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IOT for Energy Efficiency in Smart Universities: A Complete Review

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Abstract

Universities face increasing challenges in managing energy consumption and improving their environmental efficiency. The use of the Internet of Things (IOT) in smart universities is one of the innovative solutions to achieve these goals. As campus energy management focuses on integrating renewable energy sources and implementing monitoring and control systems, smart universities aim to achieve energy sustainability. This study revolves around reviewing a group of previous research to evaluate the uses of IOT in improving energy efficiency in universities. The methods and techniques applied in this context are analyzed with emphasis on the main ideas and results reached. The goal is to provide a comprehensive understanding of the challenges and opportunities in the field of energy management in smart universities using IOT technologies.

Keywords: Energy conservation, IOT, Energy consumption, Smart university.

1. Introduction

The Internet of Things (IoT) refers to a network of physical objects equipped with sensors, software, and communication technologies that enable them to collect, exchange, and process data over the Internet without direct human intervention. By connecting everyday devices and systems, IoT facilitates real time data acquisition and intelligent interaction between physical and digital environments. These connected devices range from simple household appliances to complex industrial and institutional systems.

The concept of a smart campus builds upon the adoption of advanced digital technologies to enhance the quality of academic, administrative, and operational processes within university environments. A smart campus aims to create an efficient and sustainable ecosystem by leveraging innovation to improve learning experiences, resource utilization, and operational efficiency. One of the core characteristics of a smart campus is the extensive use of IoT technologies to interconnect campus infrastructure, enabling intelligent monitoring, control, and optimization of facilities, particularly in the context of energy management.

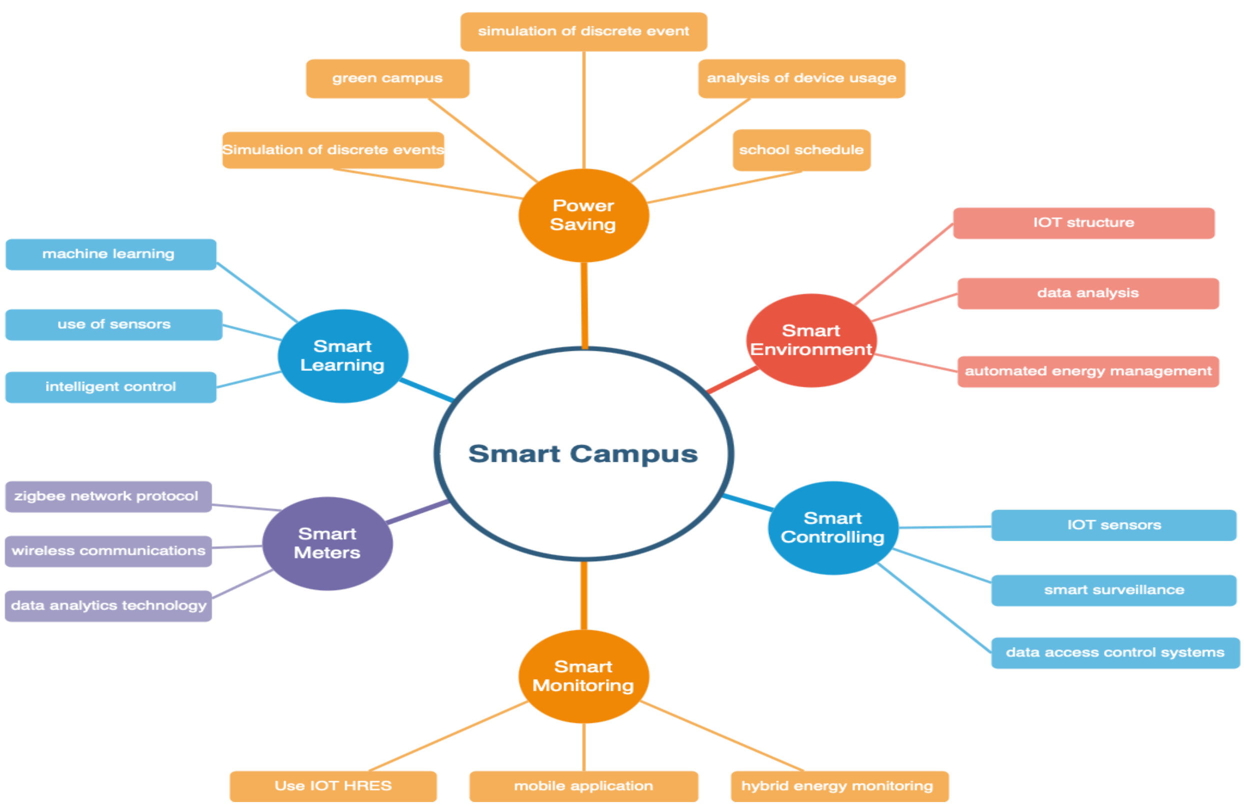

Figure 1: smart campus.

To illustrate the smart campus concept, Figure 1 presents an overview of its main components and functional domains. These include smart learning environments, smart monitoring and control systems, smart metering, intelligent environments, and energy saving mechanisms. The figure highlights how IoT sensors, data analytics, and intelligent control systems interact to improve energy efficiency and promote campus sustainability.

IoT technologies play a significant role in improving energy efficiency across buildings, industrial processes, and other energy intensive activities. By enabling continuous real time data collection, IoT provides a detailed understanding of energy consumption patterns and helps identify opportunities for optimization. In university campuses, IoT based energy management systems allow administrators to monitor energy usage more accurately and respond proactively to inefficiencies or abnormal consumption.

One of the key advantages of IoT based energy management lies in process automation. Connected sensors can detect changes in occupancy, temperature, or environmental conditions and automatically adjust lighting, heating, or cooling systems accordingly. Smart meters further support real time monitoring by providing detailed consumption data, enabling institutions to track performance and identify areas for improvement. Additionally, IoT systems can integrate data related to weather conditions, energy demand, and usage trends, supporting informed decision making such as demand response strategies and off peak scheduling. As a result, IoT driven energy management contributes to cost reduction, improved operational efficiency, and reduced environmental impact in university campuses.

Based on this context, this study seeks to address the following research questions:

Q1: How can IoT technologies reduce energy consumption on university campuses?

Q2: What are the main advantages of using IoT for reducing energy consumption?

Q3: What are the potential disadvantages and challenges associated with using IoT for energy management in university campuses?

The rest of this paper is organized as follows. Section 2 Review Methodology, Section 3 Literature Review, Section 4 summarizes the main findings, Section 5 presents the conclusions, Section 6 includes the acknowledgments, and Section 7 lists the references.

2. Review Methodology.

This paper adopts a narrative literature review approach to analyze and summarize existing research on the use of IoT technologies for improving energy efficiency in smart university campuses. A narrative review was selected due to its suitability for providing a comprehensive and descriptive overview of diverse approaches, technologies, and applications reported in the literature. The literature was collected from well known scientific databases, including IEEE Xplore, Scopus, and Google Scholar. The search process was conducted using a set of relevant keywords such as energy conservation, IOT, energy consumption, smart university.

The selected studies were published within the time frame 2016–2025, focusing on peer reviewed journal articles and conference papers written in English. Studies that were not directly related to energy efficiency or smart campus environments were excluded from the review.

3. Literature Review

1. Sensor Based and IoT Driven Energy Monitoring Systems.

Jabeen et al. (2016) Another power control system was used using each student's campus card. Ethernet, RF wireless communication, PIR and LDR sensors were used to implement this system. This system is considered efficient in controlling and improving energy consumption. Although this system demonstrates effective energy control by leveraging student campus cards and multiple sensing technologies, it relies heavily on user presence and manual identification mechanisms, which may limit its scalability and flexibility in large or highly dynamic campus environments. In addition, the study does not address issues related to data security, privacy, or integration with advanced IoT analytics platforms.

Lavanya et al. (2019) discussed smart ways to reduce energy consumption on university campuses through the Green Campus energy management system powered by the IOT In the proposed system, the data acquisition module collected energy consumption information from each device and sent it to a cloud platform for further processing and analysis. The goal of the system was to save energy and reduce costs. The researchers reported significant energy savings, which consequently led to a reduction in energy expenses. However, the system lacked the implementation of data encryption technologies such as SSL/TLS, indicating a potential area for improvement.

Vasanthapriyan et al. (2019) this study discusses how to manage and control electricity consumption. Our proposed system uses IoT technologies and sensors. It is a system that responds to human presence and provides actions related to it according to the environmental condition of the area where humans are present. Electrical appliances such as lights, fans, and air conditioners in the lecture hall are controlled according to the temperature values and light intensity detected by the sensors. The Kinect sensor was used to detect human presence. DHT22 and LDR sensors were used respectively to sense temperature, humidity, and light intensity in the area of human presence. An Arduino mega board was used to control the DHT22 and LDR sensors. This system provides real time information such as the current environmental condition of a particular place. The main goals are to reduce the waste of electrical energy and provide a suitable solution based on the IOT to reduce electrical energy consumption. The researchers propose a system that runs on sensors. They suggest using smart energy programs to provide information about electricity consumption. While this study presents an effective sensor based IoT system for real time control of electrical appliances based on human presence and environmental conditions, it is mainly limited to a single lecture hall environment. The reliance on Kinect and Arduino based hardware may increase deployment cost and complexity, potentially limiting scalability across large university campuses. Furthermore, the study does not provide a detailed evaluation of long term energy savings or system performance under varying occupancy patterns.

Kassim et al. (2018) this study discusses how to develop a prototype of a mobile application for electrical energy monitoring regarding energy consumption on a university campus. This study aims to analyze the use of electrical energy on the university campus, where a small number of smart meters are installed to monitor five main buildings on the university campus. A monitoring system has been created to collect electrical energy consumption from smart meters. The data from the smart meter is then analyzed based on the energy consumption of 5 buildings. The results display a graph of energy consumption and are presented on mobile applications using Live Code encoding. The methodology included preparing smart meters, monitoring and data collected from the main smart meters, analyzing the electrical consumption of five buildings, and developing a mobile monitoring system. The Live Code mobile application publishes the data collected from the smart meter using ION software in graphs. After that, the energy consumption results for five buildings during the day and night are presented. It thus helps campus facilities monitor the electrical energy used and thus be able to control potential outcomes in future applications Researchers propose a model for monitoring energy consumption through smart meters, where data is collected using (Ion).

This method is less efficient compared to other programs. I suggest using Eco Struxure Power Monitoring Expert.

Abusukhon et al. (2021) in his study suggested a set of steps to reduce energy consumption. First, it proposes a smart IoT based system for offices that reduces the total energy cost by 40\% based on Lecture Time Table (LTT). Second, balance energy conservation and user satisfaction by allowing manual control of devices (via voice commands) and automatic control of devices (based on LTT). Third, balance user satisfaction and energy conservation based on the percentage of overlapping time intervals of LTTs. Fourthly; Using sound sensors by developing a Java program capable of capturing and processing the human voice. The results showed that the proposed system saved about 40\% of the energy cost. Researchers suggest a set of steps to reduce energy consumption. However, these methods lack the use of smart electrical chips.

2. Communication and Energy Management Frameworks.

Wang et al. (2017) this study discusses how to build a smart IOT framework on university campuses, the goal of which is to address jobs, energy consumption, security, and safety from a user centered perspective. This was achieved by using machine learning algorithms in the codesign process of hardware and software. This study focused on managing energy consumption by using a support bus device to know the class schedule, so that the system can respond to the dynamic change of schedules. The experimental results show that the proposed framework can identify regular events and irregular events in the classroom with high accuracy. The researcher focused on managing energy consumption through the support bus device only. It is better to use sensors as well to reduce energy consumption.

Pasetti et al. (2020) This study discusses how the use of distributed control architectures and IoT technologies (wired and wireless) will lead to effective solutions for managing smart environments composed of clusters of buildings, such as university campuses. It uses an IoT architecture capable of transparently managing different communication protocols in smart environments and investigates potential applications for monitoring and controlling distributed energy resources on smart campuses. The solution is to supervise and manage the PV system in a realistic scenario. Researchers propose a distributed control method and IOT technologies to manage smart environments. However, we recommend Symphony Link technology, as it offers better security and data protection.

Eltamaly et al. (2021) proposed an IoT based architecture for HRES, consisting of a wind turbine, a photovoltaic system, a battery storage system, and a diesel generator. This proposed architecture is divided into four layers: power, data acquisition, communications network, and application layers. Due to the different communication technologies and the lack of a standard communication model for HRES, this work also defines the communication models for HRES based on the IEC 61850 standard. The monitoring parameters are classified into different categories, including electrical information, status, and environmental information. However, this research an existing architecture for the IOT as this architecture lacks wireless sensors that are used inside and outside the building to reduce energy consumption.

Gupta et al. (2024) present a study on the challenges of deploying LoRaWAN in dynamic smart campus environments, with a focus on network optimization, mobility management, and transmission power, reliable communication. The work highlights the importance of tuning key parameters such as spreading factor and transmission power to cope with signal propagation and path loss in real world scenarios. It also emphasizes the role of integrating short range and long range communication protocols with Edge, Fog, and Cloud computing to support efficient data processing and real time decision making in smart spaces. Based on practical deployment experience, the study provides insights into implementation challenges, applied methodologies, and their impact on IoT based smart environment performance, offering valuable implications for future research and practical deployments. Despite the practical relevance of this study, its findings are mainly limited to communication level optimization and do not provide a quantitative evaluation of the actual energy savings achieved at the campus scale. Moreover, the proposed approach focuses on LoRaWAN deployment challenges without comparing its performance against alternative communication technologies, which limits the generalizability of the results for broader smart campus energy management applications.

3. Intelligent and Machine Learning–Based Approaches.

ketchman et al. (2018) The Business Energy Assessment Resource (BEAR) was chosen as another solution to evaluate energy consumption in commercial buildings. This resource aims to reduce energy consumption and costs in small commercial buildings that rely mainly on limited resources. The researchers chose two commercial enterprises for the study, installed smart meters in each port and collected data using the ZigBee network protocol. Electricity consumption records were analyzed using bootstrap with sensitivity analysis, and the data were managed and visualized using custom software. Finally, energy contour maps were generated using Minitab software. The solution they used is scalable and completely data driven.

Manassra et al. (2025) Most studies on smart campus energy management have focused on specific subsystems like lighting, HVAC, or renewable energy, often using rule based or static optimization methods. Some research has used IoT sensors to collect energy data for basic monitoring and control, but these systems usually cannot adapt in real time or respond well to changing energy needs. More recent work has applied artificial intelligence and machine learning to improve energy efficiency, showing good results in predicting and managing energy use. However, most current solutions only target single applications or use one AI model, which limits their scalability and effectiveness across an entire campus. Newer research highlights the importance of integrated, data driven systems that use real time IoT data and adaptive AI to manage energy across multiple campus subsystems while keeping users comfortable and operations reliable. In summary, while the study by Manassra et al. (2025) provides a valuable overview of the evolution of smart campus energy management, highlighting the potential of IoT and AI technologies, it also reveals several limitations. Most previous solutions focused on single subsystems or relied on a single AI model, which restricts scalability and practical applicability across an entire campus. Furthermore, although the study emphasizes the importance of integrated, data driven, real time adaptive systems, it lacks detailed guidance on how such integration can be implemented in practice and does not address challenges related to data collection, processing, and system evaluation. Therefore, while the study is insightful from a theoretical and visionary perspective, further empirical research and comparative analysis of multi system applications.

Leite et al. (2018) this study discusses a method to reduce the energy consumption of battery based devices in smart campus applications. Discrete event simulation is used to demonstrate that energy consumption is reduced using appropriate prioritization and emergency network traffic balancing. A predictive algorithm and fuzzy logic controller are used to indicate the level at which the system should turn off the load to reduce power consumption. Analysis of the study shows that a significant reduction in energy consumption has been achieved. The researchers propose a discrete event simulation method to reduce energy consumption. This system lacks the use of IoT sensors.

Figure (2) presents the overall architecture of the IoT based smart energy management system, where data is collected from IoT sensors, transmitted through the communication layer, processed and managed by the EMS, and analyzed using AI based decision making, with real time monitoring and control provided through the user interface.

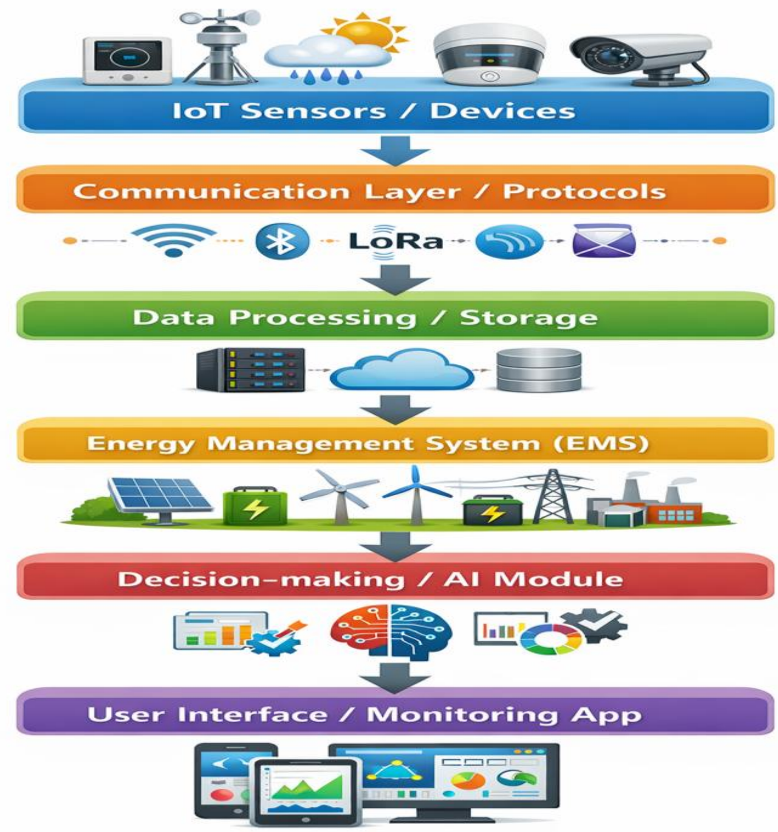

Figure 2: Architecture of the IoT-based Smart Energy Management System.

4. SUMMARY

The table below presents a collection of studies on the use of IoT technologies in energy management systems across different sectors. The table includes a summary of the different methodologies used, the benefits achieved, and the challenges faced by each study. It also highlights the key observations and findings obtained from each study. This analysis aims to provide a comprehensive overview of how IoT technologies can be leveraged to improve energy efficiency, reduce consumption, and promote sustainable energy management. By integrating smart sensors and connected systems, energy consumption patterns can be monitored and analyzed with high accuracy, enabling opportunities to be identified for efficiency improvements. For example, in smart buildings, data collected from sensors can be used to automatically adjust lighting, heating, and cooling based on the presence of people or environmental conditions, reducing energy consumption. Additionally, these technologies enable better management of renewable energy, such as solar or wind, by tracking its production, storage, and more effective use. Thus, IoT not only contributes to lowering energy costs, but also promotes environmental sustainability by reducing carbon emissions, see Table 1.

Table 1: Literature Review Summary.

Authors	**Methodology**	**Pros**	**Cons**	**Notes**
Lavanya et al., 2019	The study uses an IoT enabled system. The data acquisition unit collects energy consumption information and sends it to the cloud system for analysis.	• Efficient energy management. • Reducing energy consumption.	• Lack of infrastructure. • Limitations of High Voltage Controller.	A prototype of two electrical appliances, an air conditioner and a light bulb was implemented, the results obtained from the model were validated, the Arduino outputs were transferred to the ESP8266 WiFi module.
Gupta et al. 2024	Real world deployment of a LoRaWAN based smart campus, with empirical performance evaluation and parameter tuning (SF, Tx Power).	• Low power consumption. • Wide area coverage. • Suitable for large scale IoT.	• Performance affected by buildings and obstacles. • Mobility degrades reliability. • Requires careful parameter configuration.	LoRaWAN enables efficient and scalable communication for smart campus applications. Real world experimentation highlights the importance of proper parameter tuning and

				gateway placement to ensure reliable connectivity, especially in dynamic and obstructed environments.
Ketchman et al., 2018	The BEAR method for consuming electricity is installing smart meters and collecting data via the ZigBee protocol. Minitab software is used to process and analyze the data and identify deficiencies. Then implement the implementation of the measures and monitor them continuously.	• Provide accurate data insights. • Bootstrap enhances data analysis. • Minitab provides energy consumption trends.	• Initial investment for installation and setup. • Using BEAR requires experience. • The BEAR system requires constant maintenance.	BEAR saves energy. Detailed data analysis and visualization helps reveal peak usage times and areas of high consumption. Which leads to cost savings.
Abusukhon et al., 2021	The study proposes building a system and comparing it to the proposed IOT system. The system calculates the cost of energy consumption. Sensors and an (IoT) energy management	• Significant reduction in energy consumption. • Secure system data. • Comprehensive cost analysis.	• Lack of detailed information. • Potential challenges. • Long term cost efficiency analysis.	A smart office system was proposed. The proposed system reduced energy waste by 40%. Based on LTT, the cost of energy saved generated by the proposed IoT system was evaluated and compared to the

	system are used in the system.			cost of energy consumed generated by the platform.
Jabeen et al., 2016	EMS implementation entails needs analysis, selection of appropriate technology and sensors, installation of sensors, development of software to collect and control data, integration, reliability testing and user training. Continuous monitoring improves performance, This approach ensures efficient energy.	• Control Automation. • Electricity optimization system.	• Complexity in implementation. • Technology Risks.	Energy management integrates communications and sensor technology to optimize energy use, reduce costs and improve efficiency. Administrators can control and monitor settings and automate processes, resulting in a simpler and more effective approach.
Eltamaly et al., 2021	The study uses an IOT based architecture to support grid integration of a hybrid energy system. Hybrid power communication models were designed and	• Improve the power system. • Classification of monitoring information.	• Infrastructure challenges. • Difficulty of correct identification.	An IOT based architecture was used for renewable energy. The performance of the communication network of the HRES was evaluated using OPNET

	implemented based on the (IEC 61850) standard. The per formance was evaluated using communication architectures (Ethernet, Wi-Fi).			Modeler. Simulation results showed the feasibility of Ethernet and Wi-Fi based architectures for controlling and monitoring the HRES.
Vasanthapriyan et al., 2019	The study uses an automated system to control electricity consumption in the lecture hall using a Kinect sensor and (DHT22, LDR) sensors. An Arduino mega board is used to control the sensors.	• Intelligent energy saving. • Response to human presence. • Real time information.	• Data privacy risks. • Large financial investments. • Energy technology risks.	The questionnaire showed that poor lighting and ventilation cause student discomfort, and that the Kinect sensor is more effective than the PIR sensor, while the system focuses on reducing energy use and providing real time data.
Kassim et al., 2018	The proposed system is a smart measurement of energy consumption via smart meters. It uses the (SQL) database system.	• Consumption monitoring. • Collect and analyze data. • Provide a representation of energy capacity.	• Lack of data. • Costs were not discussed. • High development cost.	The use of electrical energy on campus was analyzed, and the results are presented in graphs. The energy

	The data is analyzed and information is displayed on the smart meter and mobile application.			consumed by buildings was also presented.
Wang et al., 2017	The study uses a smart home system (CASAS), the behaviors focused on are energy use behaviors. (MATLAB) simulation and deep learning were used to analyze the collected data.	• Comprehensive. Use Machine learning algorithms. • Support vector machine. Experimental results.	• Algorithm limitations. • Smart application challenges.	An initiative has been set up at the University of California, where experimental results show that 97.5% accuracy has been achieved in distinguishing regular classroom events from irregular classroom events. A classification accuracy rate of 97.6
Manassra et al., 2025	AI driven integrated energy management framework using real time IoT sensor data and simulation based evaluation.	• Reduces total energy consumption by up to 59.125% • Integrates multiple campus subsystems in one unified framework • Optimizes energy usage without affecting user comfort.	• Strong dependence on high quality IoT sensor data. • Requires adaptive and well trained AI models. • Needs robust cybersecurity to	Proposes a unified AI framework integrating multiple campus subsystems rather than focusing on a single application.

		• Supports sustainability and cost reduction.	protect IoT infrastructure.	
Leite et al., 2018	The study uses discrete event simulation to analyze and reduce energy consumption. A predictive algorithm and fuzzy logic controller are used to determine when to stop the load. A (GSM, UMTS) model was developed and a Random Waypoint model was simulated.	• Network traffic routing. • Reduce power consumption. • Energy consumption modeling.	• Random changes. • Network traffic balance. • Increased priority for emergency traffic.	Five case studies for simulating discrete events were presented, and the results showed a direct relationship between the base station's traffic load and energy consumption. Network balancing and prioritizing congested networks can reduce message delay. The model emphasizes the importance of simulation and analysis tools in data grid power modeling.
Pasetti et al., 2020	The study uses an IOT architecture, which is based on managing communication	• Communication protocols management • UseLoR WAN technology. • Extensibility.	• Protocol Management challenges. • Challenges of LoRaWAN technology.	An IoT based architecture was proposed, an experimental verification of LoRaWAN

	protocols in smart environments, by analyzing their feasibility using a campus data model. And using (LoRaWAN) technology for communication scenarios.		• Increased security risks.	technology was performed on its suitability in terms of coverage and latency, the advantages of the proposed solution in PV system supervision and management were highlighted.

The summarized advantages and disadvantages presented in Table 1 directly address the second and third research questions. The reviewed studies highlight that IoT based energy management systems offer significant benefits, including real time monitoring, automation, improved energy efficiency, and cost reduction. However, several challenges were also identified, such as system complexity, deployment and maintenance costs, data security concerns, interoperability issues, and scalability limitations in large campus environments.

5. Conclusion

In conclusion, this study highlights the significant potential of IoT technologies to enhance energy efficiency in smart universities. The literature review demonstrates that IoT systems enable real time monitoring, automated control of energy intensive operations, and effective integration with renewable energy sources, collectively contributing to operational cost reduction, sustainability, and improved campus comfort. However, the analysis also reveals key gaps: most implementations focus on individual subsystems rather than campus wide integration, the application of AI models is often limited to single solutions, and security and privacy challenges remain insufficiently addressed. Therefore, while IoT adoption offers a robust framework for energy optimization, future research should focus on developing scalable, secure, and fully integrated IoT frameworks that leverage real time data and adaptive AI for comprehensive smart campus energy management.

6. Acknowledgment

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7. Conflict of Interest

Authors has no conflict of interest to declare

8. References

Vermesan, O., & Friess, P. (Eds.). (2013). *Internet of things: converging technologies for smart environments and integrated ecosystems*. River publishers.

Lavanya, A., Jeevitha, M., & Bhagyaveni, M. A. (2019). IoT-enabled green campus energy management system. *International Journal of Embedded Systems and Applications*, *9*(2), 21-35.

Gupta, H. P. (2024). Lessons learned: A smart campus environment using lorawan. *arXiv preprint arXiv:2410.09927*.

Ketchman, K. J., Khanna, V., Parrish, K., & Bilec, M. M. (2018). Small Business Electricity Disaggregation: Where can we improve? Towards increased transparency of appliance modal parameters. *Energy and Buildings*, *176*, 194-202.

Abusukhon, A., Hawashin, B., & Lafi, M. (2021). An Efficient System for Reducing the Power Consumption in Offices Using the Internet of Things. *International Journal of Advances in Soft Computing & Its Applications*, *13*(1).

Jabeen, A., & Kumar, D. M. (2016). Automatic classroom lighting controller and energy saving based on microcontroller unit. *International Advanced Research Journal in Science, Engineering and Technology*, *3*(7), 201-203.

Eltamaly, A. M., Alotaibi, M. A., Alolah, A. I., & Ahmed, M. A. (2021). IoT-based hybrid renewable energy system for smart campus. *Sustainability*, *13*(15), 8555.

Vasanthapriyan, S., & Randima, V. (2019). Design IoT based smart electricity power saving university: Analysis from a lecture hall. *Journal of Computer Science*, *15*(8), 1097-1107.

Kassim, M., Rahman, M. A., Yahya, C. K. H. C. K., & Idris, A. (2018). Mobile application for electric power monitoring on energy consumptions at a campus university. *Indonesian Journal of Electrical Engineering and Computer Science*, *11*(2), 637-644.

Wang, Y., Saez, B., Szczechowicz, J., Ruisi, J., Kraft, T., Toscano, S., ... & Nicolas, K. (2017, October). A smart campus internet of things framework. In *2017 IEEE 8th Annual Ubiquitous Computing, Electronics and Mobile Communication Conference (UEMCON)* (pp. 498-503). IEEE.

Manassra, A., & Işık, G. (2025). A Model for Artificial Intelligence Supported Energy Management in Smart Campuses. *Journal of Smart Systems Research*, *6*(2), 74-92.

Leite, J. E., Massaro, F. R., Martins, P. S., & Ursini, E. L. (2018, December). Reducing power consumption in smart campus network applications through simulation of high-priority service, traffic balancing, prediction and fuzzy logic. In *2018 Winter Simulation Conference (WSC)* (pp. 1156-1167). IEEE.

Pasetti, M., Ferrari, P., Silva, D. R. C., Silva, I., & Sisinni, E. (2020). On the use of LoRaWAN for the monitoring and control of distributed energy resources in a smart campus. *Applied Sciences*, *10*(1), 320.