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INTERNET OF THINGS (IOT) IN SCHOOLS: IMPROVING THE EFFICIENCY AND QUALITY OF EDUCATION

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Abstract

The implementation of the Internet of Things (IoT) in the school environment promises a significant transformation in improving the efficiency and quality of education. IoT technology enables the creation of a more interactive and personalised teaching-learning process, providing an educational experience that is better suited to the needs of individual students. In addition, IoT helps teachers monitor student progress in real-time, enabling more effective intervention and assistance. In terms of school management, IoT makes it easier to automate various operational tasks such as inventory control, energy management, and facilities maintenance, all of which contribute to cost savings and improved learning environments. However, successful implementation of IoT requires adequate technological infrastructure as well as special attention to privacy and data security issues. Therefore, cooperation between various stakeholders is necessary to overcome these challenges and maximise the potential of IoT in education.

Keywords: Internet Of Things (IoT), School, Efficiency, Education Quality.

Introduction

Education is an important foundation in the development of a nation. Along with the development of technology, the world of education has also undergone a significant transformation. Technology transformation in education has opened up significant new opportunities in the teaching and learning process. With the application of technologies such as Learning Management Systems (LMS), e-learning platforms, and interactive learning applications, students can now access teaching materials anytime and anywhere. Technology also enables personalisation of learning, where curriculum can be tailored to each student's level of understanding and learning pace. In addition, advances in virtual reality (VR) and augmented reality (AR) offer a more immersive and engaging learning experience. This transformation not only eases access to education, but also improves student engagement and learning outcomes, making technology a vital component in the development of modern education systems.

Then, one of the technologies that is currently being applied in the education sector is the Internet of Things (IoT). The Internet of Things (IoT) is a network of physical devices embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems via the internet. IoT allows real-world objects, such as vehicles, home appliances, and industrial devices, to communicate autonomously and perform certain tasks without human intervention. With this capability, IoT creates an integrated ecosystem, where data collected from sensors can be analysed to generate better insights and decisions. The implementation of IoT can improve operational efficiency, generate new services, and provide smarter solutions in various sectors, including manufacturing, transportation, healthcare, and education.

The application of IoT in education offers a wide range of potentials to improve school operational efficiency and learning quality. By using IoT sensors and devices, schools can optimise the use of resources such as electricity and water, improve security, and simplify facilities management. In addition, IoT devices such as interactive whiteboards, attendance sensors, and distance learning devices can provide students with a richer and more personalised learning experience.

The Internet of Things (IoT) plays an important role in the transformation of education by providing a more interactive, connected, and efficient learning environment. With IoT, educational institutions can implement smart solutions such as smart classrooms that enable increased interaction between teachers and students through connected devices such as smartboards, attendance sensors, and IoT-based evaluation tools. In addition, IoT can be used for school facility management, such as automatic lighting and temperature settings, which create a more comfortable learning environment. Data collected from IoT devices can also help in real-time monitoring and analysis of student performance, enabling learning that is tailored to individual needs. In this way, IoT not only modernises educational infrastructure, but also improves the quality of teaching and learning, providing a richer and more adaptive educational experience.

However, the implementation of IoT in schools still faces various challenges. Some schools do not fully understand the benefits and ways of implementing IoT, and some are still hampered by budget and infrastructure issues. Therefore, a comprehensive study is needed to evaluate the impact and benefits of using IoT in schools.

This study aims to examine how the implementation of IoT can increase the efficiency of school operations and improve the quality of education. Thus, it is hoped that the results of this study can provide a clearer picture of the potential of IoT in supporting the education process, as well as offer practical recommendations for educational institutions that want to adopt this technology.

Research Methods

The study in this research uses the literature method. The literature research method is a research approach that involves collecting, analysing, and interpreting data from existing sources to answer a research question or investigate a particular problem. In this research, researchers collect information from various references such as books, scientific journals, articles, research reports, and other documents to build a theoretical framework or understand the context of the topic under study (Sahar, 2008); (Arikunto;, 2000). This process includes steps such as identification of relevant sources, evaluation of the quality and credibility of sources, and synthesis of findings to identify trends, gaps or recent developments in the field of study. This method is particularly useful for gaining in-depth insights without the need to conduct direct experiments or surveys, and is often used as a basis for follow-up research or as a means to validate findings from primary research. (Fadli, 2021).

Results and Discussion

Iot Implementation Can Improve Efficiency in Schools

The Internet of Things (IoT) is a technology concept that describes a network of physical devices connected to the internet, which have the ability to collect, share, and exchange data among themselves without human intervention (Nguyen et al., 2021). These devices include a wide range of objects, from household appliances, vehicles, health devices, to industrial sensors. Using technologies such as sensors, actuators, wireless connectivity, and specialised software, IoT enables real-world objects to communicate and work together in a connected ecosystem. The result of this integration is increased operational efficiency, optimisation of resources, and the creation of new services that are smarter and more responsive (Molaei et al., 2020).

The basic principles of IoT involve four main elements: devices (things), connectivity, data analytics, and interaction. First, things include any kind of object that can be equipped with sensor or actuator technology to interact with its environment. Second, connectivity is the ability of devices to connect to the internet network using various communication protocols such as Wi-Fi, Bluetooth, or mobile networks (Alsharari, 2021). Thirdly, data analytics is the process of collecting and processing data generated by the device, which is used to identify patterns, make predictions, and provide actionable insights. Finally, interaction encompasses the way these data and insights are used to control devices or design responses that can be automated based on specific conditions. These principles work together to create IoT solutions that add value through automation, control, and knowledge gained from real-time monitoring (Hizam & Ahmed, 2020).

IoT components and architecture consist of several key elements that work together to create an integrated and functional system. The main components of IoT include physical devices (sensors and actuators) that are responsible for collecting data and executing commands, network connectivity that allows devices to communicate with each other and exchange data, cloud computing platforms that provide

infrastructure for data storage and processing, and analytics applications that process data to generate insights and necessary actions (Cai et al., 2020). The IoT architecture is usually divided into several layers, starting from the device layer (perception layer) that collects data from the physical environment, the connectivity layer (network layer) that transmits the data to the data centre, the data processing layer that manages and analyses the information, to the application layer (application layer) that presents the results of the analysis to the end user in an accessible form through the user interface. The synergy between these components and layers results in an IoT ecosystem that is able to provide effective, efficient, and responsive solutions to various industry needs and challenges (Mishra & Chakraborty, 2020).

The implementation of the Internet of Things (IoT) in the school environment can bring significant changes in improving operational efficiency and creating a better learning environment. One way IoT can improve efficiency in schools is through smart energy management systems. By installing sensors and IoT devices on lighting, heating, ventilation, and air conditioning systems, schools can monitor energy usage in real-time (Sefati & Navimipour, 2021). The data collected allows the system to automatically adjust energy consumption according to actual needs, such as turning off lights or air conditioners when classrooms are not in use, thereby reducing energy waste and operating costs (Laghari et al., 2021).

In addition, IoT can strengthen security systems in schools. IoT-based CCTV cameras equipped with facial recognition and motion detection technology can improve surveillance throughout the school area. This smart security system can send real-time alerts to security officers if suspicious activity is detected, so that responses to potential threats can be made faster and more precisely. IoT-based tracking devices can also be used to monitor the whereabouts of students and teachers in emergency situations, ensuring that all individuals can be located and treated properly (Zaballos et al., 2020).

In terms of academics, IoT can improve the efficiency and effectiveness of learning. For example, a smart classroom equipped with IoT devices can provide an adaptive learning environment. Sensors can measure air quality, temperature, and noise levels, and automatically adjust classroom conditions to optimise student concentration. IoT-based learning aids can also be used to personalise each student's learning experience, by presenting content tailored to individual learning outcomes and styles, and facilitating more in-depth and collaborative interactions between students and teachers (Zainuddin et al., 2020).

School inventory and asset management can also be optimised with IoT technology. With RFID tags or IoT sensors attached to educational devices and tools, schools can track the usage and movement of items in real-time. This helps in ensuring efficient use of resources, reducing inventory loss or damage, and enabling better management of budget planning (Qiu et al., 2020). Automated reporting from these IoT systems can also reduce the administrative burden for staff, freeing up more time and resources to focus on other learning and school development activities. As a result, the

implementation of IoT not only saves costs and time, but also supports the creation of a safer, more convenient, and innovative educational environment.

Iot Implementation Can Improve Education Quality

The application of the Internet of Things (IoT) in education opens up great opportunities to improve the quality of learning, based on data that can be used to optimise various operational and academic aspects. One of the main contributions of IoT in education is through the personalisation of learning. With IoT sensors and devices, data related to student performance, participation, and interaction can be collected in real-time. This information allows educators to understand individual student needs, customise teaching methods and materials, and provide more specific and useful feedback (Sepasgozar et al., 2020). Thus, each student can receive personalised attention according to their abilities and learning styles.

IoT can also support more interactive and engaging learning, where devices such as smart whiteboards and wearables can be integrated into the classroom environment. These devices allow students to participate in learning more actively through multimedia learning experiences, simulations, and data-backed experiments. In addition to strengthening student engagement, these technologies can create a more collaborative and creative learning atmosphere, facilitating group discussions and team-based projects that can develop critical skills such as teamwork and problem-solving (Kassab et al., 2020).

Furthermore, IoT can improve the quality of education by supporting more effective monitoring and evaluation. IoT-based systems can provide comprehensive data analysis on a school's academic and non-academic activities, such as facility usage, student attendance, and even assessment mechanisms. Schools can utilise this information to identify areas for improvement, formulate better learning strategies, and ensure education policies are implemented more effectively. For example, data analysis can reveal the balance between time spent in the classroom and extracurricular activities, and its impact on academic performance (Zhong et al., 2022).

The use of IoT in education has the potential to break down geographical barriers through distance learning. With the integration of IoT-enabled distance learning platforms, students can access educational resources from anywhere and at any time, transcending the physical boundaries of the campus. For schools that are geographically remote or in emergency situations, this technology can provide continuity in education, ensuring that the learning process is not interrupted (Tsourela & Nerantzaki, 2020). As IoT technology grows, the quality of education can continue to improve by providing more equitable and inclusive access, empowering students from diverse backgrounds to reach their full potential (Mohamad, 2022).

In addition to the benefits mentioned, the application of IoT in education can also improve the operational efficiency of educational institutions. With this technology,

various management processes, such as inventory control, energy management, and facility maintenance, can be automated and monitored in real-time. For example, with IoT sensors installed in school buildings, energy consumption can be monitored and optimised, reducing operational costs. Likewise, IoT devices can detect facility maintenance needs more proactively, thereby reducing disruptions and improving the comfort of the learning environment (Wang et al., 2022).

In addition to operational benefits, security in educational environments can also be improved with the implementation of IoT. IoT-based security systems, such as smart surveillance cameras and arrival sensors, can monitor activities around the campus in real-time. This not only helps in maintaining the physical safety of students and staff, but also creates a safer and more conducive learning environment. The school can immediately respond to any potential threats or incidents through notifications and alarms generated by the system, ultimately increasing the sense of security and trust of all parties involved in the education process (Lv & Li, 2021).

One of the challenges in implementing IoT in the education sector is the need for adequate technological infrastructure and awareness of privacy issues. Stable internet connectivity and devices that can communicate with the network are the main requirements that must be met. In addition, wise management of student data is essential to protect privacy and ensure that sensitive information is not misused. Schools, governments, and technology providers need to work together to overcome these obstacles by providing secure, affordable, and high-quality digital education (Iftekhar et al., 2020).

In conclusion, the application of IoT in education has great potential to improve the quality of learning and operations of educational institutions. From personalisation of learning to security and operational efficiency, IoT can transform the way education is delivered and managed, making it more interactive, collaborative, and inclusive. While there are challenges to overcome, investment in the right technology infrastructure and data policies can help realise the full benefits of IoT solutions in education. As such, IoT is not only a tool but also a key catalyst in accelerating transformation and improving the quality of education in the digital age.

Conclusion

The implementation of the Internet of Things (IoT) in schools offers a range of significant benefits that can improve the efficiency and quality of education. Through the use of IoT devices, the teaching-learning process becomes more interactive and personalised, allowing students to have a learning experience that suits their individual needs. In addition, this technology makes it easier for teachers to monitor student progress in real-time, providing the necessary data for timely intervention and assistance. School operational management has also improved through the automation

of inventory control, energy management, and facility maintenance, which can save costs and create a more comfortable learning environment.

However, the implementation of IoT in the education sector also demands adequate technological infrastructure and extra attention to privacy issues. Stable internet connectivity and compatible devices are required to support effective network communication. In addition, student data management must be done wisely to protect the privacy and security of sensitive information. Cooperation between schools, government and technology providers is essential to overcome these challenges. Overall, despite the obstacles, the potential for IoT to revolutionise education is huge, making it worth investing in to accelerate the transformation of education into the digital era.

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