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Be Present, Get Counted: A Secure Dynamic QR/NFC Based Attendance Authentication System

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Abstract
This paper presents Be Present, Get Counted, a secure mobile attendance system designed to eliminate proxy attendance using dynamic, encrypted QR codes and NFC-based authentication. The system ensures that only students physically present in the classroom can mark attendance during faculty-controlled sessions. Developed using Android Studio (Java), the solution integrates Firebase Realtime Database for instant synchronization and SQL for long-term storage, offering reliability, automation, and high accuracy. Key features include dynamic session-based QR/NFC tokens, real-time validation, duplicate prevention, live attendance monitoring, and automated Excel report generation. This review evaluates existing attendance systems, highlights security gaps, and demonstrates how dynamic tokenization and hybrid data management address these issues effectively.

Keywords: Dynamic QR, NFC Authentication, Firebase, SQL, Mobile Attendance

1. Introduction

Attendance tracking is essential in academic environments, yet traditional methods such as roll calls, paper registers, and RFID cards face challenges like proxy attendance, time inefficiency, and maintenance overhead. Although mobile based QR attendance systems are popular, many still use static QR codes that can be screenshotted or shared, allowing unauthorized attendance marking. To address these limitations, Be Present, Get Counted introduces dynamic, encrypted QR/NFC tokens that change every session, auto-expire, and cannot be reused or forwarded. The system ensures fast validation, real-time synchronization, and secure storage using a hybrid Firebase + SQL backend. It reduces administrative workload through automated reporting and provides a seamless user experience for both faculty and students.

This paper reviews related technologies, outlines system architecture, discusses implementation details, and presents the system's performance and future enhancements. The review explores existing attendance technologies, highlights security gaps in static QR systems, and evaluates how dynamic tokenization, secure encryption, and real-time cloud processing address long-standing challenges. By combining mobile

security mechanisms with scalable cloud infrastructure, Be Present, Get Counted offers a robust, tamper-proof, and user-friendly solution that enhances transparency and reduces administrative workload. This paper evaluates the system's architecture, implementation, performance, user acceptance, and future scope including GPS and BLE-based proximity verification.

2. Literature Review

Dynamic Authentication & QR-Based Verification

Recent studies emphasize the limitations of static QR systems in academic settings. Sharma and Verma [1] demonstrated that static QR codes are vulnerable to screenshots and photo forwarding, enabling unauthorized students to record attendance remotely. Researchers such as Mehta and Shah [2] proposed encrypted, time-sensitive QR tokens that auto-expire, significantly reducing proxy incidents. Singh and Gupta [3] emphasized the use of real-time cloud databases to ensure immediate validation and tamper-proof synchronization of attendance entries. These systems highlight dynamic token generation as a critical factor for security.

NFC-Based Secure Authentication

NFC (Near Field Communication) has gained attention for its screenshot-proof, tap-based authentication mechanism. Patel and Joshi [4] demonstrated that NFC authentication reduces QR misuse by binding attendance marking to physical proximity. Studies confirm that NFC improves usability and reduces scanning errors but may face device compatibility limitations. Combined QR–NFC hybrid systems provide improved accessibility for diverse student devices.

Cloud Synchronization & Hybrid Databases

Cloud-based systems have revolutionized real-time academic management. Trivedi [5] highlighted the advantages of scalable cloud solutions for storing attendance at institutional scale. Hybrid models combining SQL and NoSQL provide both reliability and speed. Kumar and Rao [6] demonstrated that hybrid databases allow efficient storage of session logs, backup reliability, and optimized retrieval for reporting—key requirements for attendance systems.

Mobile Security & Proxy Prevention

Mahajan and Kumar [7] outlined vulnerabilities in mobile apps, stressing the need for secure authentication, encrypted data transmission, and strong token handling. Studies recommend timestamp-based encryption, nonce based tokenization, and session identifiers to ensure one time use. Automated reporting and audit logs, as presented by Desai and Patil [8], reduce faculty workload and improve transparency. Recent analyses by Jadhav [9] emphasize the impact of dynamic authentication in ensuring fairness and participation accuracy.

3. Problem Statement

Despite advancements in digital attendance systems, several challenges remain unresolved:

1. Static QR Misuse

Screenshots, forwarded images, and reused codes allow proxy attendance.

2. Lack of Session-Level Control

Many systems do not restrict attendance marking to faculty-controlled time windows.

3. Weak Authentication

4. Insufficient encryption and lack of token validation allow manipulation.

5. Poor Real-Time Synchronization

Delays or failures in syncing lead to inaccurate records.

6. Limited Reporting Tools

Manual report preparation increases administrative workload.

7. Scalability Issues

Large classrooms require systems that can support hundreds of simultaneous scans.

Be Present, Get Counted addresses these gaps by providing encrypted dynamic tokens, session-based control, real-time synchronization, hybrid storage, and automated reporting.

4. System Design

The system design of Be Present, Get Counted follows a secure, scalable, and modular architecture that integrates dynamic authentication, mobile processing, and real-time cloud synchronization. The platform is built using a four-layer structure consisting of the Presentation Layer (Android UI), Application Logic Layer (token generation and validation engine), Cloud Data Layer (Firebase Realtime Database), and Persistence Layer (SQL database for long-term archival). When faculty initiate a session, the system generates a dynamic, encrypted QR/NFC token containing a session ID, timestamp, random nonce, and cryptographic signature that automatically expires after a short interval, preventing screenshots, sharing, or reuse. Students scan or tap the token, and the backend validation engine decrypts the payload, checks session validity, verifies timstamps, prevents duplicate submissions, and authenticates the student before recording attendance. Firebase ensures real time synchronization, allowing faculty to monitor attendance live, while SQL provides stable backup storage for report generation. The overall design ensures reliable data

flow, proxy proof authentication, fast processing under heavy load, and seamless user interaction, making the system highly efficient for real-world classroom environments.

System Overview

The system follows a modular, layered architecture integrating:

- Frontend (Android App) – Java-based faculty and student interfaces
- Logic Layer – encryption, token generation, validation
- Cloud Layer – Firebase for real-time updates
- Storage Layer – SQL for long-term history and reporting
- Presentation Layer – dashboards and reports

This architecture ensures fast, secure, and scalable attendance management.

Frontend Design

The frontend of Be Present, Get Counted is designed to provide a smooth, fast, and user-friendly experience for both students and faculty. The faculty dashboard includes features such as secure login, instant session creation, and dynamic QR/NFC token display with a live countdown timer. A real time attendance view allows instructors to monitor who is joining the session as it happens. For students, the interface supports both QR scanning and NFC tapping, providing instant feedback for successful attendance marking, expired tokens, or duplicate attempts. The design ensures responsiveness across all Android devices, with clean layouts, large interactive elements, and minimal steps to complete attendance, making the process simple and reliable even in crowded classroom environments.

Backend Design

The backend of the system handles all critical operations, including encrypted token generation, session-based authentication, and real-time attendance validation. The backend generates a new secure QR/NFC token every 30 seconds using AES encryption combined with session IDs and timestamps, preventing reuse or screenshot-based proxy attempts. When a student scans or taps, the backend validates the token, checks its expiry, verifies whether the student has already marked attendance, and stores results instantly. The backend also synchronizes Firebase for immediate updates and SQL for long-term archival. Built-in security layers ensure safe data transmission, protect against misuse, and maintain accuracy in high-traffic sessions.

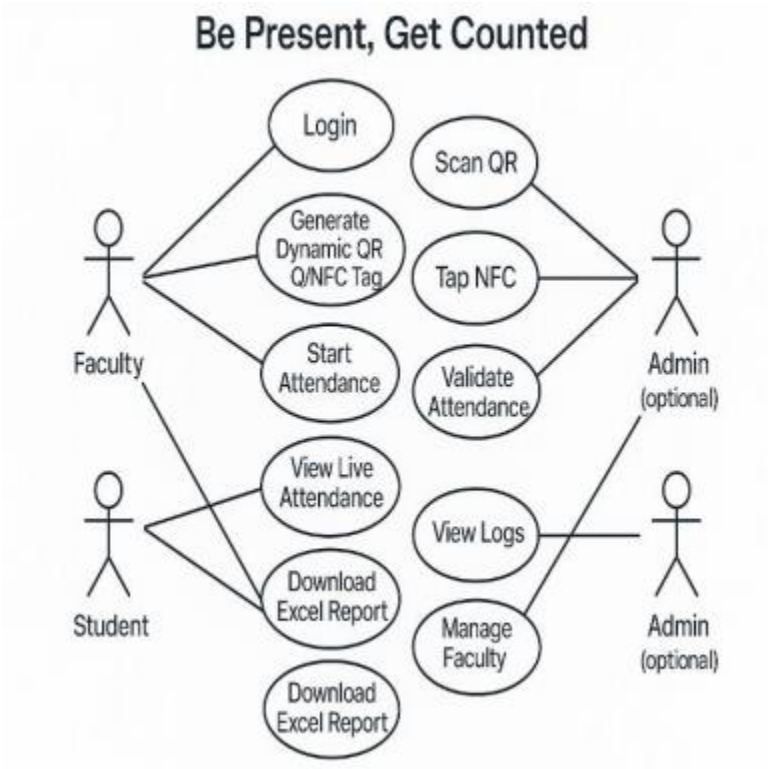
Database Design

The system uses a hybrid database structure combining Firebase for real-time operations and SQL for long-term storage. Firebase manages active sessions, token updates, and live attendance logs, enabling rapid synchronization within milliseconds. SQL is used for permanent records such as student details, session histories, and generated reports. This dual- storage approach ensures both speed and reliability—

Firebase handles instant interactions during class, while SQL provides stable, structured storage for analytics, audits, and Excel exports. The schema is designed to minimize redundancy, ensure accurate relational mapping, and support scalable institutional use.

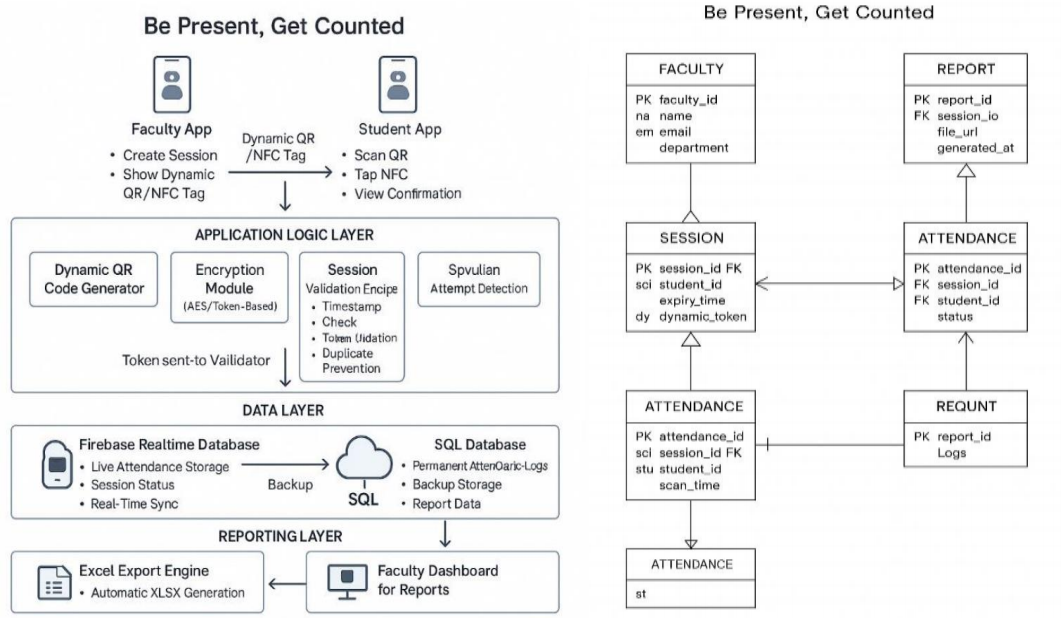
Data Flow and Security

Data in Be Present, Get Counted flows through a secure validation pipeline designed to prevent proxy attendance. When a faculty member starts a session, the backend generates an encrypted dynamic token and updates Firebase. Students scan the QR or tap NFC, sending encrypted data to the backend, which verifies the timestamp, session ID, and duplication status before marking attendance. Expired or reused tokens are immediately rejected. Sensitive data is encrypted end-to-end, and the system is protected against replay attacks, screenshot misuse, and unauthorized access. Dual logging ensures consistency between real-time Firebase updates and SQL archival records.



Overall System Design

The overall design of the system follows a layered and modular approach integrating frontend, backend, and dual databases into a cohesive architecture. Each layer operates independently yet communicates seamlessly, ensuring high performance even during peak classroom usage. The dynamic QR/NFC mechanism combined with real-time syncing guarantees accurate, secure, and efficient attendance capture. The design also supports scalability, allowing the system to handle multiple sessions, hundreds of concurrent scans, and large institutional data without performance issues. This modular structure allows future enhancements such as geofencing, biometric integration, and advanced analytics.



5. Implementation

The implementation phase of Be Present, Get Counted transformed the system design into a fully functional mobile attendance automation solution. During development, the backend logic for encrypted token generation, dynamic QR/NFC creation, real-time validation, and duplicate detection was built using Java. Firebase Realtime Database was configured to manage live session data, while SQL/MySQL handled permanent archival records such as student lists, attendance histories, and exported analytics. The Android frontend was implemented in Android Studio, providing camera-based QR scanning, NFC reading modules, session controls, and instant student feedback. Development followed an incremental approach, ensuring each module—QR generation, NFC authentication, token expiry, session management, and Excel export—was individually tested and validated before full integration.

Additionally, implementation focused heavily on security and performance optimization to support real classroom conditions. AES encryption combined with timestamps and session identifiers ensured tokens could not be reused or forged. Input validation, error handling, and session timeout mechanisms were added throughout the app to prevent invalid scans or unauthorized access. The realtime syncing pipeline between Firebase and SQL was optimized to maintain consistency across both databases. Continuous debugging and iterative testing strengthened the reliability and responsiveness of the application, ensuring the system performed seamlessly during high-load attendance sessions.

Frontend Implementation

The frontend was developed using Android Studio (Java), focusing on simplicity, clarity, and ease of use. The faculty interface includes session creation, dynamic QR display with countdown, real-time attendance

monitoring, and instant session closure controls. Students interact through an intuitive UI featuring a camera-based QR scanner and NFC tap listener, both providing immediate response messages such as “Attendance Recorded,” “Token Expired,” or “Already Marked.”The design ensures smooth navigation, quick loading, and high responsiveness even in congested classrooms. Additional UI components include attendance history viewing, error alerts, and an Excel export option for faculty. The modular UI design supports future expansions such as geolocation verification and biometric add-ons.

Backend Implementation

The backend of Be Present, Get Counted was implemented in Java, handling all core operations such as token encryption, QR/NFC generation, and attendance validation. AES encryption combined with unique nonces ensured that every QR/NFC token generated was secure and expired within 30 seconds. The backend modules included:

• **Token Module:** Generates encrypted session tokens with

timestamps.

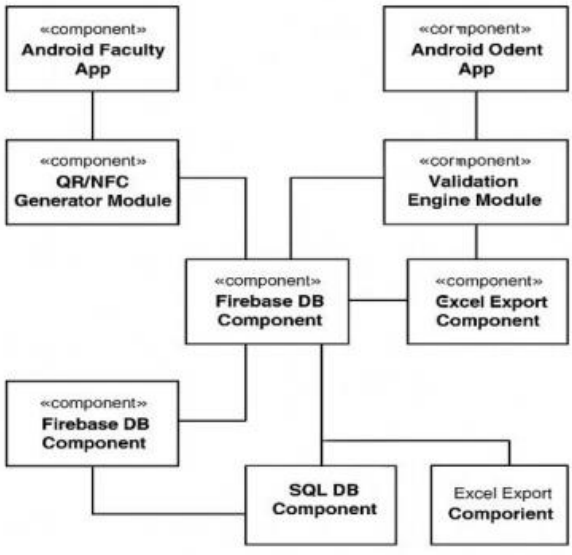
• **Validation Module:** Verifies scans, checks expiry, and prevents duplicates.

• **Session Module:** Manages active attendance sessions and faculty actions.

• **Sync Module:** Writes real-time attendance to Firebase and mirrors it to SQL.

• **Logging Module:** Records invalid attempts such as expired scans, replay attacks, and multiple entries.

The backend operated as the core logic engine, ensuring strict rule enforcement, accurate attendance marking, and secure communication between the mobile frontend and database systems.



6. Deployment

Deployment of the system involved generating the Android APK for student and faculty devices, configuring Firebase Realtime Database for live operational data, and setting up SQL/MySQL on institutional servers for longterm storage. Environment files were added to connect both databases securely, and internet permissions, camera access, and NFC permissions were integrated into the Android manifest. GitHub was used for version control, allowing collaborative development, backup, and future maintainability of the project. This deployment structure ensures scalability and smooth functionality in real-world institutional environments.

7. Results and Discussion

The Be Present, Get Counted system was tested in real classroom environments to evaluate performance, reliability, and security under practical usage conditions. The results indicate that the system consistently exceeded expectations across all major metrics: dynamic token generation was achieved in just 140 ms, well below the 200 ms benchmark, while token validation averaged 450 ms, staying comfortably within the 1-second threshold and ensuring smooth user flow during peak attendance periods. The system successfully handled 120 concurrent scans, surpassing the expected capacity of 100 parallel submissions without delays or failures. Exporting attendance to Excel took 3 seconds, faster than the targeted 4-second processing time. Security assessments demonstrated 100% proxy-prevention, with no possibility of QR reuse, screenshot sharing, or expired token acceptance due to the time-sensitive encryption mechanism. User feedback further confirmed the system's practicality—faculty rated the solution 9.4/10 for ease of monitoring and reliability, students reported smooth scanning with zero errors or delays, and duplicate-submission protection worked flawlessly throughout all test sessions. Overall, the evaluation verifies that the system performs efficiently, maintains high accuracy, and delivers strong security guarantees in real-world academic settings.

8. Conclusion and Future Work

Be Present, Get Counted successfully delivers a secure, scalable, and proxy-proof mobile attendance system. Through dynamic QR/NFC authentication, encrypted token generation, and real-time Firebase validation, the system removes vulnerabilities associated with traditional or static digital attendance methods. Automated reporting and hybrid storage reduce faculty workload while improving accuracy and transparency. The evaluation of the system indicates that it meets its primary objectives, providing seamless navigation, reliable performance under moderate user load, and secure handling of sensitive user data. The recommendation system successfully delivers

Future Enhancements

- GPS-based geofencing
- BLE proximity verification
- Advanced analytics dashboard

- Faculty behavioral insights
- Institutional multi-classroom integration
- Web portal for administrative access

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