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Improving Employee Engagement and Productivity at Federal Polytechnic Kabo: Design and Implementation of Digital Attendance Systems for Staff and Students

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Abstract **Original Research Article**

Employee engagement and productivity are widely recognized as critical indicators of institutional effectiveness in higher education. Traditional methods of recording attendance such as manual roll calls and paper based sign in sheets, remain common in many institutions. However, these approaches are inefficient, time consuming, manipulation and susceptible to human error. To overcome these limitations, digital attendance management systems have been developed, particularly those utilizing Quick Response (QR-code) authentication. While these systems offer improvements in attendance automation and data management, many solutions still face challenges related to security vulnerabilities, implementation costs and overall usability.

This study presents design and implementation of a secure QR code based digital attendance management system for staff and students at Federal Polytechnic Kabo. The system used Laravel framework, utilizing the Model View Controller architecture. The backend is powered by PHP, while the user interface was designed using HTML, CSS, and JavaScript. Data management is deployed on a dedicated Apache web server to enhance security and operational performance.

The results indicate the system performance and highlight the effectiveness of cost efficient database management, representing a significant improvement over conventional QR based attendance systems. The integration of additional security mechanisms, including QR code expiration and screenshot prevention, addresses critical weaknesses in existing systems.

Furthermore, the system enables management to access a reporting dashboard to monitor staff absenteeism and lecture attendance trends, thereby supporting improved institutional governance and decision making. Overall, the proposed QR code based system offers a modern and reliable solution for attendance management in newly established and rapidly growing tertiary institutions, enhancing student participation while significantly improving administrative efficiency and accuracy in attendance monitoring

Keywords: Digital Attendance System, Backend, Frontend, QR-code, HTML, JAVA Scripts, PHP..

1. Introduction

Digital transformation become essential for effective governance and service delivery in tertiary institutions. Among the core administrative functions of educational institutions, attendance management plays a critical role in payroll administration, performance evaluation, workforce planning and institutional accountability. Despite significant advances in information and communication technologies, many tertiary institutions in Nigeria continue to rely on manual attendance register systems that are prone to error, inefficient, vulnerable to impersonation and data loss.

Globally, the Fourth Industrial Revolution has reshaped organizational management through the integration of digital technologies into operational and performance-monitoring processes [4]. In higher institutions, attendance management systems have evolved from manual registers to more advanced technologies such as biometric authentication, radio-frequency identification (RFID), and mobile-enabled platforms [8]. These technologies improve accuracy, reduce administrative workload, and promote institutional transparency. However, their adoption in resource constrained environments remains limited due to financial, infrastructural, and maintenance challenges.

Nigeria's tertiary education sector comprising universities, polytechnics, and colleges of education continues to face governance constraints, infrastructural deficits, and outdated administrative systems despite its rapid expansion in recent years **[12]–[14].**

Manual attendance processes, which are widely used in many federal polytechnics, are not only inefficient but also incapable of generating reliable analytics for evidence based decision making. Over time, such inefficiencies can negatively affect employee morale, weaken institutional engagement, and diminish trust in administrative processes [19].

Established in 2023 in Kano State, Federal Polytechnic Kabo exemplifies many of these systemic challenges. With approximately 400 staff and 2,000 students, the institution relies primarily on manual attendance registers. This practice has resulted in incomplete records, limited monitoring of lateness and absenteeism trends, and increasing administrative workload. These operational constraints are further compounded by limited digital infrastructure and varying levels of digital literacy among staff and students. Consequently, any proposed solution must balance technological robustness with affordability, sustainability, and ease of deployment.

At Federal Polytechnic Kabo, attendance monitoring for both staff and students has traditionally been paper based. This approach has resulted in delayed reporting, limited real time oversight, inaccurate documentation, increased absenteeism, and a growing administrative burden.

As staff numbers and student enrollment continue to rise, these shortcomings have become increasingly evident, highlighting the urgent need for a secure, automated, and scalable attendance management system.

To address these limitations, this study proposes the design and implementation of a secure, dynamically generated QR-code–based attendance management system tailored to the operational context at Federal Polytechnic Kabo.

The proposed framework incorporates encrypted QR payloads, time-bound validation tokens, hybrid authentication mechanisms, centralized MySQL database integration, role-based access control, and real-time analytics dashboards. The system architecture is designed to ensure scalability, fault tolerance, data integrity and minimal infrastructure dependency.

By transitioning from manual registers to a secure digital attendance platform, the institution can modernize its administrative processes while promoting transparency, accountability, and data-driven governance. Ultimately, the proposed system aims to enhance employee engagement, improve productivity, strengthen institutional oversight, and provide a sustainable model for digital transformation in Nigerian polytechnics and similar higher education institutions.

By combining cost-effective QR-code authentication with a centralized digital database, the system improves data integrity, reduces administrative workload, and supports evidence-based decision-making. Consequently, the proposed approach provides a practical, efficient, and sustainable attendance management solution suitable for institutions with limited technological resources.

2. Related Work

Attendance management systems constitute a fundamental component of administrative control in academic and organizational environments. Traditional manual attendance recording methods are widely criticized for their susceptibility to human error, delayed in reporting, excessive administrative workload, and vulnerability to impersonation. These limitations have motivated the adoption of digital attendance systems designed to improve operational efficiency, accuracy, and accountability. Contemporary studies consistently demonstrate that automated attendance solutions particularly those based on QR-code technology significantly enhance transparency, data integrity, and productivity within institutional settings [4].

Multiples attendance management technologies have been made to address these challenges, including biometric fingerprint systems, facial recognition systems, RFID cards, while biometric systems offer high authentication accuracy, they require substantial capital investment, stable electricity supply, routine calibration, and specialized technical support. They may also raise privacy and hygiene concerns, particularly in post-pandemic contexts [15]. RFID systems provide faster processing speeds but involve higher per-user costs and recurring expenses related to hardware maintenance and card replacement [17].

In contrast, Quick Response Code (QR- Code) based attendance systems provide a cost effective and scalable alternative that is well suited to resource limited educational environments [3]. QR codes store large amounts of data, support built in error correction, and can be easily scanned using widely available android devices such as smartphones without requiring complicated hardware. Furthermore, integration with centralized databases enables real time monitoring, automated reporting, predictive analytics, and secure audit logging [7].

Despite these advantages, many existing QR-code attendance solutions remain limited by static code generation, limited scalability, inadequate encryption mechanisms, and weak integration with institutional information systems.

Fig 1: QR Code

2.1 Evolution of Digital Attendance Systems

The evolution of automated attendance management systems reflects a continuous effort to balance record accuracy with administrative efficiency, as established by Kumar et al. [16] and [21], who demonstrate that digital frameworks support institutional accountability and mitigate absenteeism. While biometric

solutions involving fingerprint and facial recognition offer superior identification accuracy, their adoption is frequently hindered by high capital expenditures for specialized hardware, hygiene sensitivities, and intensifying data privacy concerns [8]. Similarly, while Radio Frequency Identification (RFID) improves scanning speeds, it introduces recurring logistical costs and hardware maintenance that may be unsustainable for resource constrained environments. In contrast, QR-code-based architectures have emerged as a highly scalable and cost-effective alternative, leveraging the universal compatibility of mobile devices and robust error correction capabilities for dynamic authentication. However, a critical gap remains regarding the vulnerability of standard QR systems to proxy attendance through code sharing. This study addresses this limitation by integrating expiring session identifiers and screenshot prevention mechanisms, thereby bridging the gap between the logistical advantages of QR based systems and the rigorous security requirements of modern institutional governance.

2.2 Impact on Engagement and Productivity

The implementation of digital attendance systems extends beyond simple operational efficiency, significantly influencing behavioral and organizational outcomes. As noted by [17], automated monitoring encourages a culture of punctuality and heightened employee engagement, thereby reinforcing institutional discipline. However, the productivity gains by these systems are frequently undermined by technical vulnerabilities such as card sharing and inadequate authentication [3]. By moving beyond mere attendance capture and integrating data with productivity monitoring tools and decision support dashboards, institutions can transform records into actionable insights. This research addresses this limitation by hardening the security of the process through anti proxy mechanisms and providing a comprehensive analytical dashboard. Such integration ensures that attendance tracking serves as a catalyst for improved governance, ultimately driving sustained engagement and measurable gains in institutional productivity.

2.6 Optimization of the Proposed System

Despite the increasing adoption of QR code based attendance systems in educational institutions, existing studies largely focus on basic attendance automation, with limited attention given to management integration and broader institutional governance support. Most previously developed systems primarily emphasize QR code generation and scanning for attendance capture, while providing inadequate mechanisms for preventing proxy attendance or generating analytical insights that can support administrative decision making. In addition, many implementations lack scalable system architectures and centralized data management frameworks capable of supporting both staff and student attendance monitoring within a unified platform.

To address these limitations, the proposed system for Federal Polytechnic Kabo introduces an optimized QR code based attendance framework that integrates secure dynamic QR code generation and server side validation mechanisms to enhance system security and operational reliability. Beyond basic attendance recording, the system incorporates automated reporting and leave management modules within a centralized web-based platform supported by database and access control.

By combining secure authentication with driven administrative tools, the proposed framework extends beyond conventional attendance systems and provides a more comprehensive and institution-oriented solution tailored to the operational needs of tertiary institutions, particularly in resource-constrained environments [31].

3. Methodology

This section present design methodology for the development of a secure, QR Code based attendance management system for Federal Polytechnic Kabo staff and student. The system comprises four primary user classifications, each defined by distinct operational responsibilities.

The method followed focuses on Data collections, System Analysis, Network Design, System Hardware Configuration (Scanner and Server), Implementation of System Software

(Database and Interface), Simulation and testing. The approach integrates dynamic QR code generation, mobile scanning technology, displaying the user information's, and stored in centralized database management to automate attendance recording.

Each phase contributes in achieving the objective of building a reliable platform.

1. **Admin:** Responsible for system initialization, staff provisioning, and information management.
2. **Lecturer:** Acts as the primary data source for students scheduling, coordinating directly with the Administrator.
3. **Students:** Generate attendance records via a QR code authentication interface using smart phone
4. **Management:** Exercises administrative oversight through the monitoring and generated attendance report

4. Results and Discussion

This section discussed the results obtained from the design and implementation of the proposed secure QR code based attendance management system. The results shows how the developed system improves attendance recording efficiency, enhances security and remove the limitations associated with conventional manual attendance systems. The evaluation is based on the implementation stages described in the methodology. Figure 2 displays the proposed system architecture that captures all constituent elements and interactions within the system.

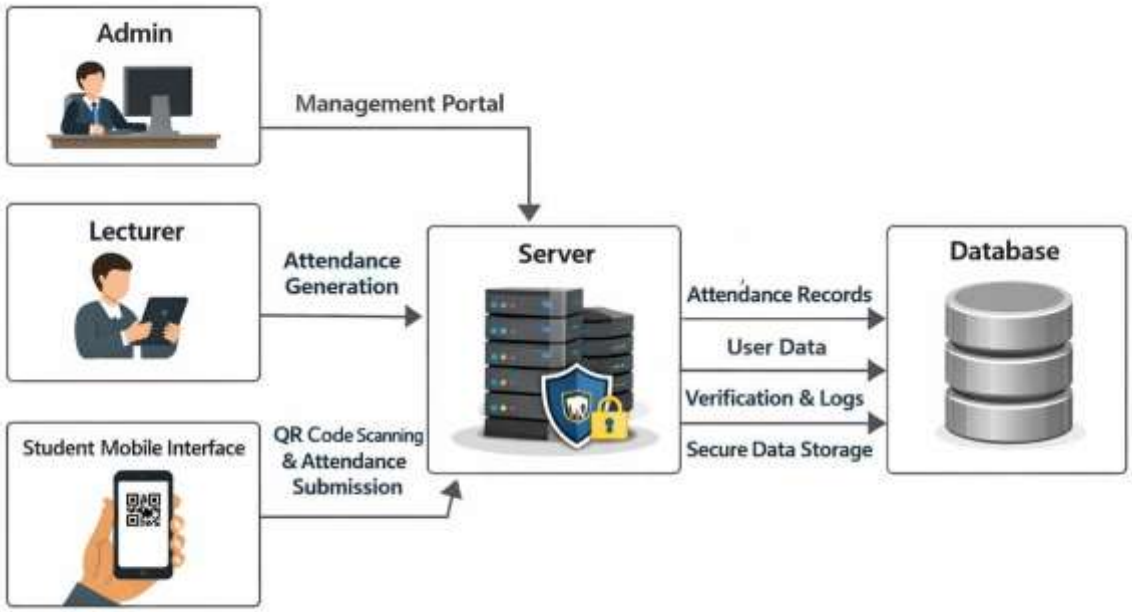

Figure 2: Proposed system Architecture of the secure QR-Code Attendance management system

4.1 System Implementation Overview

The proposed system was implemented using a client server architecture consisting of four primary functional modules: Administrator module, Lecturer module, Student authentication module, and Management monitoring module. A centralized server hosts the attendance database and system logic, while users interact with the system through web based and mobile interfaces. Figure 3 illustrates the proposed system architecture for the system, outlining the operational workflow among administrators, lecturers, and students. It highlights the integration of session creation, QR code

generation, scanning, and the subsequent server side verification and storage processes.

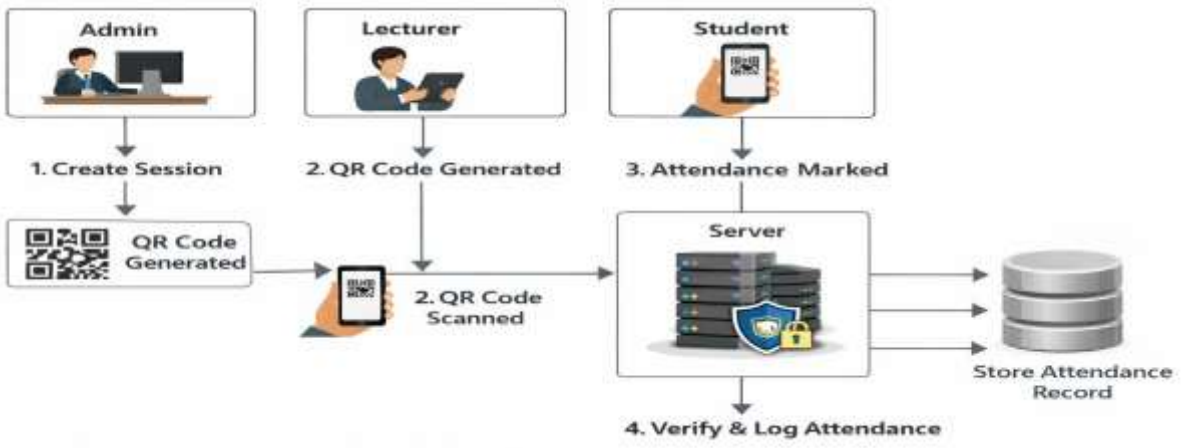

Figure 3: Operational Workflow of the QR Code Attendance System

4.2 Lecturer Session Creation and Dynamic QR Code Generation

In the implemented system, the lecturer initiates an attendance session for a specific course. Once the lecture session is created, the system dynamically generates a unique QR code associated with the lecture time, course identifier, and authentication token. This QR code is displayed to students for scanning during the lecture.

Figure 4: Dynamically Generated QR Code for Course (CTE 115, Data Structure and Algorithm) Attendance Authentication.

Testing confirmed that each generated QR code contains user details including student ID, Name session and whether the user is authorize or not preventing duplication or reuse of the attendance token.

Student ID	Student Name	Scan Timestamp	Location Verificati
ND/CET/24/001	ABDULLAHI SHUAIBU	09:18:22 AM	Verified: CBT HALL
ND/CET/24/002	NAJIB SHAMSUDDEEN MUHAMMAD	09:18:25 AM	Verified: CBT HALL
ND/CET/24/003	MUTTAKA ALIYU ABDULLAHI	--	Not Scanned
ND/CET/24/004	SHARFADDINI IBRAHIM SANI	09:18:35 AM	Verified: CBT HALL

Figure 5: Real-Time Student Attendance List

4.3 Student Authentication and Attendance Recording

Figure 5 presents the fundamental operational workflow of the proposed attendance system. In the process, a student initially scans the QR code using a mobile device, after which the system displays the relevant course and lecture information for verification. Upon reviewing these details, the student submits the attendance request, and the system subsequently confirms that the attendance has been submitted and successfully recorded.

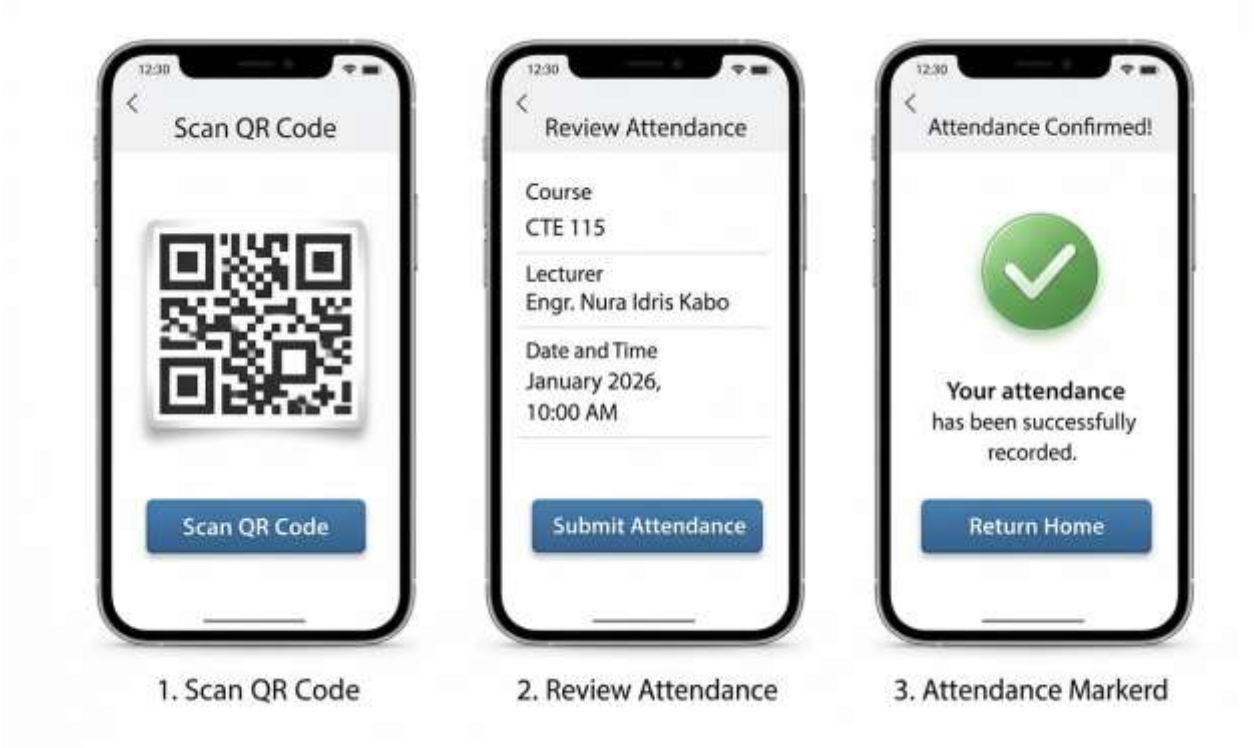

Figure 6: Student Mobile Interface for QR-Code Scanning and Attendance Submission.

4.4 Attendance Monitoring and Administrative Reporting

The figure presents a real time attendance monitoring summary which consist lecturer generates a QR code for the current class session, allowing students to scan the code to register their attendance. The system automatically records and analyzes the check in data, providing a students who are present, late, and absent, along with visual attendance statistics and a detailed list of individual student records with corresponding check-in times. This enables institutional management to effectively monitor attendance patterns and support informed decision-making. The same operational framework will also be applied to the staff of the institution, ensuring a consistent and standardized approach to attendance monitoring and management across all institutional personals.

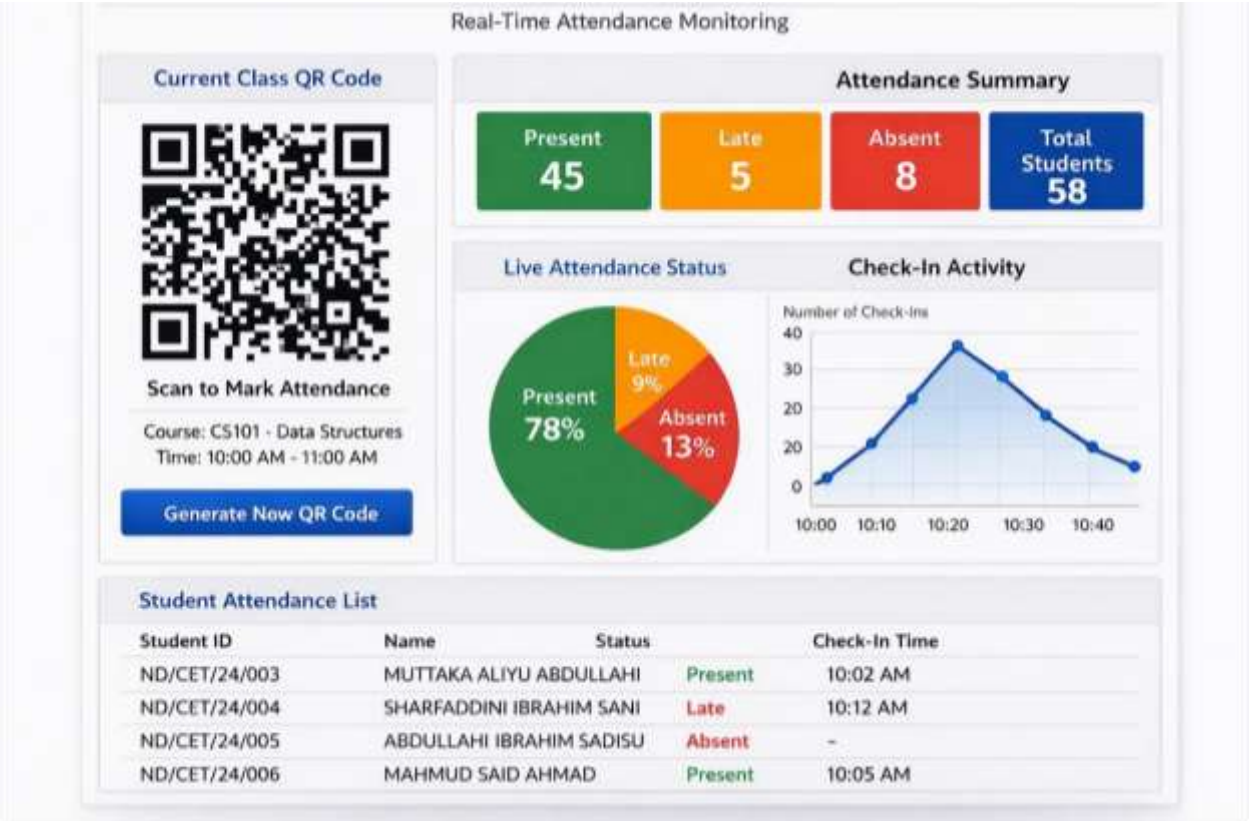

Figure 7: Lecturer Dashboard Showing Real-Time Attendance Monitoring.

4.6 Discussion of Results

The results confirm that the proposed QR code based attendance management system provides a reliable solution for modern academic institutions. The harmonization of mobile authentication, dynamic QR-code generation, and centralized database management enables efficient attendance recording while maintaining strong protection against manipulation or misuse. The system also improves administrative transparency through automated reporting and real time monitoring capabilities.

Overall, the findings indicate that the proposed system substantially enhances operational efficiency, security, and administrative transparency, thereby fostering improved employee engagement and productivity at the Federal Polytechnic, Kabo.

5. Conclusion

This study successfully designed and implementation a secure QR Code based digital attendance management system for Federal Polytechnic Kabo. The proposed system provides an efficient and cost effective solution for improving attendance accuracy, operational transparency, and institutional productivity. The results confirm high authentication reliability, rapid processing speed, and resilience against duplication and replay attacks.

6.0 Recommendations and Future Enhancements

To further strengthen system capability and long-term sustainability, the following enhancements are recommended:

1. Integration of hybrid verification mechanisms (e.g., optional facial verification for high-security sessions).
2. Implementation of machine learning models for absenteeism prediction and behavioral analytics.
3. Integration with institutional payroll and academic management systems for unified data processing.

These enhancements will expand the system from a secure attendance tool into a comprehensive institutional performance management platform.

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