Applying Biometric Technology in School Attendance and Security Management

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ABSTRACT

In today's digital era, security and efficiency in attendance management in the school environment are very important. Biometric technology has become a new trend in improving security and optimizing the attendance recording process, replacing manual systems prone to errors and fraud. This research aims to analyze the effectiveness of applying biometric technology in school attendance and security management. Specifically, this research focuses on evaluating how this technology can reduce cheating, increase the accuracy of attendance data, and strengthen school security systems. This research uses quantitative methods with a case study approach at five schools implementing a biometric system. Data was collected through surveys of school administrators and direct observation of the registration and identity verification processes at these schools. Data analysis was carried out using descriptive and inferential statistics. This research shows that using biometric technology significantly increases the efficiency and accuracy of the attendance recording system. Student attendance is recorded quickly and accurately, with virtually no cheating. This technology also strengthens the security system by ensuring that only verified individuals can access school facilities. This research concludes that applying biometric technology in school attendance and security management has proven very effective. This technology optimizes attendance and improves security, providing a safe environment for students and staff. The research recommends wider adoption of biometric technology in other schools to improve security and operational efficiency.

Keywords: *Biometric Technology, Attendance Management, Security Schools*

INTRODUCTION

In recent years, attendance management and security in educational environments have faced challenges, especially with the increasing need to integrate advanced technologies to address fraud and unauthorized intrusion (Yoshitoshi & Takahashi, 2023). School security, as a top priority, involves not only the physical protection of students and staff but also the accuracy of recording attendance which is often vulnerable to manipulation. This problem is made more complex by the limitations of traditional systems that are still widely used, which tend to be inefficient and frequently

inaccurate (Corcoran & Kelly, 2023). This research was inspired by the urgent need to address these deficiencies, focusing on implementing biometric technology as a potential solution. The inadequacy of the manual attendance system, which is still prevalent in many educational institutions, causes various problems, ranging from false attendance to unauthorized access, which can endanger the school environment (Sharma et al., 2022). This issue is a serious concern for school administrators responsible for the security and integrity of attendance data. Therefore, in-depth research is needed to identify solutions that are not only effective in reducing fraud but also strengthen the security system. Implementing biometric technology in schools can address this need by providing a means of almost impossible verification to duplicate, reducing the risk of human error, and speeding up the recording process.

Using biometric technology in school attendance and security management is an innovative step that can strengthen the integrity of the education system ("Immersive Remote Collaboration and Workplace Tracking Systems, Mobile Biometric and Sentiment Data, and Algorithmic Monitoring and Wearable Augmented Reality Technologies in Generative Artificial Intelligence-Based Virtual Human Resource Management," 2023). This technology enables the identification of individuals based on unique physical characteristics, such as fingerprints, irises, or even facial patterns, all of which are difficult to fake. The application of this technology not only addresses the weaknesses of the manual attendance system but also improves school security by controlling access to school facilities more strictly. This study explores the extent to which biometric technology can effectively integrate these security solutions, evaluating the benefits and potential barriers to its implementation in the school environment. This research was conducted because of a knowledge gap regarding the practical implementation and effectiveness of biometric technology in an educational context. Although a large body of literature proposes the theoretical benefits of biometric technology, few studies examine its application directly in schools. Thus, this research contributes to filling this gap by offering an empirical analysis and in-depth evaluation of the application of biometric technology in educational institutions. Through surveys and observations in several schools that have implemented these systems, this research seeks to validate the effectiveness of biometric technology in real contexts and provide evidence-based recommendations for best practices in attendance management and school security.

Literature of Review
Biometric Technology in School Attendance Management

Biometric technology has emerged as an advanced and innovative solution for school attendance management ("A Study on the Protection of Biometric Information against Facial Recognition Technology," 2023). With the ability to identify individuals based on unique physical or behavioral characteristics, biometric technology offers many benefits in educational contexts (Fernando et al., 2022). One of the main roles of biometric technology in school attendance management is to increase the accuracy of attendance recording (Malatji et al., 2021). Traditional systems that use signatures or

manual recording are often prone to errors and manipulation, such as false attendance or 'buddy punching,' where one student records attendance for another. Biometric technologies, such as fingerprint, facial, or iris recognition, ensure that each student must be physically present to verify their identity, thereby increasing the integrity of attendance data (Negri et al., 2019).

Besides increasing accuracy, biometric technology also plays an important role in improving the efficiency of the attendance recording process (Calvo-Sanz et al., 2022). Time is one of the most valuable resources in a busy school environment. The fast biometric verification process allows students to enter class without waiting in long queues, reducing delays at the start of the school day and allowing teachers to start lessons on time. Automated attendance data can be directly integrated with the school information system, which makes it easier for the administration to manage attendance data for various purposes, such as attendance reports, assessments, and other administrative purposes (Aldana-Aguirre et al., 2017). By reducing administrative workload, teachers and school staff can allocate more time and resources to learning and teaching activities.

From a security perspective, biometric technology offers significant improvements compared to traditional methods. Biometric systems can be integrated with access control systems, ensuring that only registered individuals, such as students, teachers, and staff, can enter school facilities or certain areas (Hamidi, 2019). This reduces the risk of unauthorized access that could threaten students' physical safety and the integrity of the school. With accurate and verifiable attendance logs, schools can also quickly identify where students are in emergencies, such as fires or other circumstances that require rapid evacuation. This is very important to ensure the safety of all individuals in the school environment.

However, implementing biometric technology in school attendance management is challenging (Manta et al., 2020). One of the main challenges is the significant costs associated with purchasing and maintaining this advanced technology. Schools may need help allocating funds for such a system, especially in disadvantaged areas (Kearney & Graczyk, 2020). Additionally, privacy and ethical considerations need to be addressed, including concerns about the storage and use of student biometric data. Laws and regulations regarding personal data protection must be strictly adhered to to avoid privacy violations. Schools should adopt clear policies regarding who can access biometric data and under what circumstances and ensure that all data is protected with adequate security measures.

To overcome cost issues, schools can seek support from government programs or partnerships with technology companies that can provide technology as part of corporate social responsibility (CSR) programs. This can be an effective solution for schools experiencing budget constraints. As for privacy, educational institutions need to ensure transparency in using biometric data and provide assurances to parents and students about data security and ethical use. Training and education on biometric technology should also be provided to all stakeholders, including students, parents, teachers, and

school staff, to increase understanding and acceptance of this technology. In terms of technical solutions, schools must ensure adequate technical support for the maintenance and troubleshooting of biometric systems (Clarke & Burt, 2019). This could be a trained internal IT team or a contract with a technology provider for ongoing support services. Effective communication with all stakeholders is also important to address concerns and increase acceptance of this new technology. Transparency in communication about benefits, procedures, and data protection is key to gaining support from the school community.

Schools can create safer and more efficient learning environments through this comprehensive approach. Using biometric technology increases the accuracy and efficiency of attendance recording and provides a greater sense of security for the entire school community (Fu et al., 2022). Therefore, other schools may consider adopting this technology as a step towards more modern and reliable attendance and security management. Thus, biometric technology can become a key component in a comprehensive school management strategy, making a significant contribution to achieving higher and better educational goals.

Biometric Technology in Security Management in Schools

Biometric technology has developed rapidly and has become a highly reliable solution in various sectors, including education (Peng et al., 2022). In the school context, biometric technology is crucial in improving security management. Biometric systems that rely on fingerprint, facial, iris, or voice recognition provide a much safer and more efficient way to control access and monitor activity in the school environment. By recognizing individuals based on unique physical characteristics, this technology can prevent unauthorized access and reduce potential threats to student and staff safety.

One of the main goals of implementing biometric technology in school security management is to ensure that only authorized individuals can access school facilities (Bartfeld et al., 2019). With a biometric access control system, schools can restrict access to certain buildings, laboratories, or other sensitive areas to only verified students, teachers, and staff. This reduces the risk of intrusion by unwanted outside parties, which could threaten the safety and security of the school community. Additionally, activity logs generated by biometric systems allow schools to track who enters and leaves the facility at any given time, providing useful data in investigations or emergencies.

Biometric technology also plays a role in improving school responses to emergencies (Vandana & Kaur, 2022). In the case of a fire, natural disaster, or other security incident, biometric systems can help identify the whereabouts of students and staff quickly and accurately. This information is vital to ensure effective evacuation and that nothing is left inside the dangerous building. Emergency response teams can work more efficiently and save more lives with real-time data that can be accessed immediately. In addition, biometric technology can help prevent bullying and violence in schools. By closely monitoring student movements on campus, schools can identify suspicious behavior patterns or conflict situations before they escalate into more serious

problems. Facial recognition systems, for example, can be integrated with surveillance cameras to detect suspicious incidents and provide early warnings to security officers or school administrators.

However, applying biometric technology in school security management also faces several significant challenges (Iwasokun et al., 2022). One of the main challenges is the high cost of implementing and maintaining this technology. Many schools, especially those in disadvantaged areas, may need more budgets to adopt biometric technology widely. Additionally, there are also legitimate concerns regarding privacy and data protection. The storage and management of student biometric data must be carried out carefully to ensure that personal information is not misused or leaked. Schools can explore funding sources to address cost concerns, such as government grants, partnerships with technology companies, or corporate social responsibility (CSR) programs. This way, they can get the financial support necessary to implement biometric technology without sacrificing their budget for other educational needs. Additionally, schools need to comply with applicable privacy and data protection regulations. This includes adopting strong data encryption, strict data access policies, and transparent procedures for collecting, storing, and using biometric data.

Training and education are also important components in successfully implementing biometric technology. Schools must provide adequate training for students, teachers, and staff on the use of this technology and its benefits and risks. This education is important to ensure that all parties understand how biometric systems work, how they can contribute to maintaining data security, and how this technology can improve their security in the school environment. Increasing understanding and acceptance of biometric technology through open communication and ongoing education is key to successful implementation. With the right approach, biometric technology can significantly benefit school security management. In addition to improving physical safety by controlling access and monitoring activity, this technology can also enhance students' emotional and psychological safety by creating a safer and more controlled environment. Implementing biometric technology can also help schools build a reputation as an institution that cares about the safety and well-being of their students (Quinan & Hunt, 2022), which in turn can attract more students and support from the community.

There are several previous research opinions. According to(Ali et al., 2022), the first research is titled Automated Attendance Management Systems: Systematic Literature Review. The results of his study stated that different automatic identification technologies have become trends, extensive research has been conducted, and many applications have been produced to maximize technology features. According to(Hernandez-de-Menendez et al., 2021), the second research is titled Biometric Applications in Education. The results of his study stated that the biggest challenge this technology must overcome is security and privacy issues, which must be addressed to develop the technology to its full potential fully. It is desirable that this literature review can provide researchers with a sound vision of biometric technology's potential in

education. The third research, according to(Lamin et al., 2021), is titled Implementing Student Attendance System Using Fingerprint Biometrics for Kolej Universiti Poly-Tech Mara. Using the system embedded with biometrics, reporting on absenteeism is genuine and easy. Lecturers just need to print it out and take the necessary action. Therefore, fingerprint biometrics is useful and helpful in keeping track of and managing the attendance of students.

This research also proposes innovation by integrating more sophisticated biometric technology and implementing more accurate and faster recognition algorithms. In the state-of-the-art context, biometric technology has been widely used in various sectors, but its application in the education sector is still relatively new. This research will look at how these technologies can be adapted to meet specific educational needs, emphasizing reliability, speed, and ease of use, as well as how to overcome barriers such as cost, privacy, and social acceptance. The novelty of this research lies in the application of biometric technology on a wider scale and is more focused on security management in the school environment. Although some previous research has explored the technical aspects of biometric technology, this study broadens the horizon by evaluating the social and operational implications of such technology in educational settings. It is hoped that this research will not only strengthen empirical data on the effectiveness of biometric technology but will also inspire further research to explore the potential adaptation of this technology in various aspects of school life.

RESEARCH METHOD

This research implements a quantitative approach to evaluate the effectiveness of biometric technology in attendance management and improving security in the school environment (Jung, 2019). Meanwhile, an exploratory research design combined with survey and observation techniques was adopted to collect data on the implementation and results of the biometric system in selected schools.

Sample Selection

This research involved a sample of five urban schools adopting biometric technology over the past year. School selection is based on criteria that include variations in school size (both large and small schools) and diversity in levels of technology implementation (from early to advanced stages). These inclusive criteria aim to provide a representative and comprehensive picture of the applications of biometric technology in various educational contexts.

Data collection

Primary data is obtained through two main methods: survey and observation. The survey was addressed to administrators, teachers, and IT staff directly managing biometric attendance systems (May et al., 2021). This survey explores information regarding the efficiency of the system in reducing cheating, the accuracy of recording attendance, and the impact of the system on school security. Survey responses were measured using a Likert scale to assess user satisfaction with the implemented system. Direct observations were carried out to validate the information obtained from the

survey. This activity includes inspection of technological infrastructure, biometric identity verification process at school entry and exit, and observation of security procedures integrated with the biometric system. The purpose of the observation is to understand the operation of the biometric system in daily practice and identify potential problems or weaknesses in its implementation.

Research Instrument

The instruments used in this study included a questionnaire specifically designed for surveys and an observation guide for recording data during school visits. Survey questionnaires are structured to produce quantifiable and comparative responses from respondents, while observation guidelines are created to ensure the consistency and accuracy of the observed data.

Data analysis

The collected data was analyzed using descriptive statistical techniques to describe the general characteristics of the data and inferential statistics to test the established hypotheses. Inferential analysis was conducted to determine the significance of the relationship between implementing biometric technology and increased security and efficiency of attendance management (Sepúlveda Carmona, 2019). The use of statistical software such as SPSS or SAS allows efficient data analysis, including t-test or ANOVA testing, to evaluate differences between different groups or conditions in the study.

Validity and Reliability

Guaranteeing the validity and reliability of the research was carried out by piloting the instrument in schools that were not included in the main sample and verifying the contents of the questionnaire and observation guidelines by experts in education management and information technology. Data triangulation was carried out by combining results from surveys and observations to strengthen confidence in research findings.

Research Ethics

This study received approval from the relevant ethics committee, and participants provided informed consent before participating. This research complies with applicable research ethical standards, including confidentiality and anonymity of participant data. With this method, it is hoped that this research can provide in-depth insight into the influence of biometric technology on attendance management and increasing security in schools and recommend empirical evidence for implementing similar technology in other educational institutions.

RESULTS AND DISCUSSION

Using biometric technology in attendance management and security in schools has received increasing attention as an innovative solution to improve efficiency and security in educational environments (Abomhara et al., 2021). Biometric technology, which includes fingerprint, iris, facial, and voice recognition, offers methods that are more accurate and difficult to spoof than traditional systems. This article will discuss how the application of

biometric technology can overcome various problems faced by schools in attendance management and security, as well as present survey results from several schools that have implemented this technology. Biometric technology provides a means of identity verification that is highly accurate and almost impossible to fake. This is especially important for recording attendance and improving security in a school context. Biometric systems can reduce the risk of attendance fraud, such as students registering attendance for other students. Additionally, this technology can enhance a school's response to emergencies by ensuring that all individuals can be quickly identified and located.

The application of biometric technology in school attendance and security management offers various advantages but also disadvantages that need to be considered (Southwest State University et al., 2020). An in-depth analysis of these advantages and disadvantages will help schools make informed decisions about implementing this technology. One of the main advantages of biometric technology is its high accuracy in identity verification. Biometric systems such as fingerprint, facial, and iris recognition provide identification methods that are almost impossible to fake. In a school context, this means that student attendance data can be recorded very accurately, reducing the risk of fraud, such as recording false attendance by students. Biometric technology speeds up the process of recording attendance. Students only need a few seconds to verify their identity, much faster than manual methods such as signatures or card scanning. This efficiency allows teachers to save valuable time and focus on teaching activities. With a biometric system, schools can increase security by tightly controlling access to facilities. Only verified individuals can access certain areas, such as classrooms, laboratories, or administrative offices. This reduces the risk of unauthorized entry and ensures the school environment remains safe.

Biometric technology can be integrated with other school management systems, such as academic and security information systems (Alrahawe et al., 2021). This integration allows schools to have a holistic view of student data, including attendance, academic achievement, and discipline records. This also makes it easier to create more comprehensive reports and data analysis. Biometric systems reduce the possibility of human error in attendance recording and access control. With a manual system, errors such as forgetting to record attendance or recording incorrect information are very likely to occur. Biometric technology automates this process, ensuring that the data collected is accurate and free of human error. However, one of the main drawbacks of biometric technology is its high implementation costs. Schools must invest significant funds to purchase biometric hardware, install software, and train staff to use these systems. Maintenance and repair costs also need to be taken into account, which can be a burden for schools with limited budgets. The use of biometric data raises significant privacy concerns. Biometric data, such as fingerprints and facial scans, is sensitive personal information. This data must be stored and managed with extreme care to prevent privacy violations and data misuse. Schools must ensure that they comply with data protection regulations and clearly communicate to parents and students how this data will be used and protected.

Although biometric technology is very accurate, there are some situations where it may encounter difficulties. For example, facial recognition can be less precise in poor lighting

conditions or if there is a significant change in a student's appearance. Additionally, some biometric technologies may be unreliable if students experience injuries or physical changes that affect their fingerprints or facial features. Implementation of biometric technology requires adequate technological infrastructure. Schools need to have a reliable computer network, compatible hardware, and technical support ready to handle any problems that may arise. Schools that do not have this infrastructure may need help implementing and maintaining biometric systems effectively. The implementation of biometric technology can also face resistance from users, be they students, parents, or school staff. Some individuals may feel uncomfortable or suspicious about the use of biometric data. Therefore, schools need to educate the school community about the benefits of this technology and explain the steps taken to protect data privacy and security.

Applying biometric technology in school attendance and security management offers many advantages, including accuracy, efficiency, increased security, integration with other systems, and reduced human error. However, some drawbacks need to be considered, such as high implementation costs, privacy issues, technological limitations, the need for adequate infrastructure, and user acceptance. Schools need to carry out careful and comprehensive planning to optimize benefits and reduce shortcomings. This includes evaluating needs and resources, ensuring compliance with privacy regulations, providing adequate training, and communicating effectively with all stakeholders. With the right approach, biometric technology can be a highly effective tool for improving school attendance management and security, providing a safer and more efficient environment for students and staff.

Table: Survey results on the application of biometric technology show the following results

NO	ASPECT	SATISFACTION PERCENTAGE
1	Attendance Data Accuracy	75%
2	Logging Speed	75%
3	Data Security	80%
4	Overall Satisfaction	75%
5	Ease of Use	80%
6	Reduced Fraud Rate	75%
7	Positive Response from Parents	75%
8	Improved Facility Security	80%
9	Integration with the School System	75%
10	Support and Maintenance	75%

The data above show that the majority of respondents are satisfied with the implementation of biometric technology in attendance and security management. The school appreciates the high accuracy of attendance data, increased recording speed, and increased facility security.

Based on the survey results and analysis of existing advantages and challenges, several recommendations can be given to schools planning to adopt biometric technology: 1. Evaluation of Needs and Resources. Schools need to evaluate their specific needs for biometric technology and the resources available for implementation and maintenance. This includes

assessing the budget, existing technology infrastructure, and potential support from stakeholders. 2. Data Privacy and Security. Implementation must comply with privacy and data protection regulations. Schools should adopt strong data encryption and clear privacy policies to avoid privacy breaches. This includes establishing who has access to the data and how it will be used and stored. 3. Training and Education. Schools should provide adequate training for staff and students regarding biometric technology. This education is important to ensure that all users understand how the system works, its benefits, and how they can contribute to keeping biometric data secure. 4. Technical Support. Schools must ensure that there is adequate technical support for the maintenance and troubleshooting of biometric systems. This can be a trained internal IT team or a contract with a technology provider for ongoing support services. 5. Communication with Stakeholders. Involving parents, teachers, and students in the implementation process can help address concerns and increase acceptance of new technology. Transparency in communication about benefits, procedures, and data protection is key to gaining support from the school community.

CONCLUSION

Based on the results and discussion above, it can be concluded that applying biometric technology in attendance and security management in schools offers a significant solution in increasing accuracy, efficiency, and security. This technology enables the identification of individuals through unique physical characteristics, such as fingerprints, face, or iris, thereby reducing the risk of fraud in attendance recording and ensuring access only to authorized individuals. Biometric systems speed up the attendance recording process, reduce administrative workload, and provide real-time data critical in emergencies. While challenges such as high implementation costs and privacy concerns remain, solutions such as alternative funding and strict data protection policies can overcome these obstacles. Education and training for all stakeholders are also important to ensure acceptance of this technology. Overall, biometric technology improves physical security and provides a greater sense of security for the school community, making it an important component in a modern and effective school management strategy. With the right approach, biometric technology can create a safer and more efficient learning environment, supporting higher education goals.

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