration of learners and teachers are essential. These days, learners and teachers are having too much trouble handling pedagogical practices. In the educational and university system, there are several issues found to prevent quality education. The significant problems listed for higher education and universities are; high

cost, physical attendance, fixed schedule lecturing, challenging to follow multiple-course, exam basis education, problems in assignment activities, depression with courses, and technical issues. The smart campus with IoT technology is the most critical and technical solution to solve all these problems and present a new and advanced solution.

With the emergence of web 2.0 [27]–[33] and IoT technology [34]–[41], the education sector represents a new global dimension. It changes education sectors almost upside down. The smart campus is a practice of digitally linking everything through cloud computing [42], IoT, and Web 2.0 to provide adequate and efficient pedagogical activities [43]–[47]. Concurrent smart campuses components are classified as; sensors [48], [49], big data [50], [51], cloud computing [52]–[54], network platforms [55], and security services [56].

The smart campus with IoT technology has advantages and disadvantages. Significant advantages considered as; enhances student education programs, enhances respite time, significantly reduces human error in education, offers a versatile atmosphere for pedagogical practices and hybrid learning. In

comparison, disadvantages consider as; technological knowledge and implementing the cost of the system. A knowledgeable person is the best asset to society as well as a country. To deliver the best asset, the government must focus and improve higher education with current trends like a smart campus. So it is an essential obligation to identify the best infrastructure for the smart campus concept. Therefore this study aims to identify the different smart campus applications and provide the best scenario via a survey.

2 Methodology

A systematic literature review was used to conduct this review article, which is the practice of recognizing, evaluating, and deciphering all examination brings about request to give answers to investigate questions [57] comprise of a few exercises, in particular; indicating the exploration questions, choosing contemplates, separating required information, integrating information, and describing the outcome. Furthermore, the following research problems and relevant motivation were formulated in Table: 1 to focus on this review article.

Table 1. Research Questions and Motivation

S. No	Research Questions	Motivation
RQ1	Available features in Smart Campus.	Recognize a smart campus/university's features to have a target for developing a smart campus with the most usable features.
RQ2	Supported technologies.	Finding the most appropriate technologies and energy consumption to reduce the smart campus's cost and maintenance.
RQ3	Contributions towards university management and academic activities.	Find a way to make academic activities easy such as attendance, classroom &, etc., easy document management system, and outer environment management such as parking, garbage collection.
RQ4	Analyzing the IT infrastructure of the university.	Analyzing available IT related hardware and software tool within the campus environment and suggest require IT tools.
RQ5	Security issues in Smart campus.	Find the reasons and solutions for any security issues on the smart campus and recommend better solutions if possible.

According to the above table: 1, we have extracted 95 research papers from 125 research papers where all

the papers published in both Journals and Conferences proceedings based on the following criteria,

- Majority of the Published papers between 2014 and 2020
- Only full papers
- Peer-reviewed papers
- Articles is an open access

3 Literature review

S. C. Mukhopadhyay and T. Islam [58] Smart campus enable us to connect to live sessions outside of the university premises using the Internet of Things. A. Abdullah, M. Thanoon, and A. Alsulami [45]. It is possible to confirm the campus's security and stakeholders from any suspicious activities and crime incidents until back up reach the campus with sensors and drone cameras while there are challenges such as financial, technical, and political. A. Zhamanov, Z. Sakhiyeva, R. Suliyev, and Z. Kaldykulova [59] Smart campus can help control room temperature while laboratory and classrooms are empty. Further, teachers & students can be monitored with RFID, and administrative staff can directly see students' feedback on instructors through the mobile application.

M. Rao, R. Swathi, M. Sneha, S. Kotian, and N. Rao [60] Energy such as power can be saved in a smart campus environment via IoT, which can view as a future of Artificial Intelligent. Also, WIFI sensors can work better than Bluetooth, and Zigbee enables smart devices. Meanwhile, D. M. S. P. K. Dawndasekare and A. Jayakody [61] Researcher suggested the following concepts to implement IoT in Higher education, such as Campus energy management and eco-system monitoring, secure campus and classroom access control, student's health monitoring, and Improving teaching & learning using RFID, and NFC. Further, T. M. Fernández-Caramés and P. Fraga-Lamas [62] Smart campus use the IT infrastructure of IoT and Cloud computing to monitor the system of the university where it not only the good communications but also reduce the energy consumption to maximize IoT battery life through blockchain, which can deliver accountability, transparency, cyber-security, and

redundancy to the processes and data managed by a university.

A.-F. Abdelrahman, Abuarqoub; Hesham, Abusaimh; Mohammad, Hammoudeh; Diaa. Uliyan; Muhannad A. Abu-Hashem; Sharefa, Murad; Mudhafar, Al-Jarrah; Fayez [63] Smart campus can help control & reduce errors in attendance, Computers can be shut down automatically, and Laboratory energy waste can be reduced with the help of RFID attached student ID card.

S. Ambilkar, S. Hegonde, R. Therade, and S. Lingamwar [64] proposed a system that can collect data using contactless technology such as NFC via web and mobile application.

A. Alghamdi and S. Shetty [65] investigated that using IoT on different perspectives such as not only intelligent buildings, smart grid, and learning environment to deliver cost-effective, efficient, and high-quality services to the community on campus. However, employing IoT in other campus services such as access control, voting, and parking is discussed. Furthermore, S. N. Kane, A. Mishra, and A. K. Dutta [66] proposed that a smart campus can be adopted with a Smart room, smart parking, and smart education using sensors PIR, RFID, and camera.

Z. Y. Dong, Y. Zhang, C. Yip, S. Swift, and K. Beswick [67] pointed that smart campus act as a primary key of Smart city and would not possible without the technologies such as IoT, Cloud computing, and Augmented Reality (AR), furthermore, the researcher proposed a system called Human-centered Learning-oriented smart campus (HLSC) which mainly focused on three services namely Essential services, Personalized services, and Additional services.

S. Fortes et al. [68] proposed a solution to the improvement of the existing Smart campus system with Green island that is characterized by its vegetation, energy efficiency, advanced technology, & comfort; and Innovation plan such as, foster research, innovation, and development of interdisciplinary projects based on the Smart-Campus infrastructures and framework.

S. Syidada, E. Wahyuningtyas, and F. H. S. Pratama [69] Campus internal and external IT infrastructure can be analyzed using McFarlan Strategic, Grid Analysis, and IT trend analysis, respectively. Furthermore, B. Sánchez-Torres, J. A. Rodríguez-Rodríguez, D. W. Rico-Bautista, and C. D. Guerrero [70] IoT is still facing security issues and can be reduced using encryption. In addition to that, C. D. G. B. Sánchez-Torres, J. A. Rodríguez-Rodríguez, and D. W. Rico-Bautista [71] Encryption is the significant secure way to information transformation through radio frequency; however, AWS-ECC508 chip will be implemented in future for the betterment of security of the smart campus; also there will be web development framework that supports IoT systems.

X. Zhou [72] Researchers proposed a Smart campus model with subsequent subsections such as alignment of smart campus with smart city concepts, smart microgrid in smart campus, community-oriented services, unified view of smart campus, propagation under smart campus, and achieving long term prosperity with the smart campus where all these submodels together work for better campus management by analyzing collected data via RFID, Actuators, Sensors, Cloud computing, Augmented reality, and web services.

R. Jurva, M. Matinmikko-Blue, V. Niemelä, and S. Nenonen [73] proposed an architecture which can develop using real 5G, IoT, MEC, and cloud computing as technologies for the smart campus development; and, All in one card using NFC technology can be added more value to smart campus for payment-related actions [74] which is support the statement of G. Guo [75] Programmable Logic Controller (PLC) can develop with the help of IoT and RFID, it can be used to replace almost all the cards used in campus environments such as Student ID, Library ID, Staff ID, Medical certificates, etc. to make automatic settlement platform which helps to create Smart campus environment.

T. Bi [76] proposed a smart campus design using new technologies based on Building Information Modeling (BIM), which can be used to build a model using Autodesk Revit software, 3D Geographic

Information System (3DGIS) can help to develop a database using Skyline software.

Sagar R et al. [77] developed an android application for communication services among academic activities. From the result of that study, it could be identified that the developed system is highly effective in record maintenance and storage facilities. This system also provided high efficiency in time management. Students and teachers have done academics within less amount of time when compared with the typical traditional method. Hence working with a smart environment provide highly advantage over traditional methods.

As stated by Nuzzaci & Vecchia [78], it could be identified that learning in the new and technological domain increases the knowledge and quality of education at a higher level than the traditional method. Hence smart campus is the right way of doing pedagogical activities these days.

Judita KASPERIŪNIENĖ and Sigitas DAUKILAS [79] made a study regarding smart educational technology in the learning process at a vocational training center. To this study, randomly selected 25 vocational teachers were interviewed using focus group interviews. This study revealed that teachers use technological tools and aspects to communicate in between students for academic purposes most of the time. Nowadays, smart technology is partially available almost everywhere for simplifying educational activities. Building a smart campus would be a high impact on those who do the pedagogical activities. However, H. El Mrabet [80] Youngest teachers have much more positive support than those who have older in terms of new Technological concepts; which is line with Hwang [81] tried to identify what are the key factors which help student and teachers to adapt toward a smart learning environment in a smart campus. Moreover, the study exposed that adaptiveness, the interface of learning and teaching environment, and context-awareness are the critical aspect that attracts the student and teachers into smart education in smart campus.

Nathan Nachandiya et al. [82] proposed a conceptual model for creating a smart campus [72], [83]

classroom with Big data [84], mobile computing [85], cloud computing [86], and network infrastructure. This conceptual system consists of six layers: Network Layer, Cloud computing layer, Big Data layer, Smart Application layer, Smart Device layer, and Awareness layer. Students and teachers can work with smart device layers such as pc, mobile phone, and other devices. The application layer provides a specific application of the smart classes developed by the smart campus team. The smart device layer can use this application by installing those applications into smart devices. The Cloud layer provides all functionalities of the database with high security. The teacher can upload their assignment and necessary pieces of stuff into the cloud layer, and students can download that using their devices. The network layer helps to transfer all data from the device to the cloud with the network protocol. The significant data layer provides a better analysis of the vast volume of data, and it will keep only necessary data into the cloud layer. Hence student and teacher having their pedagogy activity via a smart and digital environment in an effective manner. Meanwhile, some other studies criticized that smart campuses and classrooms must incorporate into the physical and digital environments [87]–[89] as a blended learning method. Hence this proposed system's digital space is highly perfect whilst physical space must be focus to be delivering the best pedagogical services in between students and teachers.

Bart Valks and et-al [90] analyzed the space use measurement in real-time universities in their survey study. Sensors are utilized to computerize lighting, heating, and ventilation is given individuals' presence or the number of occupants in some universities. Depending on the temperature changes and lightning changes, few sensors are used to calculate the number of occupants in the universities' classrooms. Some other universities use Bluetooth, wearable sensors, and Wi-Fi to monitor the people to manage the universities' space usage.

Another study conducted by Yao CHEN [91] suggested a modular framework model for the smart campus. Their conceptual model uses Things

technology, mobile internet, big data, cloud computing, emerging information technologies such as intelligent decision-making, knowledge management, artificial intelligence, virtual reality. The smart campus's modular framework model is the detailed design of each technical element's technical structure, including the communication module, the environmental module, the data module, and the service module.

Yang Liu and Liang-Shan Shao [92] said in their research that, "Smart campus" refers to the internet as the Foundation, in light of utilization service framework and the development of teaching, research, organization, and campus life as one of insight and intelligence of teaching, learning, and living condition. The development of a smart campus means improving campus understudies' learning and living conditions and fabricating an exhaustive data administration stage, which is insightful, innovative, and open.

A novel ubiquitous learning model within a pervasive smart campus environment is defined by Yacine Atif, Sujith Mathew [93] in their research study. The research supports learner-centered methodologies and improves cooperation soul over the different campus offices to monitor learning needs and survey learning results autonomously. In the same research, they suggested, some images of the book can be augmented with 3D virtual Imagery via a mobile device to enrich the instructional value of the book contents (viewing a 3D model of a molecule discussed in the book by merely pointing a mobile screen to the molecule in the book).

Smart Library and Smart Campus are tied to the technological development of Web4.0 suggested by Hubert C. Y. Chan, Linus Chan [94]. With the evolution of web 1.0 to web 2.0 and web 3.0 and web 4.0, the library system can also be evolved to library 4.0. They posited that Library 4.0 must include software-based approaches and technological environment development such as maker space, Google Glass, context-aware technology, digitalization of contents, big data, Cloud computing, and augmented reality. This concept has been

extended to the whole campus by them. They said that, with library 4.0, campuses could be integrated with capitalizing on IoT, RFID, GPS technology in its education system. the suggestion mentioned above strengthens learning capacity, happiness, and competitiveness for universities. They suggested some intelligent system, such as RFID Applications, Smart Bookshelf, 24-hour Self-Service Library, Smart Locker, Robot (Stocktake), Book Drop and Sorting Unit, Room & Equipment Booking System, Self-Check-In/Out Station, Book Sterilizer,

Intelligent Monitoring System, Real-Time Location System, Recommender System, Face Recognition System and AI Greeting Robot.

D W Rico-Bautista [95] suggested a Conceptual framework for smart-university. They analyzed how the IT technologies used and each factor within the university can enrich the university community. They suggested an IT organization unit of the universities that should adapt all these "Smart" technologies to the university environment in its teaching, research, and management or government facets.

Table 2. Smart University Concepts, proposed & Developed Technologies and Suggested Solutions

Concept	Proposed/ Developed Technologies/ Applications	Suggested solution to overcome security issues
Smart Campus	IoT, 5G, MEC, NFC, and Web & Mobile apps	N/ A
Security of a Campus premises and stockholders	Drone and RFID, and NFC	N/ A
student feedback via Smart classroom	Mobile Application	N/ A
Energy serving via Smart campus	RFID, IoT, WIFI sensors, and Smart student ID card	N/ A
Student Health Monitoring System	RFID, and NFC	N/ A
Smart Parking	IoT	N/ A
HLSC	IoT, Cloud Computing, AR	N/ A
IoT	IoT	Encryption
Smart room, Smart Parking, and Smart education	PIR, and RFID	N/ A
Analyzing IT infrastructure	McFarlan Strategic Grid analysis and IT trend analysis	N/ A
Payment	NFC and Smart Card	Encryption
Smart campus	RFID, Blockchain, IoT supported web system	Encryption
Smart Building	BIM, 3D GIS	N/ A
PLC	IoT and RFID	N/ A
Smart Communication	Android App	N/ A
modular framework model of the smart campus	IoT, Mobile Internet, Big data, Cloud Computing, Intelligent decision making, AI, and VR	N/ A
Smart Learning	AR with 3D virtual Imagery via mobile Devices	N/ A
Smart Library	Web 4.0, Maker spaces, Google glass, context-aware technology, AR, IoT, RFID, GPS, and AI	N/ A

4 Conclusions & Recommendations

The smart campus is a growing concept among educational places and an essential portion of any higher educational institute not only for learning activities but also for the entire activities such as Administration, Building maintenance, Energy serving, Campus Access, Payment, Parking, avoid environmental pollution, etc. of any campus across the globe which leads to save time and cost in the long time frame.

There were a lot of technologies and Software development processes such as IoT, RFID, Blockchain, 5G, AI, VR, Cloud computing, GPS, NFC &, etc. and Mobile & Web Applications respectively have involved during the development of Smart campus but most of the researchers have used or suggested to use IoT and RFID as technologies and Mobile app for the easy maintenances of Smart Campus; It is confirmed that these technologies have more user-friendliness compare to the others in terms of cost, speed, device support, resource persons, and references. Furthermore, most of the researchers mainly focused only on Smart campuses' development, not on the security side of this new concept and Campus' IT infrastructure.

Therefore, based on the above studies, we as researchers, summarized that the Smart campus could be developed not only for the academic purposes but also must be supported entire campus infrastructure to make every action of the Institution easy, cost-effective, highly secure of data management and campus access using IoT and RFID through any mobile application for staff and students for their daily campus activities. Further, the campus management must do the IT infrastructure analysis before starting the development of a Smart campus using McFarlan Strategic Grid analysis and IT trend analysis or any other recommended way.

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