E-ISSN: xxxx-xxxx
DOI: https://doi.org/10.64803/cessmuds.v1i1.14

QR Code-Based Attendance Systems in Education: A Systematic Literature Review on Data Accuracy and Sustainable School Management

Jodi Hendrawan[1], Ika Devi Perwitasari[2*], Fajar Maulana[3]

[1]Faculty of Computational Science and Digital Intelligence, Information System, Universitas Pembangunan Panca Budi, Medan, Indonesia
[2]Faculty of Computing and Meta-Technology, Computer Science and Digital Technology Department, Sultan Idris Education University, Perak, Malaysia; Faculty of Computational Science and Digital Intelligence, Information System, Universitas Pembangunan Panca Budi, Medan, Indonesia
[2]Informatics, Universitas Adzkia, Padang, Indonesia
E-mail: [1]jodihendrawan@dosen.pancabudi.ac.id, [2*]ikadeviperwitasari@dosen.pancabudi.ac.id, [3]fajar@adzkia.ac.id
*E-mail Corresponding Author: ikadeviperwitasari@dosen.pancabudi.ac.id

Abstract

Abstract: This study aims to evaluate the effectiveness of QR Code-based attendance systems in enhancing data accuracy and supporting sustainable school management. A Systematic Literature Review (SLR) was conducted using the PRISMA framework to analyze 9 selected articles published between 2015 and 2025. The review process involved identification, screening, eligibility assessment, and inclusion, with data extracted regarding research objectives, methods, respondents, applied technologies, and findings. The results indicate four major themes. First, efficiency was the most consistent advantage, as QR Code systems significantly reduced the time required for attendance and minimized administrative workload. Second, accuracy and reliability improved through automated digital records, reducing human errors and enabling evidence-based decision-making in educational institutions. Third, security was enhanced with innovations such as randomized QR, animated QR, and dynamic QR codes integrated with geofencing and IMEI validation, effectively preventing fraudulent practices like proxy attendance and buddy punching. Fourth, QR Code attendance systems demonstrated clear contributions to sustainable school management, particularly through integration with academic and financial systems, thereby promoting transparency and institutional accountability. This review concludes that QR Code-based attendance systems represent a simple yet strategic innovation with significant academic and managerial implications. Future research should focus on comparative studies across different QR Code models, long-term evaluations, and wider applications in primary and secondary schools to further strengthen digital transformation in education.

Keywords— QR Code; attendance system; data accuracy; security; sustainable school management; systematic literature review.

I. INTRODUCTION

The development of digital technology over the past decade has brought significant transformations to various aspects of life, including education. One increasingly prominent innovation is the use of QR Code-based attendance systems in schools and universities. While attendance may seem like a routine administrative task, it has broad implications for educational management, from student performance evaluation to human resource administration. Traditional manual methods such as roll calls and signature sheets are often time-consuming and prone to errors. In response, QR Codes have emerged as a faster, more practical, and cost-effective solution (Koh et al., 2017), reducing the administrative burden while creating opportunities for integration with broader school management systems.

Literature consistently shows that efficiency is one of the key advantages of QR Code-based attendance. Studies confirm that a process that usually takes minutes can be reduced to seconds when students scan a QR code linked to institutional databases (Irawan et al., 2024; Stupina et al., 2021). This automation not only minimizes classroom disruption but also reduces human error, thereby enhancing data accuracy. Attendance data collected digitally can be directly analyzed for academic and administrative purposes, such as tracking discipline, identifying attendance patterns, and linking these to academic outcomes (Ilham & Yuniarti, 2022; Sunarjo et al., 2024). This positions QR-based attendance not merely as a recording tool but as a strategic instrument for data-driven decision-making.

Another significant strength of QR-based systems is their ability to foster connectivity with stakeholders. For example, Galgo (2020) demonstrated that QR systems can send instant notifications to parents, encouraging family involvement and accountability. This aligns with sustainable education practices, where transparency

and participation are essential. Thus, attendance management becomes more than internal recordkeeping—it transforms into a communication tool that extends benefits across the educational ecosystem.

Nevertheless, challenges persist. Dependence on infrastructure, such as stable internet and compatible devices, can hinder adoption in resource-limited environments (Karia et al., 2019). Risks of misuse, such as students sharing codes to falsify attendance, threaten the integrity of data (Mohammed & Zidan, 2023). During the COVID-19 pandemic, digital literacy disparities among students also affected system effectiveness (Abdellatif et al., 2022). These challenges underscore the importance of robust system design and readiness in infrastructure and user training.

From a broader perspective, the relevance of QR Code attendance systems is tied to the agenda of sustainable school management. Sustainability in education emphasizes efficiency, accountability, and transparency (Alam, 2022; Al-Rahmi et al., 2019). By automating attendance, teachers and staff can dedicate more time to pedagogy rather than routine tasks (Caytuiro-Silva et al., 2024). Integrating QR Codes into systems such as e-Class or financial administration demonstrates how attendance can directly support governance and institutional sustainability (Scholtz et al., 2018; Winanti et al., 2024).

Adoption success is also influenced by technology acceptance factors. According to the Technology Acceptance Model (TAM), perceived ease of use and perceived usefulness are critical to user uptake (Riantini et al., 2021). Evidence shows that age, educational background, and attitudes toward technology affect acceptance levels (Jansen-Kosterink et al., 2021; Nzabonimana et al., 2024). Well-designed, user-friendly QR systems have been shown to increase student and teacher engagement (Camilleri & Camilleri, 2022; Krochinak et al., 2022). These psychosocial dimensions are therefore essential considerations for sustainable implementation.

Despite growing interest in QR Code-based attendance systems, several research gaps remain. First, most studies focus on technical design, while the link to sustainable school management practices has been less explored. Second, there is limited analysis connecting attendance accuracy to accountability and transparency in governance. Third, while technological innovations such as randomized QR, dynamic QR, animated QR, and blockchain-enhanced systems have been introduced, they have not been systematically compared.

This study addresses these gaps through a Systematic Literature Review (SLR) to evaluate the effectiveness of QR Code-based attendance systems. Specifically, it explores their role in enhancing data accuracy and their contribution to sustainable school management. This review aims to provide both theoretical contributions to the literature on digital education management and practical insights for institutions considering adoption. Accordingly, the central research question is: “What is the effectiveness of QR Code-based attendance systems in improving data accuracy and supporting sustainable school management based on evidence from a Systematic Literature Review?”

II. RESEARCH METHODOLOGY

This study employed a Systematic Literature Review (SLR) approach to analyze the effectiveness of a QR Code-based attendance system in improving attendance data accuracy and supporting sustainable school management. SLR was chosen because it synthesizes relevant research findings, assesses methodological quality, and draws comprehensive conclusions from published findings.

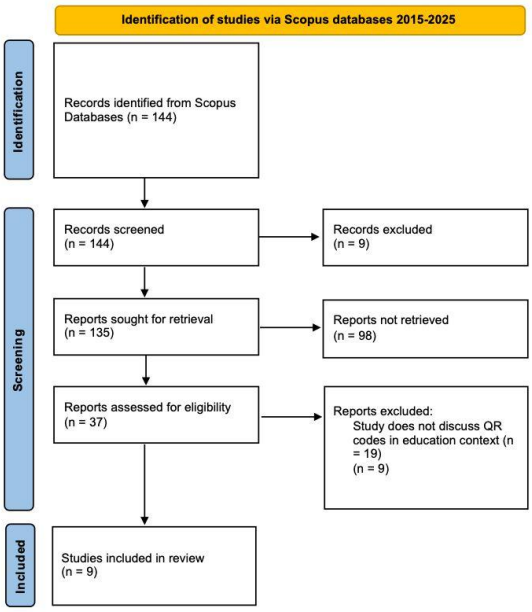

Figure 1. Prisma Study Flow Diagram

The research process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which include identification, screening, eligibility, and inclusion. During the identification stage, a literature search was conducted by Scopus databases, using keywords such as "QR Code attendance ". The search focused on the period from 2015 to 2025 to capture trends in the last decade, particularly the period of accelerated digital transformation due to the COVID-19 pandemic.

The initial search yielded 144 articles. Next, a screening phase was conducted to eliminate duplicates, non-journal articles, proceedings without full text, and article that not in english. After screening, 135 articles remained. The eligibility phase was conducted by reviewing the abstracts, methods, and results to assess compliance of 37 article with the inclusion criteria, namely: (1) the study discussed QR Code-based attendance systems

in educational institutions; (2) there was a clear report of objectives, methods, and results; (3) the study used an empirical approach (implementation, case studies, surveys, trials, or system development). Articles that were opinion pieces, editorials, or solely discussed QR technology without a connection to education were excluded.

In the final phase, 9 articles met the inclusion criteria for in-depth analysis. These articles covered a variety of contexts, from students and lecturers to teachers and school administrative staff. The research methods used in these articles varied, including system implementation, surveys, case studies, system trials, and qualitative approaches. This diversity broadens perspectives on the effectiveness and acceptability of QR Code-based attendance.

To maintain consistency, the data extraction process was conducted using an extraction form containing: author name and year, article title, research objectives, methods, sample or respondents, technology/variables used, and key findings. The data extraction results were then compiled into comparative tables to facilitate the identification of patterns, similarities, and differences between studies. Some articles focused on efficiency (e.g., Winanti et al. (2024); Stupina et al. (2021)), while others emphasized accuracy and security (Imanullah & Reswan (2022); Mohammed & Zidan (2023); Nwabuwe et al. (2023)), and integration with sustainable school management (Caytuiro-Silva et al., 2024).

Data analysis was conducted using thematic synthesis, which grouped research findings based on key emerging themes, such as efficiency, accuracy, security, management integration, and user acceptance. This technique was chosen because it highlights each article's contribution to a more comprehensive understanding.

With this SLR method design, the research is able to provide a comprehensive picture of the trend of QR Code attendance implementation in the educational context, while also emphasizing its contribution to strengthening sustainable school management.

III. RESULTS AND DISCUSSION

A. Results

The literature search, conducted according to the SLR protocol, yielded 9 articles that met the inclusion criteria and were relevant to the topic of the effectiveness of QR code-based attendance systems in education. These articles were published between 2018 and 2024, reflecting the increasing research trend associated with digital transformation and the need for more accurate attendance systems. The research contexts included students (6 studies), lecturers and administrative staff (1 study), school teachers (1 study), and system trials without direct respondents (2 studies). The countries of origin of the studies varied, including Malaysia, Russia, Indonesia, Egypt, and other countries, with a focus on the implementation of digital technology in education.

The research methods used were relatively diverse. Four articles used a systems development and technical implementation approach (e.g., Imanullah & Reswan (2022); Amirulloh et al. (2020); Siew et al. (2024)). Two articles used quantitative surveys to assess user perceptions (Abdellatif et al., 2022). One article was a case study (Mohammed & Zidan, 2023), while the other two used a proof-of-concept approach or system trials (Ayop et al., 2018; Nwabuwe et al., 2023). Another article used User Acceptance Testing (UAT) and prototyping to test integration with an academic management system (Winanti et al., 2024). This diversity of methodologies indicates that QR Code attendance was studied from both a technical perspective (system validation, application development) and a user perspective (satisfaction, perception, user experience).

The technologies used in the studies also varied, demonstrating the evolution of QR Code attendance systems:

Table 1. Technological Variations in QR Code Attendance Systems

No	*Technology Variation*	*Description / Function*	*References*
1	Static QR Code	Used as the base system for digital attendance	(Siew et al., 2024; Stupina et al., 2021)
2	QR Code + GPS / Geolocation	Validates user location to ensure presence	(Amirulloh et al., 2020; Ayop et al., 2018)
3	Location-Linked QR Code	Developed during the pandemic to enhance security & reliability	(Abdellatif et al., 2022)
4	Randomized QR Code + MAC Address	Strengthens security with randomized authentication	(Imanullah & Reswan, 2022)
5	Dynamic QR Code + Geofencing + IMEI	Prevents *buddy punching* and proxy attendance	(Nwabuwe et al., 2023)
6	Animated QR Code (2 codes/second)	Improves accuracy and reduces fraud	(Mohammed & Zidan, 2023)
7	QR Code integrated with e-Class	Supports lecturer management and financial administration	(Winanti et al., 2024)
8	QR Code Integrated with IoT	QR codes deliver instant resource access, while IoT handles	(Patil et al., 2023)

	data logging, monitoring, and integration for lab management

The results of the synthesis analysis revealed four major themes:

Table 2. Key Findings from the Systematic Literature Review

Theme	***Evidence from Studies***	***Key Insights***
Efficiency and Speed	(Ayop et al., 2018; Patil et al., 2023; Stupina et al., 2021)	QR-based attendance significantly accelerates attendance recording. Ayop (2018) showed QR + GPS not only speeds up validation but also provides accurate location data, perceived as more satisfying than manual methods.
Data Accuracy and Reliability	(Abdellatif et al., 2022; Mohammed & Zidan, 2023)	QR + location was rated *usable, reliable, secure, and accurate* by 132 medical students. Animated QR improved accuracy and user experience, reducing errors and ensuring more valid records.
Security and Fraud Prevention	(Abdellatif et al., 2022; Imanullah & Reswan, 2022; Nwabuwe et al., 2023)	Randomized QR reduced fraudulent practices via added authentication. Dynamic QR with geofence & IMEI prevented proxy attendance and buddy punching. Students confirmed QR systems as safer than manual methods.
Integration with Sustainable School Management	(Caytuiro-Silva et al., 2024; Patil et al., 2023; Winanti et al., 2024)	QR integrated into e-Class facilitated financial & administrative processes, increasing transparency and efficiency. Broader digital attendance also reduced the workload of school staff, supporting sustainable governance.

B. Discussion

The analysis of ten articles indicates that efficiency is the most consistent advantage of QR Code-based attendance systems. Studies by Stupina et al. (2021), Ayop et al. (2018), and Winanti et al. (2024) confirm that using QR Codes speeds up attendance recording compared to manual methods such as roll call. This aligns with the findings of Koh et al. (2017), which state that QR Codes can reduce attendance time by more than 50%. This efficiency is not only related to time but also relates to a reduction in the administrative burden on lecturers, teachers, and school staff. Caytuiro-Silva et al. (2024) emphasize that automated attendance allows educators to focus more on the primary task of teaching rather than managing attendance records. Thus, this study confirms previous literature and strengthens the argument that operational efficiency can be achieved through the implementation of QR Codes.

Table 3. Thematic Matrix of Selected Articles (n=9)

Article / Theme	***Efficiency***	***Accuracy***	***Security***	***Sustainability / Integration***
(Nwabuwe et al., 2023)	–	–	✓	–
(Patil et al., 2023)	✓	–	–	✓
(Stupina et al., 2021)	✓	–	–	–
(Amirulloh et al., 2020)	✓	✓	–	–
(Ayop et al., 2018)	✓	–	–	–
(Abdellatif et al., 2022)	–	✓	✓	–
(Mohammed & Zidan, 2023)	–	✓	✓	–
(Winanti et al., 2024)	✓	✓	–	✓
(Siew et al., 2024)	✓	✓	–	–

In addition to efficiency, the theme of attendance data accuracy emerged strongly in the study by Abdellatif et al. (2022), Mohammed & Zidan (2023), and Siew et al. (2024). QR Codes have been shown to produce more valid attendance data and reduce manual recording errors. Abdellatif et al. (2022) reported that 132 medical students rated the QR + location system as usable, reliable, secure, and accurate. This supports the findings of Khamdamov et al. (2020) who emphasized the importance of data accuracy in educational management information

systems. Moreover, Ilham & Yuniarti (2022) added that accurate attendance data is a crucial indicator in institutional evaluation and education funding allocation. These findings indicate that QR Code attendance not only assists with attendance recording but also contributes to improving data quality, which serves as the basis for strategic decision-making in school management.

Security issues are a major focus in the literature and research findings. Nwabuwe et al. (2023) developed a system using dynamic QR codes, geofencing, and IMEI, which proved effective in preventing buddy punching and fake attendance. Imanullah & Reswan (2022) also confirmed that randomized QR codes with MAC address authentication can minimize the risk of fraud. Mohammed & Zidan (2023) even introduced animated QR codes with two per second, which increased accuracy and real-time attendance. These findings align with Karia et al. (2019), who warned of potential vulnerabilities if the system only uses static QR codes without additional validation mechanisms. Abdellatif et al. (2022) also found that students perceived the system as more secure than manual methods. Therefore, it can be emphasized that strengthening security aspects is key to the sustainability of digital attendance systems, ensuring that the advantages of efficiency and accuracy are not compromised by the risk of fraud.

One of the most significant contributions of this research is its connection to sustainable education management. The article by Winanti et al. (2024) shows that integrating QR codes with e-Class not only facilitates attendance recording but also connects directly to the lecturer payroll system. This supports the literature by Scholtz et al. (2018), which emphasizes the importance of a business intelligence framework in managing sustainable education data. Similarly, Alam (2022) noted that continuing education requires a transformational approach that combines efficiency, transparency, and accountability. Thus, the results of this study not only demonstrate the technical superiority of QR Codes but also confirm their contribution to the managerial and institutional policy dimensions.

The results also show relatively high user acceptance of QR Code attendance. Abdellatif et al. (2022) found that medical students rated the QR + location system as easy to use, reliable, and secure. This aligns with the Technology Acceptance Model (TAM), which states that perceived ease of use and perceived usefulness are key factors in technology adoption (Riantini et al., 2021). Research by Winanti et al. (2024) also showed that integrating QR Codes into e-Class increased user satisfaction, which aligns with the study by Jansen-Kosterink et al. (2021) that age and attitudes toward technology influence acceptance. These findings reinforce the literature that technology adoption in education depends not only on technical factors but also on user perception, comfort, and readiness.

Academically, this research makes an important contribution by filling a research gap. Most previous studies have focused on the technical aspects of QR Codes, such as scanning speed or reducing manual errors. However, this research broadens the perspective by emphasizing the connection between QR Code attendance and the principles of sustainable school management. Thus, the academic contribution of this research is to enrich the literature on digital education management and provide an understanding of how simple technologies like QR Codes can have a significant impact on educational governance.

From a practical perspective, this research provides recommendations for schools and universities. First, QR Code attendance systems should not be standalone but integrated with academic, financial, and human resource management systems. Second, to overcome infrastructure and digital literacy barriers, institutions need to provide user training, as noted by Hussain et al. (2020). Third, security models such as randomized QR or dynamic QR need to be considered to ensure the system is truly capable of preventing fraud. Thus, the practical implication of this research is that QR Codes can be an efficient, accurate, and secure education management solution that also supports institutional transparency.

At the policy level, the results of this study support the importance of accurate attendance data for evidence-based decision-making. Ilham & Yuniarti (2022) emphasized that attendance data is a crucial indicator for institutional evaluation and is directly linked to funding. With the support of digital technology, educational institutions can increase transparency and accountability in governance. This provides a basis for governments and education administrators to adopt QR Code attendance as part of their sustainable digital transformation strategy for education.

This study has several limitations. First, it only analyzed ten articles, so the data coverage is relatively limited. Second, the majority of articles are from higher education contexts, so generalization to elementary or secondary schools is limited. Third, most of the studies are small-scale trials or prototypes, so long-term evaluations are not yet available. Fourth, there are no international standards regarding the implementation of QR Code attendance (whether static, randomized, animated, or dynamic). This provides an opportunity for further research, including direct comparisons across various technologies on a large scale.

Overall, this discussion confirms that QR Code-based attendance is not only superior in technical aspects such as efficiency and accuracy, but also has significant implications for security, user acceptance, and sustainability of school management. This research supports previous literature (Alam, 2022; Caytuiro-Silva et al., 2024; Khamdamov et al., 2020; Koh et al., 2017) and

expands upon it by emphasizing the integration of QR Codes into sustainable education governance. Thus, this research makes important academic and practical contributions and opens the door to further research on the standardization and evaluation of QR Code attendance implementation at various levels of education.

IV. CONCLUSION

This study presents a synthesis of 9 selected articles using a Systematic Literature Review (SLR) approach to assess the effectiveness of a QR Code-based attendance system in improving data accuracy and supporting sustainable school management. The study results reveal four key findings. First, efficiency is the most consistent advantage, with QR Codes accelerating attendance recording, reducing administrative burdens, and enabling educators to focus more on learning (Ayop et al., 2018; Stupina et al., 2021; Winanti et al., 2024). Second, data accuracy is also prominent, with QR codes proven to produce more valid attendance records, reduce manual errors, and support strategic decision-making in education management (Abdellatif et al., 2022; Mohammed & Zidan, 2023).

Third, security is a primary concern, with innovations such as randomized QR codes, animated QR codes, and dynamic QR codes based on geofencing and IMEI cards proven effective in preventing fraudulent practices such as buddy punching (Imanullah & Reswan, 2022; Nwabuwe et al., 2023). Fourth, this study demonstrates the contribution of QR Code attendance to sustainable school management, particularly through integration with academic and financial systems, as demonstrated by Winanti et al. (2024). Thus, this study not only confirms the technical benefits of QR Codes but also strengthens the literature on the digitalization of educational governance.

Academically, this study enriches the literature by filling a research gap, namely the connection between digital attendance systems and the principles of sustainable school management. Practically, this study provides guidance for educational institutions to adopt QR Codes not only as an attendance recording tool, but as an integral part of a broader information management system.

V. RECOMMENDATIONS

Several suggestions can be made for future research. First, a comparative study is needed across various QR technologies (static, randomized, animated, and dynamic) to determine the most secure and efficient implementation standards. Second, research needs to be expanded to elementary and secondary schools, given that the majority of current studies focus on higher education. Third, a long-term evaluation is needed to assess the sustainability of implementation, including the impact on organizational culture, cost efficiency, and governance transparency. Fourth, integration with other technologies such as blockchain or cloud-based analytics can be explored to strengthen data security, accountability, and predictability.

With these considerations in mind, QR Code-based attendance has great potential as a simple yet strategic innovation to support the efficiency, accuracy, and sustainability of education management in the digital age.

VI. REFERENCES

Abdellatif, H., Sirasanagandlae, S. R., Al-Mushaiqri, M., & Sakr, H. F. (2022). Location-Linked QR Code as a Safe Tool for Recording Classroom Attendance During COVID-19 Pandemic: Perspectives of Medical Students. *Medical Science Educator*, *32*(5), 971–974. https://doi.org/10.1007/s40670-022-01625-7

Alam, A. (2022). Mapping a Sustainable Future Through Conceptualization of Transformative Learning Framework, Education for Sustainable Development, Critical Reflection, and Responsible Citizenship: An Exploration of Pedagogies for Twenty-First Century Learning. *Ecs Transactions*, *107*(1), 9827–9840. https://doi.org/10.1149/10701.9827ecst

Al-Rahmi, W. M., Yahaya, N., Aldraiweesh, A., Alturki, U., Alamri, M. M., Saud, M., Kamin, Y., Aljeraiwi, A. A., & Alhamed, O. A. (2019). Big Data Adoption and Knowledge Management Sharing: An Empirical Investigation on Their Adoption and Sustainability as a Purpose of Education. *Ieee Access*, *7*, 47245–47258. https://doi.org/10.1109/access.2019.2906668

Amirulloh, I., Iskandar, I. D., Apriyani, Y., Warnilah, A. I., Purnia, D. S., & Surahman, M. (2020). Teacher Attendance Monitoring System Teaching with QR-Code and Geo Location using Android Platform. *Journal of Physics: Conference Series*, *1641*(1). https://doi.org/10.1088/1742-6596/1641/1/012030

Ayop, Z., Lin, C. Y., Anawar, S., Hamid, E., & Azhar, M. S. (2018). Location-aware event attendance system using QR code and GPS technology. *International Journal of Advanced Computer Science and Applications*, *9*(9). https://doi.org/10.14569/ijacsa.2018.090959

Camilleri, M. A., & Camilleri, A. C. (2022). *Utilitarian and Intrinsic Motivations to Use*

Mobile Learning Technologies: An Extended Technology Acceptance Model. 76–81. https://doi.org/10.1145/3545922.3545935

Caytuiro-Silva, N. E., Maraza-Quispe, B., Castro-Gutiérrez, E., Paredes, K. R., Sulla-Torres, J. A., Alcázar-Holguin, M. A., & Choquehuanca-Quispe, W. (2024). Optimizing Attendance Management in Educational Institutions Through Mobile Technologies: A Machine Learning and Cloud Computing Approach. *International Journal of Interactive Mobile Technologies (Ijim)*, *18*(12), 112–128. https://doi.org/10.3991/ijim.v18i12.46917

Galgo, J. J. (2020). Efficacy of Scan Attendance Manager Application Using Quick Response Code in Dagohoy National High School, Bohol, Philippines. *International Journal of English Language Studies*, *2*(4), 1–12. https://doi.org/10.32996/ijes.2020.2.4.1

Ilham, M., & Yuniarti, Y. (2022). Implementation of Management Information Systems to Enhance Educational Quality. *Idarah (Jurnal Pendidikan Dan Kependidikan)*, *6*(1), 15–26. https://doi.org/10.47766/idarah.v6i1.177

Imanullah, M., & Reswan, Y. (2022). Randomized QR-code scanning for a low-cost secured attendance system. *International Journal of Electrical and Computer Engineering*, *12*(4). https://doi.org/10.11591/ijece.v12i4.pp3762-3769

Irawan, A. I., Santoso, I. H., Istikmal, & Rahayu, M. (2024). Implementation of QR Code Attendance Security System Using RSA and Hash Algorithms. *Jurnal Nasional Teknik Elektro Dan Teknologi Informasi (Jnteti)*, *13*(1), 53–59. https://doi.org/10.22146/jnteti.v13i1.4395

Jansen-Kosterink, S., Hurmuz, M. Z., Ouden, M. E. d., & Velsen, L. v. (2021). Predictors to Use Mobile Apps for Monitoring COVID-19 Symptoms and Contact Tracing: Survey Among Dutch Citizens. *Jmir Formative Research*, *5*(12), e28416. https://doi.org/10.2196/28416

Karia, C. T., Hughes, A. D., & Carr, S. (2019). Uses of Quick Response Codes in Healthcare Education: A Scoping Review. *BMC Medical Education*, *19*(1). https://doi.org/10.1186/s12909-019-1876-4

Khamdamov, U., Abdullayev, A., Elov, J., & Sultanov, D. (2020). Conceptual Model of the Education Management Information System for Higher Education Institutions. *International Journal of Advanced Trends in Computer Science and Engineering*, *9*(5), 7295–7300. https://doi.org/10.30534/ijatcse/2020/59952020

Koh, K. C., Ariyananda, P. L., Gupta, E., Khajotia, R., Nagappan, S., Visuvanathan, V. V, Mahmood, M. M., Chua, S. H., & Chung, P. S. (2017). Medical Students' Perception on the Use of QR Code Versus Traditional Pen-and-Paper as an Attendance Record Tool in Medical School. *Journal of Mobile Technology in Medicine*, *6*(3), 2–6. https://doi.org/10.7309/jmtm.6.3.2

Krochinak, S., Cui, S., Ajayi, B., Egonu, R., & Kim, E. (2022). A Mixed-Methods Study of Secondary Student and Teacher Attitudes Towards Mobile Education Apps in Lagos. *Journal of Education Society and Behavioural Science*, 72–83. https://doi.org/10.9734/jesbs/2022/v35i121196

Mohammed, M., & Zidan, K. A. (2023). Enhancing Attendance Tracking Using Animated QR Codes: a Case Study. *Indonesian Journal of Electrical Engineering and Computer Science*, *31*(3), 1716. https://doi.org/10.11591/ijeecs.v31.i3.pp1716-1723

Nwabuwe, A., Sanghera, B., Alade, T., & Olajide, F. (2023). Fraud Mitigation in Attendance Monitoring Systems using Dynamic QR Code, Geofencing and IMEI Technologies. *International Journal of Advanced Computer Science and Applications*, *14*(4). https://doi.org/10.14569/IJACSA.2023.0140410 4

Nzabonimana, E., Malele-Kolisa, Y., & Hlongwa, P. (2024). The Feasibility and Acceptability of a Mobile Application for Oral Health Education Among Adults in Rwanda. *Clinical Cosmetic and Investigational Dentistry*, *Volume 16*, 359–369. https://doi.org/10.2147/ccide.s481599

Patil, V. K., Patil, K. D., Gaikwad, S., & Yadav, S. (2023). QR Code-Based Pedagogy for Laboratory Resource Management in Indian Higher Education Institutes. *Journal of Engineering Education Transformations*, *36*(4). https://doi.org/10.16920/jeet/2023/v36i4/23117

Riantini, R. E., Tjhin, V. U., & Atmojo, R. N. P. (2021). How Is the Adoption of Digital Marketing Services for Smart City Application Users? *Joiv International Journal on*

Informatics Visualization, *5*(1), 57–62. https://doi.org/10.30630/joiv.5.1.438

Scholtz, B., Calitz, A. P., & Haupt, R. (2018). A Business Intelligence Framework for Sustainability Information Management in Higher Education. *International Journal of Sustainability in Higher Education*, *19*(2), 266–290. https://doi.org/10.1108/ijshe-06-2016-0118

Siew, E. S. K., Chong, Z. Y., Sze, S. N., & Hardi, R. (2024). Streamlining Attendance Management in Education: A Web-Based System Combining Facial Recognition and QR Code Technology. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *33*(2). https://doi.org/10.37934/araset.33.2.198208

Stupina, M. V., Anistratenko, K. V., & Pazina, L. O. (2021). Using the QR code as a means of automating the process of accounting for attendance at educational classes. *Journal of Physics: Conference Series*, *2131*(2). https://doi.org/10.1088/1742-6596/2131/2/022077

Sunarjo, R. A., Chakim, M. H. R., Maulana, S., & Fitriani, G. (2024). Management of Educational Institutions Through Information Systems for Enhanced Efficiency and Decision-Making. *International Transactions on Education Technology (Itee)*, *3*(1), 47–61. https://doi.org/10.33050/itee.v3i1.670

Winanti, Nugroho, A., Haryanto, B., Supiana, N., & Fernando, E. (2024). Integrating QR Code to e-Class System forManaging Attendance Lecture Services in HigherEducation. *International Journal of Information Engineering and Electronic Business*, *16*(4), 93–104. https://doi.org/10.5815/ijieeb.2024.04.06