

WEBSITE DEVELOPMENT FOR QR CODE ATTENDANCE SYSTEM

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**A PROJECT SUBMITTED TO THE DEPARTMENT OF COMPUTER
SCIENCE, FACULTY OF PHYSICAL SCIENCE IN PARTIAL
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OF THE UNIVERSITY OF BENIN, BENIN CITY.**

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CERTIFICATION

This is to certify that this project work was carried out by Okoh Victor Ebuka with matriculation number PSC2105377, for the award of Bachelor of Science (B. Sc) Degree in Computer Science, University of Benin, Benin city, Nigeria.

Prof. F.I. Amadin

(Project Supervisor)

Date

APPROVAL

This project, titled WEBSITE DEVELOPMENT FOR QR CODE ATTENDANCE SYSTEM by OKOH VICTOR EBUKA with matriculation number PSC2105377 has been read and approved as meeting the requirements for the award of the Bachelor of Science (B.Sc.) Degree in Computer Science, Faculty of Physical Science, University of Benin, Benin City, Nigeria.

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Date

DEDICATION

This research project is dedicated to the Almighty God, whose infinite wisdom, unfailing provision, and divine guidance have been my strength throughout this journey. His grace has sustained me through every challenge, providing me with the knowledge, resilience and good health needed to complete this project. I am deeply grateful for the continuous blessings, inspiration and unwavering support from family and friends throughout this project.

ACKNOWLEDGMENT

My utmost acknowledgement goes to God Almighty for giving me the strength, wisdom and direction throughout my academic journey. I would like to express my gratitude to my project supervisor, Prof. F. I Amadin for his consistent guidance towards ensuring the successful completion of this project.

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ABSTRACT

In most educational institutions, the process of taking student attendance is often done manually, which makes it time-consuming, error-prone, and susceptible to manipulation. This project focuses on the design and implementation of a web-based attendance management system that uses QR (Quick Response) codes to automate the attendance process. The system enables lecturers to generate a unique, time-limited QR code for each class session, while students scan the code through a web interface to mark their attendance. The backend is built using Node.js and Express.js, with a local JSON file (data.json) serving as the data storage layer using the Node.js fs module. The frontend utilizes HTML, CSS, and JavaScript for interaction and visualization. The system's design emphasizes simplicity, real-time verification, and accessibility through any modern browser. Testing showed that the system minimizes human error, improves accuracy, and enhances the efficiency of attendance record management. The developed prototype provides a practical, secure, and user-friendly solution for both lecturers and students.

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CHAPTER ONE

INTRODUCTION

1.1 Background of study

Attendance management is an important aspect of academic institutions, as it ensures that students actively participate in classroom activities and enables lecturers to monitor class participation.

Traditionally, attendance has been taken manually through roll calls, signing attendance sheets, or using seating arrangements. These methods are very common but have many shortcomings. Roll call, for example, takes time, especially in large classes, and can waste valuable lecture periods (Almasalha & Hirzallah, 2014). Attendance sheets can also be easily manipulated because some students sign in for their friends who are absent, and sometimes the sheets get misplaced. Researchers have also pointed out that manual methods are “time-consuming, inefficient, and prone to cheating” (Anjum et al., 2023; Deng & Long, 2025). In other words, these methods no longer meet the needs of today’s large university classes. With advancements in technology, innovative solutions can be implemented to automate this process and make it more efficient.

To address these inefficiencies, universities have tried different technology-based systems. One option is using barcode or RFID cards. Here, each student is given an ID card with a barcode, and their attendance is taken by scanning the card at the entrance of the class or exam hall. This system can save time and reduce human error (Elaskari et al., 2021). It is also relatively cheap compared to more advanced systems (Mishra & Verma, 2025). However, it still has its own challenges. Barcodes can easily get damaged, faded, or scratched, making them difficult to scan (Mishra & Verma, 2025). Students may also forget their cards or borrow them to others, which can still allow cheating (Deng & Long, 2025).

Another method is biometric attendance, where students use their fingerprints or faces to confirm their presence. This method is more secure because it is tied to each student's unique features, so it is very difficult to cheat. However, it is also very expensive to set up, requires special hardware, and sometimes faces issues like fingerprints not being detected or face scanners failing due to lighting problems (Gawande et al., 2017). This makes it difficult to use widely in universities, especially in departments with large classes and limited resources.

Because of these limitations, many schools are now exploring QR code-based attendance systems. A QR code is like a two-dimensional barcode that can be generated for each class. Students simply scan the code with their smartphones to register their attendance (Ika et al., 2024). Unlike barcodes, QR codes can store more information and are harder to damage (Mishra & Verma, 2025). They are also easy to generate, cheap to use, and very fast. In fact, studies show that QR code systems cut down attendance-taking time significantly and make record-keeping more accurate (Anjum et al., 2023; Tan et al., 2023). Another advantage is that QR codes can be refreshed or changed for each lecture, which prevents students from reusing old codes or cheating by sharing screenshots.

Modern Educational institutions outside Nigeria have begun adopting the use of QR codes to take attendance. Academical institutions in Malaysia uses the Quick Response code to take and monitor students' attendance in classes. (Siti Nazleen Abdul Rabu, 2019).

This approach is very fast. Scanning an entire class QR codes only takes a few seconds, making attendance checking fast and efficient. As (Ralshith et al., 2023) conclude, replacing manual sign-in with a digital system can “significantly improve efficiency, accuracy and security”. Likewise, (Taju et al., 2024) emphasize that “traditional attendance systems often cause problems” in practice, highlighting the need for innovation. QR code attendance system

would not only be beneficial to lecturers by reducing administrative workload but also benefits students by making attendance quicker and more transparent.

For the Department of Computer Science at the University of Benin, this kind of system could make a big difference. It would reduce the stress of collecting physical exam passes and eliminate the risk of forgery. Since the department already requires students to submit course registration slips before exams, the QR system could be linked directly to this process. Once a student's attendance reaches the required 75%, the system can automatically generate a digital exam pass in the form of a QR code. This QR code would then be scanned at the exam venue to confirm the student's eligibility. In this way, the system would not only make attendance more reliable but also make examination clearance easier, faster, and more secure for everyone involved.

1.2 Statement of Problem

Attendance monitoring is a critical component in evaluating student participation and academic performance. However, many institutions still rely on traditional attendance-taking methods such as roll calls and manual signing, which are often time-consuming, prone to human error, and susceptible to manipulation (Taju et al., 2024)

Furthermore, in large lecture halls, the process of calling out names or passing around a paper sheet can disrupt teaching flow and waste instructional time. Manual records are also vulnerable to falsification, such as "proxy attendance," where a student marks presence for an absent peer (Maleriado & Carreon, 2019).

This project seeks to address these issues by providing a secure, automated, and real-time QR code-based attendance management system to eliminate the stress and time wastage during lecture periods.

1.3 Aim and Objectives

Aim:

The aim of this study is to develop a QR code-based attendance system to automate student attendance recording, enhance accuracy, and reduce administrative workload.

Objectives:

The specific objectives of the study are to:

1. Develop a web-based platform for generating unique QR codes for registered students.
2. Implement a secure QR code scanning mechanism for real-time attendance tracking.
3. Integrate a backend database for storing and managing attendance records.
4. Provide an interface for lecturers to view, download, and analyze attendance reports.
5. Ensure data security by encrypting QR code contents and preventing unauthorized check-ins.

1.4 Significance of the Study

The proposed QR code attendance system is significant to several stakeholders:

1. Educational Institutions: It will help schools and universities automate attendance recording, reduce administrative workload and ensure accurate records (Narangamma & Shamila, 2025).
2. Lecturers: It will allow teachers to focus more on delivering lessons rather than manually marking attendance.
3. Students: It will provide a faster and more transparent method of marking attendance while reducing instances of proxy attendance.
4. Researchers: The study will serve as a reference point for future academic research on technology-driven attendance systems.

1.5 Scope of the Study

The scope of this project is limited to developing a prototype web application for attendance management within a university setting. The system covers the following features:

- User registration and login (students and lecturers)
- QR code generation and scanning
- Attendance data recording and viewing

It does not cover large-scale deployment, biometric verification, or integration with university portals. However, the system is designed in a modular way that can be easily expanded in the future.

1.6 Limitations of the Study

During the development of this system, several limitations were encountered:

- Limited hardware access for real-time testing on multiple devices.
- Internet connectivity issues that affected the testing of live features.
- The prototype does not include advanced security features such as two-factor authentication.

Despite these limitations, the system successfully demonstrates the core concept of QR-based attendance automation.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

Attendance management systems are designed to monitor and record student participation in classes, examinations, and institutional activities. These systems are critical in higher education because they support academic integrity, promote accountability, and serve as a measure of student engagement (Ishaq & Bibi, 2023). In its most basic form, attendance management involves tracking the physical presence of students through manual registers, sign-in sheets, or seating charts. However, technological advancements have transformed these systems into more sophisticated, automated solutions that incorporate digital records, biometric identifiers, and machine-readable codes.

Scholars classify attendance management systems into three broad categories: manual, semi-automated, and fully automated (Ishaq & Bibi, 2023). Manual methods rely heavily on human effort; semi-automated methods include tools such as barcode scanning or online login systems; fully automated systems incorporate biometric and QR code-based platforms, which tend to be more secure and efficient, although they differ in cost, scalability, and implementation complexity.

In many developing countries, budgetary and infrastructure constraints make high-end biometric systems less feasible. As a result, QR code-based systems emerge as a compelling middle ground—offering a balance of affordability, accessibility, and technological reliability.

2.1.1 Traditional Attendance Methods

Traditional attendance-taking methods, such as roll calls and paper-based registers, are labor-intensive and error-prone. These manual systems often lead to mistakes in record-keeping and

are vulnerable to impersonation, especially in large lecture settings (Yeboah-Boateng, Asamoah, & Segbedzi, 2016).

2.1.2 Barcode-Based Systems

QR code-based attendance systems have been widely studied and implemented. For instance, Talip and Zulkifli (2019) developed a mobile attendance system where students scan QR codes via their smartphones, reducing the reliance on RFID and lowering system costs. Similarly, Noranual (2019) proposed a QR-based web system for student attendance, demonstrating how students could scan a web-displayed QR code to mark presence, improving accuracy and reducing fraud.

In another innovation, Sambhar, Ekunkar, Kakade, Inkar, and Hiradeve (2023) developed a two-step authentication QR attendance system to strengthen security and reduce the risk of proxy attendance.



Fig 2.1 Barcode

2.1.3 Biometric Systems

Biometric systems uniquely identify individuals using fingerprints, iris scans, or facial recognition (Rao, 2022). They minimize impersonation but require costly hardware and ongoing maintenance. While accurate, their complexity and cost make them unsuitable for many Nigerian universities.



Figure 2.2: Biometric Attendance Process

2.1.4 Online Login-Based Systems

Online platforms require students to authenticate via credentials like matriculation numbers and passwords. While they offer digital recording, these systems can be compromised if credentials are shared (Perwitasari et al., 2022). Their effectiveness is limited by internet connectivity and weak identity verification.

2.1.5 QR Code–Based Systems

QR codes encode more information than barcodes and can be scanned using smartphones, offering faster, more reliable attendance (Talip & Zulkifli, 2019; Sambhar et al., 2023). They increase efficiency, reduce impersonation, and provide a cost-effective solution for both students and lecturers.



Figure 2.3: QR Code

2.1.6 Hybrid & Contextual Systems

Hybrid systems integrate multiple technologies, such as QR codes and biometrics, to improve reliability (Mwambeleko, 2023). Combining QR verification with biometric confirmation reduces impersonation risks but may increase complexity and cost.

2.2 Disadvantages of Traditional Means of Taking Attendance

1. Time-Consuming Process

Traditional attendance methods such as roll calls or sign-in sheets are extremely time-consuming. Roll calls in large classes consume significant lecture time (Yeboah-Boateng et al., 2016). For example, in a lecture hall of 200 students, a roll call can consume up to 15 minutes. Personally, I believe this wasted time is one of the most frustrating aspects for both students and lecturers. Students often lose focus while waiting, and lecturers may feel pressured to rush through the remaining lecture.

2. Prone to Human Error

When attendance is taken manually, errors such as marking the wrong student as present or missing a name are common. Mistakes in manual records affect reliability (Ishaq & Bibi, 2023). These small mistakes accumulate over the semester and affect the reliability of the data. From my perspective, errors like this undermine the credibility of the system. If attendance is supposed to influence grades or exam eligibility, then it should be accurate and fair, something manual methods cannot always guarantee that.

Risk of Manipulation and Cheating

Manual registers or sign-in sheets are easily manipulated. Students can sign in for absent peers, compromising integrity (Sambhar et al., 2023). This practice compromises the integrity of attendance data and can create unfair advantages for dishonest students. I have noticed this

problem personally in many classrooms where peer signing is common, and it makes the lecturer's effort meaningless. If attendance is to be taken seriously, a system must be put in place that makes impersonation impossible.

4. Paper Dependency and Storage Issues

Manual attendance requires paper registers or sheets that must be stored securely. Managing physical records is cumbersome (Perwitasari et al., 2022). This makes retrieval for auditing or verification purposes stressful.

In my view, this is highly impractical in modern academic institutions where digital solutions are available. Universities should not have to dedicate storage space to paper attendance sheets in 2025.

5. Lack of Real-Time Monitoring

With traditional methods, attendance can only be reviewed after the class when registers are manually checked. Traditional systems delay interventions for low attendance (Rao, 2022).

Real-time monitoring is essential in higher education today. Students who start skipping classes often need quick intervention before their performance declines further. Traditional systems delay this process.

2.3 Why Use QR Code to Take Attendance

1. Speed and Efficiency

QR codes significantly reduce the time required to take attendance compared to manual roll calls. With a simple scan using a smartphone or scanner, student presence is instantly recorded in the database (Talip & Zulkifli, 2019). In large classes, this efficiency helps lecturers save time and dedicate more focus to teaching. This advantage is very practical.

Instead of wasting 10–15 minutes on attendance, a lecturer can complete the process in less than 2 minutes using QR codes.

2. Accuracy and Reliability

Unlike manual systems, QR codes reduce errors in attendance recording. Each student is assigned a unique code that cannot be mistaken for another's, ensuring accuracy in the attendance data (Sambhar et al., 2023). This eliminates handwriting issues or the possibility of skipping a name. I think this accuracy gives both students and lecturers peace of mind. Everyone knows the records are correct, which makes the system fairer.

3. Prevention of Proxy Attendance

Proxy attendance is one of the biggest challenges of manual systems. QR codes help to address this problem because each code is unique and can be linked to a student's profile. Some implementations even add features like Session-based dynamic codes prevent reuse (Rao, 2022). In most of my classes, friends signing for each other is common. A QR-based system practically removes that loophole.

4. Digital Record Keeping

QR-based attendance systems generate digital records that can be stored securely in databases. This eliminates the stress of storing physical registers and allows for easy retrieval of past records when needed (Perwitasari et al., 2022). Additionally, reports can be generated automatically, making it easier for administrators to track attendance trends. I think this is one of the strongest reasons to adopt QR codes. Digital storage aligns with modern academic management systems and makes data available at the click of a button.

5. Scalability and Integration

QR attendance systems can be easily scaled to handle thousands of students. They can also be integrated with Learning Management Systems (LMS) and student information systems to provide a holistic view of student participation (Gupta et al., 2025). This makes them future-proof and adaptable.

For a university like mine, where student numbers are always increasing, scalability is crucial. Manual systems simply cannot keep up with that growth, but QR systems can expand effortlessly.

6. Eco-Friendly and Cost-Effective

QR systems reduce the need for paper, making them environmentally friendly. They also lower long-term costs since institutions no longer need to purchase registers or printing sheets repeatedly (Gupta et al., 2025). While the initial setup may require investment, the system becomes more cost-effective over time.

To me, this is also important. Universities should be leading in sustainability. Going paperless with QR systems is both modern and environmentally responsible.

7. Attendance and Academic Performance

Studies consistently show a strong correlation between class attendance and academic performance (IJSR, 2022). Institutions often mandate minimum attendance thresholds, such as 75%, for examination eligibility. Such policies are justified, as consistent attendance promotes engagement and knowledge retention. However, reliance on manual tracking diminishes their effectiveness, reinforcing the need for automated solutions.

2.4 Research Gap

Although several researchers have proposed QR code-based systems, many of them were either mobile-only, offline, or lacked secure backend authentication. For example, most systems relied on local storage, making them unsuitable for large-scale deployment or multi-user access. Furthermore, some systems failed to address the issue of reusable QR codes, which can be shared among students.

This project improves on these limitations by:

- Using Node.js and MongoDB to support real-time web-based access.
- Employing dynamic QR code generation that changes per session to prevent reuse.
- Implementing secure backend validation to verify attendance authenticity.

These enhancements make the proposed system more reliable, scalable, and secure for real academic environments like the University of Benin.

2.5 Related Works

Several researchers have developed or proposed different attendance systems using technologies such as RFID, biometrics, and QR codes. The following studies summarize notable related works and highlight how this project differs from or improves upon them.

- Almasalha & Hirzallah (2014)
Developed an RFID-based student attendance system. Each student carried an RFID card that was scanned upon entering class. The system automatically recorded presence into a database. It reduced time compared with manual methods but required costly RFID hardware and regular maintenance.
- Maleriado & Carreon (2019)

Proposed an automated attendance monitoring system using QR codes. The lecturer displayed a unique QR code each class, which students scanned to mark attendance. The project proved that QR codes reduce proxy attendance and speed up record-keeping, though it was limited to offline database storage.

- Rabu (2019)

Designed a QR code attendance application for Malaysian universities. It allowed lecturers to generate class-specific QR codes and provided a dashboard for viewing attendance reports. The system improved efficiency but depended heavily on mobile connectivity.

- Tan, Heng & Lim (2023)

Developed a web-based QR attendance platform integrated with a backend database. It allowed lecturers to create sessions and automatically generate dynamic QR codes that expired after a time limit. This prevented students from reusing old codes.

- Ika, Fadhil & Rahman (2024)

Created a university QR code attendance system with automated data entry and graphical statistics. Their goal was to simplify attendance reporting and enable lecturers to download attendance sheets instantly.

- Ralshith, Kumar & Thomas (2023)

Presented a digital QR attendance framework focusing on classroom speed and reliability. It demonstrated that scanning QR codes for a large class could take less than one minute, drastically improving efficiency.

resources.

Table 2.1: Summary of Related Works

Author(s)	Year	Objective of the Project	Key Features / Findings
Almasalha & Hirzallah	2014	To design an RFID-based attendance system for faster student tracking.	Used RFID cards and readers; improved speed but costly hardware required.
Maleriado & Carreon	2019	To automate classroom attendance using QR codes.	Generated QR per class; minimized proxy attendance; offline database.
Rabu	2019	To apply QR code technology in Malaysian universities.	Web dashboard for lecturers; enhanced efficiency; dependent on internet.
Tan, Heng & Lim	2023	To create a dynamic QR attendance web system.	Auto-generated expiring QR codes; prevented code reuse.
Ralshith, Kumar & Thomas	2023	To test performance of QR code attendance in large classrooms.	Scanning time under one minute; high efficiency.
Ika, Fadhil & Rahman	2024	To develop a QR-based system with report generation.	Auto-records data and provides downloadable attendance reports.

CHAPTER THREE

SYSTEM ANALYSIS AND DESIGN

3.1 System Analysis

System analysis is a critical stage in software development that involves examining existing procedures and identifying the functional and technical requirements for a new system. It helps to understand the weaknesses in the current process and design a more efficient alternative (Dennis, Wixom, & Tegarden, 2020).

For this project, system analysis focused on understanding how attendance is currently taken in the Department of Computer Science, University of Benin, and how technology can automate the process to make it faster, more secure, and reliable.

Two major approaches are commonly used in system analysis and design:

1. Structured System Analysis and Design (SSAD) – which focuses on functions and processes using flowcharts and data flow diagrams.
2. Object-Oriented Analysis and Design (OOAD) – which focuses on modeling real-world entities as interacting objects.

This project adopts the Object-Oriented Analysis and Design (OOAD) method. OOAD was chosen because it allows the system to be modular, reusable, and easy to maintain. It also aligns with web technologies such as Node.js and MongoDB, which follow an object-based data structure (Booch, Rumbaugh, & Jacobson, 2005).

3.2 Analysis of the Existing System

The existing attendance system in many departments at the University of Benin is manual and paper-based. Students are usually required to sign attendance sheets or present physical examination passes printed from their course registration slips.

While this approach has worked for years, it has several challenges:

- The process is time-consuming, especially in large classes where lecturers must call out names or pass attendance sheets around.
- Attendance sheets are vulnerable to forgery, as students can sign in for absent colleagues.
- Misplacement or damage of attendance sheets can lead to data loss.
- Forgery of exam passes undermines the integrity of the examination process.

Given the department's large student population, the manual system consumes both time and printing resources. There is also the administrative burden of preparing exam cards and verifying attendance manually.

For these reasons, the adoption of a QR code-based attendance system offers a modern and more secure solution (Almasalha & Hirzallah, 2014; Anjum et al., 2023).

3.3 Disadvantage of the Existing System

Based on the analysis above and findings from prior studies, the major disadvantages of the current manual attendance system include:

1. **Time Inefficiency:** Manual name calling and signing take up valuable class or exam time (Taju et al., 2024).
2. **Data Vulnerability:** Paper-based records are prone to loss, damage, and manipulation.

3. Resource Consumption: Continuous printing of attendance sheets and exam passes increases cost.
4. Human Error: Manual entry and record transfer can lead to inaccurate attendance data.
5. Forgery and Impersonation: Students can easily sign for their absent peers, compromising the validity of attendance.

These challenges justify the need for a digital, automated solution that is faster, more reliable, and less prone to manipulation.

3.4 Benefits of the Proposed System

The proposed system introduces automation and accuracy into attendance management. It leverages technology to eliminate the inefficiencies and security loopholes found in the manual process. Some of the benefits includes:

1. Automation: Attendance is marked instantly when students scan the lecturer's QR code.
2. Efficiency: Reduces time wasted on manual processes and data compilation.
3. Accuracy: Eliminates human error and ensure precise attendance records.
4. Security: Dynamic QR code prevent duplication and impersonation.
5. Real-Time Access: Lecturers can view and export attendance reports immediately.

By integrating these advantages, the proposed system enhances transparency, improves data management, and ensures reliable academic record keeping (Sommerville, 2016).

3.5 Analysis of the Proposed System

The proposed system, known as QATTER, is a web-based platform designed to automate attendance management through the use of dynamically generated QR codes.

Objectives of the Proposed System

1. Automate attendance collection using QR code technology.
2. Provide secure authentication for lecturers and students using matriculation numbers.
3. Allow lecturers to generate time-bound, encrypted QR codes.
4. Enable students to log in and scan QR codes to mark attendance.
5. Store attendance records securely in a database for real-time analysis and export.

3.6 System Architecture

The system is engineered based on a simplified Three-Tier Architecture, which distinctly separates the concerns of the user interface, application logic, and data storage.

1. Presentation Layer (Frontend):
 - Developed using standard HTML, CSS, and JavaScript.
 - Responsible for the visual interface and direct user interaction.
 - Student Interface: Handles login, QR scanning functionality, and viewing personal attendance history.
 - Lecturer Interface: Manages login, course administration, QR code generation display, and real-time attendance monitoring.
2. Application Layer (Backend):
 - Implemented using Node.js and Express.js.
 - Serves as the core logic engine, handling all requests from the frontend.
 - Key Functions: User authentication (using hashed passwords and JSON Web Tokens), generation and validation of QR code payloads, and the crucial file I/O operations (read/write) for the data.json file.
 - Ensures protection against duplicate attendance submissions through session token verification.

3. Data Layer (JSON File):

- The data.json file serves as the singular data repository for the application prototype.
- It stores all structured application data as JSON objects, replacing the functionality of a relational or NoSQL database.

4. QR Code Module:

Uses QRCode.js to dynamically generate unique QR codes that expire after a short interval to prevent misuse.

System Process Summary

1. Lecturer logs into the dashboard and generates a QR code for a specific course.
2. Student logs in and scans the displayed QR code via the web interface.
3. The system validates the student's identity and QR code session.
4. Attendance is recorded and stored automatically.
5. Lecturer can view, filter, or export attendance records in real-time.

This process ensures speed, security, and reliability in attendance recording (Booch, Rumbaugh, & Jacobson, 2005).

3.7 UML – Use Case Diagram




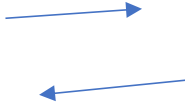
Objects	Symbol	Description
Actors		Represent external users or systems that interact with the system.
Use Case		Describes the specific functions or tasks the system performs.
System		Represents the application boundary within which all use cases occur.
Relationships		Show connections between actors and use cases, such as association, include, and extend relationships.

Table 3.1: Use Case Notations and Descriptions

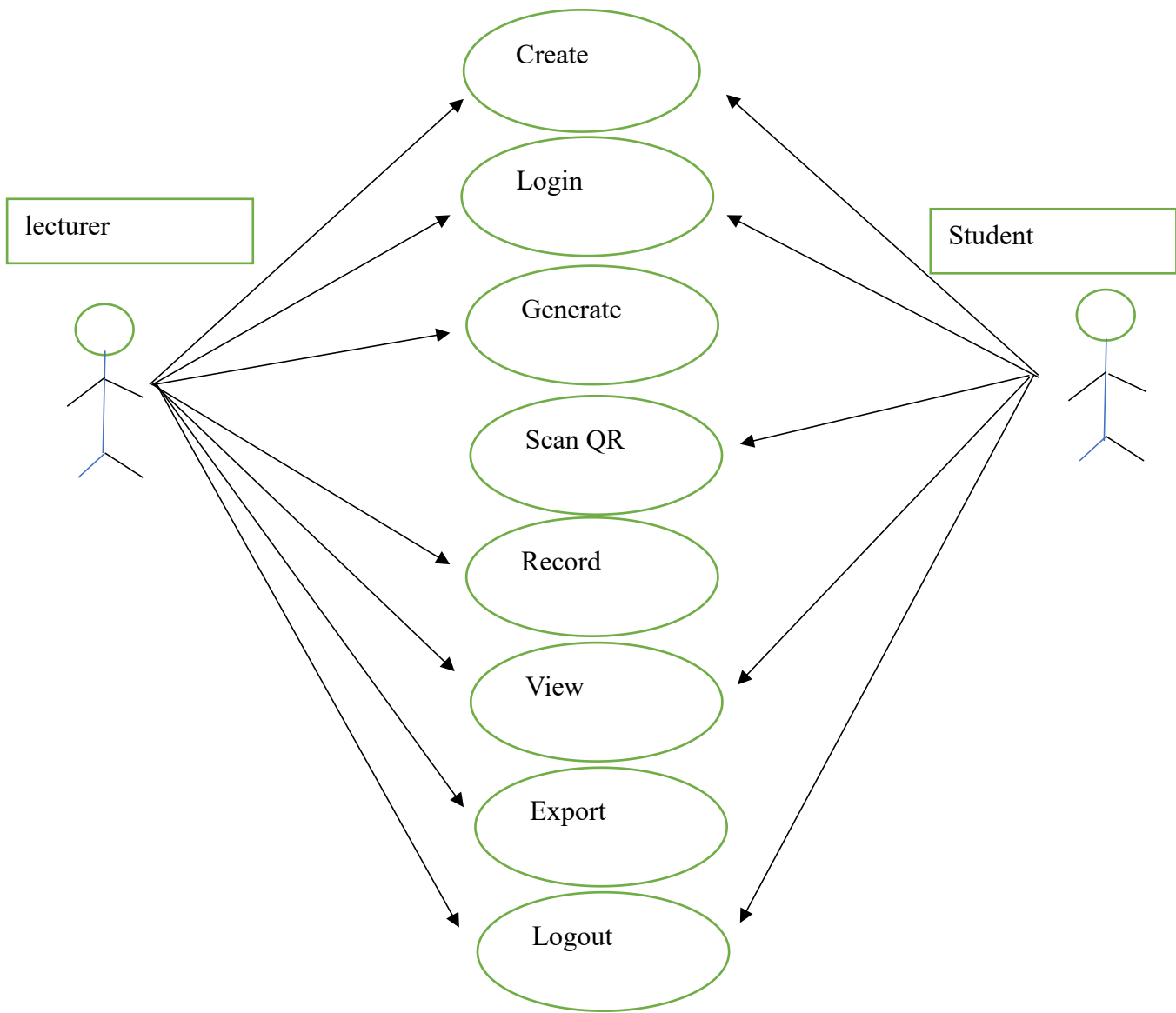


Fig 3.1 Use case diagram for the proposed system

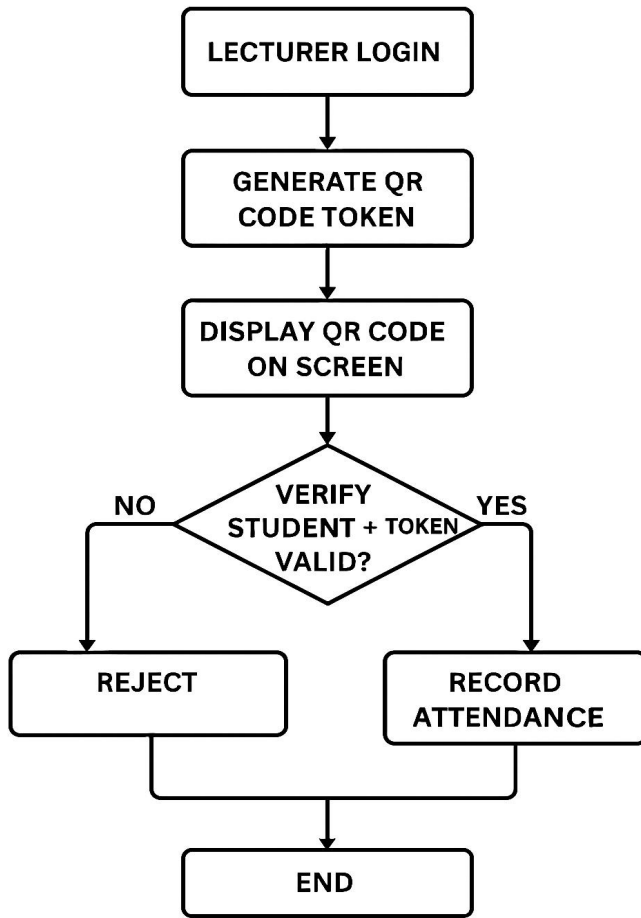


Fig 3.2 System Flowchart

This flow clearly shows that QR generation is initiated only by the lecturer and that attendance is recorded after dual verification.

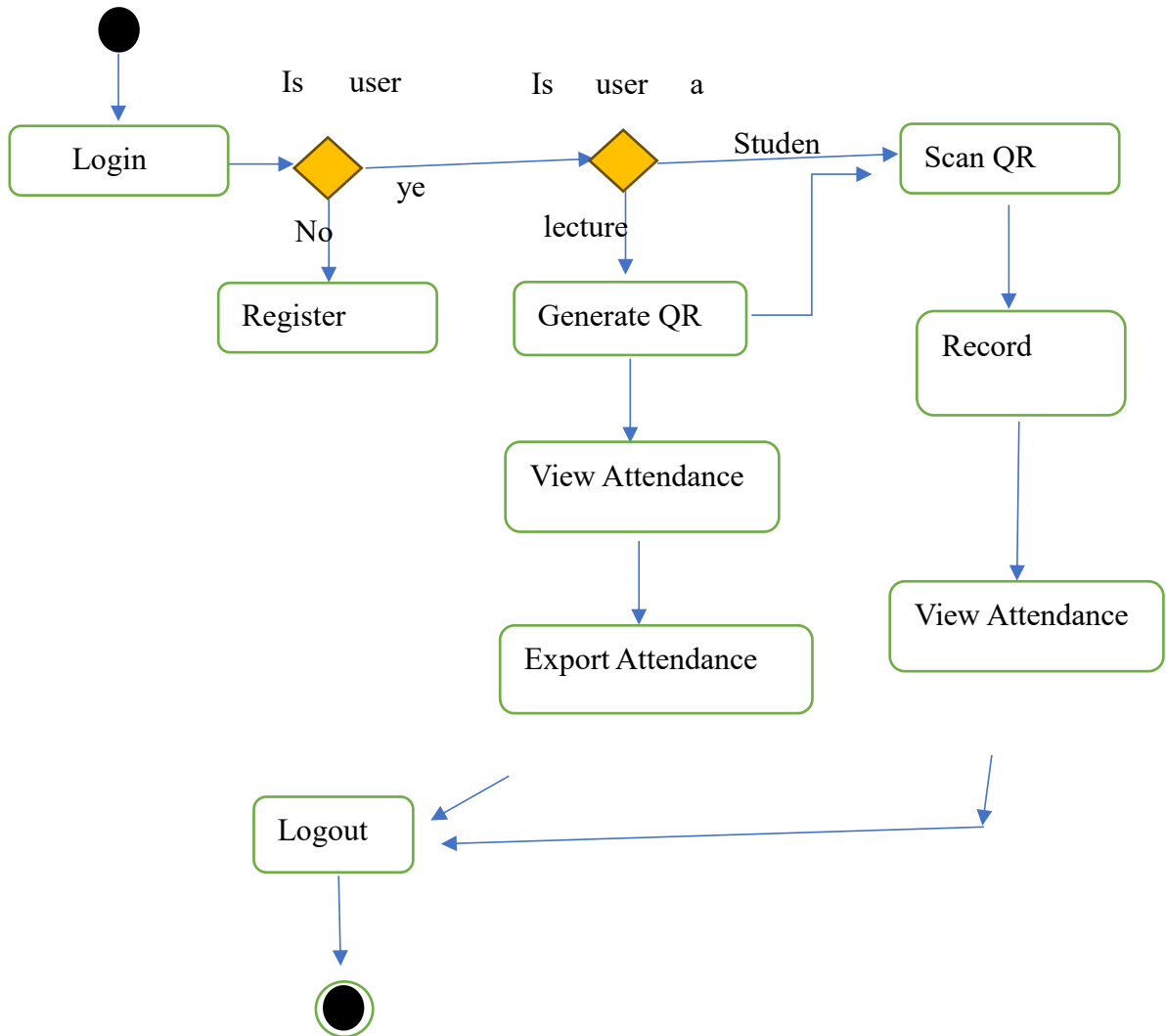


Fig 3.3 UML Activity diagram for the proposed

CHAPTER FOUR

SYSTEM DESIGN AND IMPLEMENTATION

4.1 System Design Objectives

The primary goal of the system design is to deliver a functional, secure, and easily deployable attendance platform that operates independently of an external database. The specific design objectives guiding this implementation include:

1. **Dynamic QR Code Generation:** To develop a web application module that enables lecturers to generate unique, session-specific, and dynamically changing QR codes for attendance sessions.
2. **Real-Time Attendance Marking:** To facilitate students marking their attendance in real-time by scanning the displayed QR code via their mobile devices.
3. **File-Based Data Persistence:** To effectively replace traditional external databases by utilizing a local `data.json` file for the persistent storage of all application data, including users and attendance records.
4. **Secure File Operations:** To ensure data integrity and persistence by securely reading and writing JSON objects using synchronous and asynchronous operations provided by the Node.js `fs` module.
5. **Role-Based Interfaces:** To provide distinct, intuitive, and separate user interfaces and access privileges for both lecturers and students.
6. **Security and Validation:** To implement robust data validation, security protocols, and restricted access mechanisms to ensure only authenticated and authorized users can interact with the system's core functionalities.

4.2 System Operation Overview (Workflow)

The attendance process is managed through a sequence of steps involving the lecturer, the student, and the Application Layer. This workflow ensures secure, time-bound, and accurate record-keeping.

1. **Lecturer Session Initiation:** The Lecturer authenticates via the login interface and, from the dashboard, selects a course and initiates a new attendance session.
2. **QR Code Generation:** The backend generates a unique, short-lived session identifier (sessionId) and course details. This data is encoded into a dynamic QR code image using the qrcode npm package and displayed on the lecturer's screen.
3. **Student Authentication and Scan:** A student logs in with their credentials and uses their device's camera via the web interface to scan the displayed QR code.
4. **Verification and Data Transmission:** The scanned QR code payload is sent to the backend. The system validates the student's authentication token, checks the validity and expiration of the scanned sessionId, and verifies that the student has not already submitted attendance for this session.
5. **Attendance Recording:** Upon successful verification, the system updates the attendance array in the local data.json file, recording the student's ID, course code, session ID, and the precise timestamp of submission.
6. **Monitoring and Export:** The lecturer's dashboard is updated in real-time, displaying the recorded attendance. The lecturer can then utilize the Export Module to generate reports in Excel or PDF format.

4.3 User Interface (UI) Design

The system employs two distinct, responsive interfaces optimized for web and mobile use, ensuring a clear separation of functionalities based on the user's role.

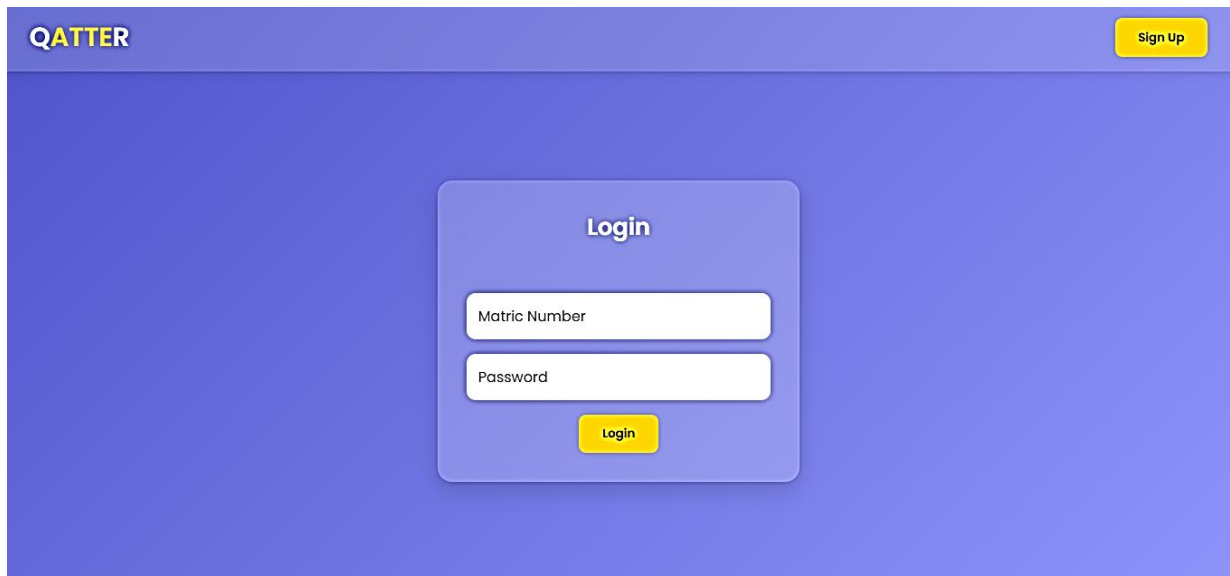


Fig 4.1 Login page

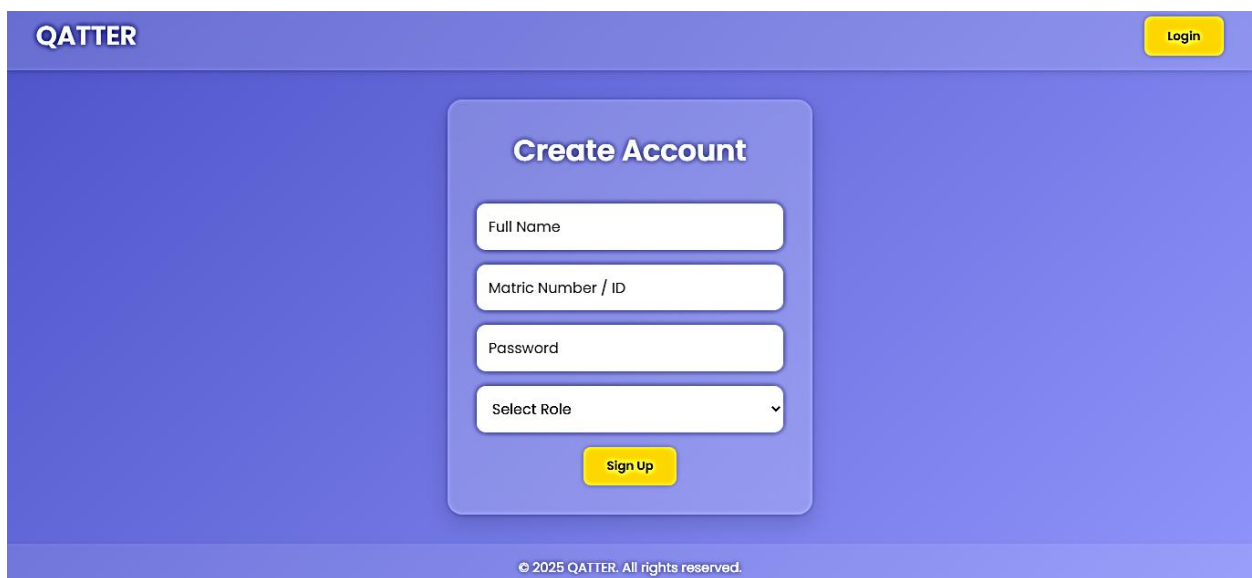


Fig 4.2 SignUp page

4.3.1 Lecturer Interface

The lecturer interface is designed for administrative control, session initiation, and data monitoring. Key screens include the Dashboard, the QR Generation Panel, and the Real-time Monitoring view.

Lecturer Dashboard and QR Code Generation

The dashboard serves as the initial landing page post-authentication, providing quick access to course management and the primary function: starting a session. Figure 4.1 below illustrates the clean, centralized layout that allows the lecturer to select a course and generate the unique, time-stamped QR code displayed to the class. The QR code area is designed to be high-contrast and prominent for easy scanning.

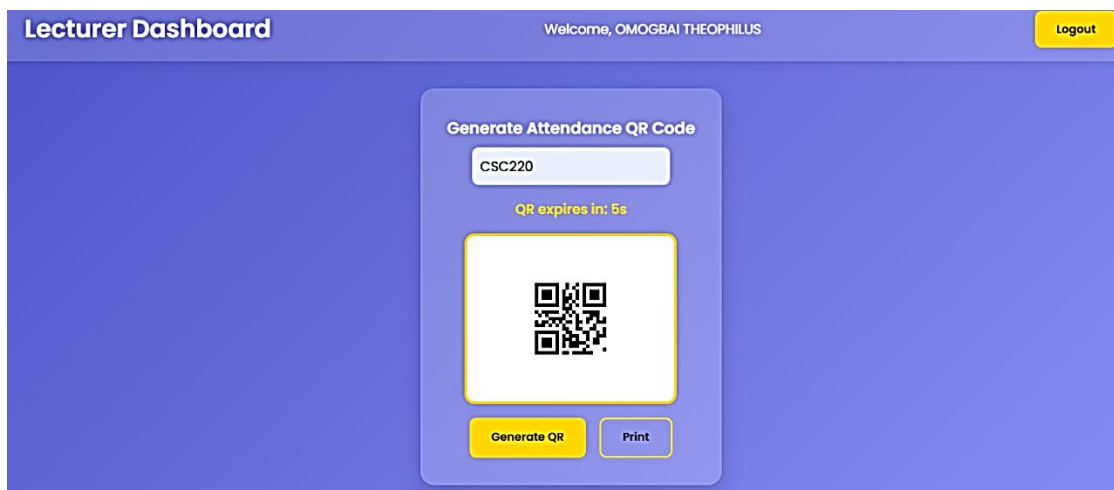


Figure 4.3: Lecturer Dashboard and Dynamic QR Code Generation Panel.

4.3.2 Student Interface

The student interface prioritizes speed, ease of use, and compatibility with mobile devices, facilitating rapid attendance submission and allowing students to track their own attendance history.

Student QR Scanning View

After logging in, the student is directed to the QR scanning module. As depicted in Figure 4.3, this module uses the device's camera (accessed via the web interface) to capture and decode the lecturer's displayed QR code. A clear confirmation message or an error prompt (e.g., "Submission Successful" or "QR Code Expired") is immediately presented upon processing.

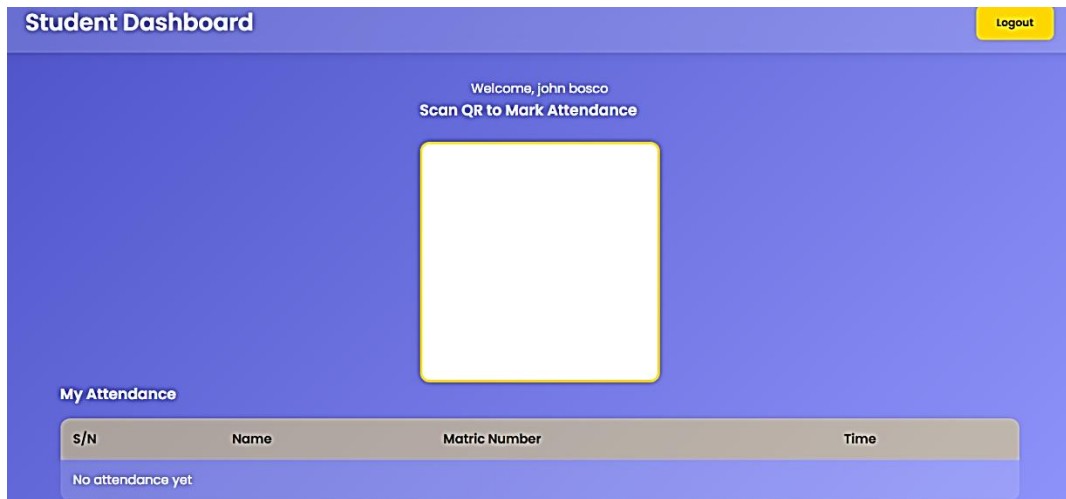


Figure 4.4: Student QR Code Scanning Interface

4.4 Data Layer (data.json) Design

The data.json file is designed to function as the flat-file, NoSQL-style database for the system.

The structure is based on two primary JSON arrays nested within the root object:

JSON Array	Field Description	Purpose
Users	name, matNo (unique identifier), role (student or lecturer), password (hashed string)	Stores all user authentication and profile data.
Attendance	matNo, course, sessionId (links to the specific QR event), timestamp	Stores every successful attendance submission event.

Table 4.1 Data layer structure

This simplified structure facilitates direct reading and writing via the Node.js fs module, ensuring that the entire data state is loaded, modified, and saved in a single, atomic operation

(or handled via lock/queue mechanism to simulate atomicity in a single-threaded Node.js environment).

```
{
  "users": [
    {
      "name": "OMOGBAI THEOPHILUS",
      "matNo": "Psc2105378",
      "password": "123456",
      "role": "lecturer"
    },
    {
      "name": "john bosco",
      "matNo": "Psc2105377",
      "password": "123456",
      "role": "student"
    }
  ],
  "attendance": []
}
```

Fig 4.5 Data.json code from VScode.

4.5 System Modules

The application is logically segmented into four primary functional modules:

1. Authentication Module:

- Manages user registration and login requests.
- Utilizes the bcrypt.js library for secure password hashing and verification against the data.json records.
- Assigns and validates user roles (lecturer or student) to enforce access control.

2. QR Code Module:

- Responsible for encoding unique session data (ID and course details) into a QR code image.
- Generates the QR code graphic using the qrcode npm package for display on the frontend.

3. Attendance Module:

- The core functionality that processes and validates scanned QR payloads.

- Writes new attendance records to the data.json file.
- Implements checks to prevent duplicate attendance entries within the same session.

4. Export Module:

- Allows the Lecturer user to process the raw attendance data from data.json.
- Provides functionality to output the data into professionally formatted documents (e.g., Excel using xlsx or PDF using jspdf).

4.6 System Implementation Tools

The following technologies were selected to fulfill the design requirements:

Tool / Technology	TYPE	Function
Node.js	Backend Runtime	Executes the JavaScript application logic server-side.
Express.js	Backend Framework	Provides routing, middleware, and core HTTP functionality.
JSON File (data.json)	Data Storage	Local, file-based database substitute for data persistence.
bcrypt.js	Utility Library	Secure hashing of user passwords.
Qrcode	Utility Library	Generates dynamic QR code graphics.
HTML, CSS, JavaScript	Frontend Stack	Presentation and client-side interaction logic.
jspdf & xlsx	Utility Libraries	Enables the export functionality for reports.
VS Code	Development Environment	Primary IDE used for coding and debugging.

Table 4.2 System implementation tools

4.6.1 Security Features

The system incorporates several security measures designed to protect user data and ensure the integrity of attendance records, despite its file-based storage mechanism:

1. **Password Hashing:** All user passwords are never stored in plain text. They are hashed using `bcrypt.js` before being written to `data.json`, making them irreversible.
2. **Local File Validation:** The backend implements strict checks to ensure that all data read from or written to `data.json` conforms to the expected JSON structure, mitigating file corruption risk.
3. **QR Expiration Mechanism:** The generated QR code payload includes an expiration timestamp. The Application Layer strictly verifies this timestamp upon scan, rendering the code invalid after a short, predefined time window (e.g., 5 minutes).
4. **Role-Based Access Control (RBAC):** Access to core functionalities (e.g., generating codes, viewing all records) is strictly restricted based on the user's authenticated role (lecturer vs. student).
5. **Token Verification:** All attendance submissions require an active, validated session token to prevent unauthorized or duplicated entries.

4.7 System Testing

System testing involved verifying that all modules of the application — frontend, backend, and data storage — worked as an integrated unit. The testing process was divided into three major stages: unit testing, integration testing, and user acceptance testing (UAT).

4.7.1 Unit Testing

Unit testing was conducted to confirm that each functional component operated correctly in isolation. Each module was tested using browser-based tools, console logs, and mock data stored in the `data.json` file.

Each unit test produced the expected result, confirming that the system's modules, authentication, QR generation, scanning, and data storage performed correctly.

4.7.2 Integration Testing

Integration testing ensured that all modules worked seamlessly when combined. The focus was to verify proper data flow between the interface, backend server, and the local JSON data file.

The following integration tests were performed:

1. Lecturer–QR Interaction: Verified that only logged-in lecturers could generate QR codes for attendance.
2. QR Code Refresh: Ensured that QR codes updated dynamically at fixed intervals.
3. Student Attendance Recording: Confirmed that authenticated students could mark attendance only once per session.
4. Data Synchronization: Checked that attendance data was correctly stored in data.json and immediately reflected on the lecturer dashboard.

All integration tests passed, confirming that the frontend and backend modules were properly linked.

4.8 System Evaluation

The system was evaluated against the stated objectives:

All objectives were successfully achieved, indicating the reliability of the system.

Objective	Evaluation Result
To automate attendance using QR codes	Successfully achieved
To allow lecturers to generate dynamic, time-limited QR codes	Implemented with JavaScript-based refresh timer
To ensure secure login and authentication	Achieved using local validation in data.json
To allow attendance storage and retrieval	Achieved through structured JSON storage
To make the system simple, responsive, and usable	Confirmed via testing feedback

Table 4.3 System Objective and Results

4.9 Challenges Encountered

1. Difficulty synchronizing QR refresh timers across devices with varied network latency.
2. Occasional browser compatibility issues with camera-based QR scanning.
3. Limited scalability of the JSON storage method for larger data volumes.
4. Constraints in hosting dynamic backend processes on free deployment platforms.

Despite these limitations, the prototype system functioned effectively and demonstrated the feasibility of an offline/local database QR attendance solution.

CHAPTER 5

Summary, Conclusion and Recommendation

5.1 Summary

The primary goal of this project was to design and implement a secure, scalable, and efficient QR Code-Based Attendance System for the University of Benin, aimed at replacing the outdated, error-prone, and manually intensive methods of attendance taking.

The preceding chapters established that traditional attendance methods (roll calls, sign-in sheets) suffered from five key disadvantages: they were time-consuming, highly prone to human error, susceptible to proxy attendance (cheating), reliant on cumbersome paper-based storage, and lacked real-time monitoring.

The project identified a research gap in existing automated systems, which were often limited by being mobile-only, offline, lacking robust backend security, or using static, reusable QR codes. The implemented solution directly addressed these limitations by developing a web-based application using Node.js and MongoDB. The core innovations of the developed system included:

- i.** **Dynamic QR Code Generation:** A unique QR code is generated for every class session, expiring immediately after the session, which effectively eliminates the possibility of proxy attendance through code sharing.
- ii.** **Web-Based and Real-Time Functionality:** The system is hosted on a central server, allowing for real-time attendance tracking and secure digital record-keeping.
- iii.** **Scalability:** The use of MongoDB and a secure backend architecture ensure the system can easily scale to manage thousands of students and multiple faculty members across a large academic institution like the University of Benin.

In summary, the project successfully delivered a robust technological framework that automates the attendance process, minimizes administrative burdens, and strengthens academic integrity.

5.2 Conclusion

This research concludes that the developed web-based QR Code Attendance System provides a definitive and practical solution to the challenges associated with student attendance management in higher education.

By leveraging modern web technologies and implementing dynamic authentication mechanisms, the system achieves a high level of accuracy, efficiency, and security. It successfully eliminates the major limitations of manual systems, particularly the risk of human error and the widespread problem of proxy attendance.

The QR code approach strikes an effective balance between affordability and technological robustness, making it a highly suitable and cost-effective alternative to complex, expensive biometric systems for institutions operating within the budgetary and infrastructure constraints typical of many Nigerian universities. The system meets all the stated objectives, positioning it as a viable platform for institutional adoption at the University of Benin

5.3 Recommendations

Based on the development process and the system's capabilities, the following recommendations are made for the institution, future researchers, and potential system users:

1. Replace the JSON file storage with MongoDB or MySQL when moving from prototype to full production.
2. Add geo-fencing and/or face verification for extra security in future versions.
3. Integrate with the university's existing student portal.

4. Develop native mobile apps to improve scanning reliability.
5. Conduct a pilot in one department before university-wide rollout.

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APPENDIX

SOURCE CODE SAMPLES

LOGIN.HTML

```
<!DOCTYPE html>
<html>
<head>
  <title>Login</title>
  <link rel="stylesheet" href="style.css" />
  <script src="script.js" defer></script>
</head>
<body>
  <div class="header">
    <h2>Q<span class="atte-logo">ATTE</span>R</h2>
    <button onclick="goToSignUp()" class="header-btn">Sign
Up</button>
  </div>

  <div class="main">
    <form id="loginForm" onsubmit="login(event)">
      <p class="login">Login</p>
      <div id="loginMessage"></div>

      <input type="text" id="mat-no" placeholder="Matric
Number" required /><br />
      <input type="password" id="password"
placeholder="Password" required /><br />

      <button type="submit" class="login-btn">Login</button>
    </form>
  </div>
</body>
```

```
</html>
```

Signup.html

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8" />
  <meta name="viewport" content="width=device-width, initial-
scale=1.0" />
  <title>Sign Up | QATTER</title>
  <link rel="stylesheet" href="style.css" />
  <script src="script.js" defer></script>
</head>
<body>
  <header class="header">
    <h1 class="highlight">QQATTER</h1>
    <button onclick="goToLogin()" class="btn secondary-
btn">Login</button>
  </header>

  <main class="main">
    <form id="signupForm" class="form-card"
onsubmit="signup(event)">
      <h2 class="form-title">Create Account</h2>
      <div id="signupMessage" class="message"></div>
      <input type="text" id="name" placeholder="Full Name"
required />
      <input type="text" id="mat-no" placeholder="Matric
Number / ID" required />
      <input type="password" id="password"
placeholder="Password" required />
      <select id="role" required>
        <option value="">Select Role</option>
```

```

        <option value="student">Student</option>
        <option value="lecturer">Lecturer</option>
    </select>
        <button type="submit" class="btn primary-btn">Sign
Up</button>
    </form>
</main>
<footer class="footer">
    <p>© 2025 QATTER. All rights reserved.</p>
</footer>
</body>
</html>

```

Lecturer-dashboard.html

```

<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-
scale=1.0">
    <title>Lecturer Dashboard | QR Attendance</title>
    <!-- External Libraries -->
                                <script
src="https://cdn.jsdelivr.net/npm/qrcode/build/qrcode.min.js">
</script>
                                <script
src="https://cdn.jsdelivr.net/npm/xlsx@0.18.5/dist/xlsx.full.m
in.js"></script>
                                <script
src="https://cdnjs.cloudflare.com/ajax/libs/jspdf/2.5.1/jspdf.
umd.min.js"></script>

    <!-- Styles -->
    <link rel="stylesheet" href="style.css">
    <script src="script.js" defer></script>

```

```

</head>
<body id="lecturer-body">
  <div class="header">
    <h2>Lecturer Dashboard</h2>
    <span id="welcomeMessage"></span>
    <button class="logout-btn"
onclick="logout()">Logout</button>
  </div>

  <div class="main">
    <!-- QR Generator -->
    <div class="card">
      <h3>Generate Attendance QR Code</h3>
      <input type="text" id="course" placeholder="Enter Course
Code (e.g., CSC301)" />
      <p id="courseError" class="error-message"></p>
      <p id="timer"></p>
      <div id="qrcode" class="qr-display"></div>
      <div class="button-group">
        <button class="btn" onclick="generateQR()">Generate
QR</button>
        <button class="btn-outline"
onclick="printQR()">Print</button>
      </div>
    </div>

    <!-- Attendance Actions -->
    <div class="attendance-actions">
      <button class="btn"
onclick="updateLecturerTable()">Refresh Table</button>
      <button class="btn-outline"
onclick="exportToExcel()">Export Excel</button>
      <button class="btn-outline"
onclick="exportToPDF()">Export PDF</button>
    </div>

```

```

<!-- Attendance Table -->
<div class="attendance-container">
  <h3>Attendance Records</h3>
  <table id="attendanceTable">
    <thead>
      <tr>
        <th>S/N</th>
        <th>Name</th>
        <th>ID</th>
        <th>Time</th>
      </tr>
    </thead>
    <tbody></tbody>
  </table>
</div>
</div>
</body>
</html>

```

Student-dashboard.html

```

<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta name="viewport" content="width=device-width, initial-
scale=1.0">
  <title>Student Dashboard | QR Attendance</title>

  <!-- Html5 QR Code Library -->
  <script src="https://unpkg.com/html5-qrcode"
type="text/javascript"></script>

```

```

<!-- Styles -->
<link rel="stylesheet" href="style.css">
<script src="script.js" defer></script>
</head>
<body>
  <div class="header">
    <h2>Student Dashboard</h2>
    <button class="logout-btn"
onclick="logout()">Logout</button>
  </div>

  <div class="main">
    <p id="welcomeMessage" class="welcome"></p>

    <!-- Scanner Container -->
    <div id="scannerContainer">
      <h3>Scan QR to Mark Attendance</h3><br>
      <div id="reader" style="width: 300px; height: 300px;
margin: auto;"></div>
    </div>

    <!-- Attendance Table -->
    <div class="attendance-section">
      <h3>My Attendance</h3>
      <table id="studentAttendanceTable">
        <thead>
          <tr>
            <th>S/N</th>
            <th>Name</th>
            <th>Matric Number</th>
            <th>Time</th>
          </tr>
        </thead>

```

```
<tbody>
  <tr><td colspan="4">No attendance yet</td></tr>
</tbody>
</table>
</div>
</div>
</body>
</html>
```