

Development and Performance Evaluation of a Secure Web-based Attendance and Payroll System with GPS Verification and Role-based Access Control

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ABSTRACT

This study presents the design, implementation, and performance evaluation of a secure web-based attendance and payroll management system incorporating Global Positioning System (GPS) verification and Role-Based Access Control (RBAC). The system addresses limitations in existing attendance systems, such as susceptibility to fraud, lack of payroll integration, and limited accessibility. The proposed system was developed using the Model-View-Controller (MVC) architecture with PHP Laravel for the backend, Blade templating for the frontend, and SQLite for database management.

An experimental evaluation was conducted using multiple datasets and simulated real-world scenarios to assess system accuracy, response time, and scalability. Results show that the system achieved an average attendance validation accuracy of 98%, with response times below 3 seconds for attendance operations and under 5 seconds for payroll processing. The integration of GPS-based geo-fencing significantly reduced fraudulent attendance attempts, while automated payroll computation eliminated manual errors.

The system demonstrates improved efficiency, security, and scalability compared to existing solutions, making it suitable for educational institutions and corporate environments requiring reliable attendance tracking and payroll automation.

Keywords

MVC architecture, geo-location, payroll system, attendance tracking, access control

1. INTRODUCTION

In today's fast-paced business environment, the need for accurate and timely attendance and payroll management has never been more critical. Traditional methods, can lead to significant delays and errors. For instance, when employees submit their time-cards at the end of a pay period, the payroll department must manually input this data into their systems, increasing the likelihood of mistakes these errors can result in over-payments or underpayments, which can have serious implications for employee satisfaction and retention. Furthermore, the time spent on these manual processes diverts valuable resources away from more strategic initiatives within the organization. The implementation of a web-based attendance system with payroll

automation addresses these challenges head-on. By automating the attendance tracking process, organizations can capture employee clock-in and clock-out time in real time, eliminating the need for manual entry thereby reducing potential human error [7]. It also streamlines the payroll process, allowing for quicker and more accurate calculations.

Additionally, the system can be designed in the future to accommodate various pay structures, including hourly wages, salaries, and overtime, ensuring that all employees are compensated fairly and accurately traditional methods often prove to be inefficient, vulnerable to human mistakes, and lacking in real-time monitoring features. Consequently, there is an escalating need for automated, scalable and effective approach to attendance management to boost productivity and to maintain efficiency of in organizations [8]. In recent years; the advents of the internet and advancements in web technologies have facilitated the development of innovative solutions to supplant manual and subsystems. A web-based attendance system and payroll management system exemplifies such a solution, utilizing the capabilities of the internet to efficiently and effectively track, manage, and report attendance.

These systems have gained considerable attraction due to their user-friendliness, accessibility, automation, and real-time monitoring functionalities.

2. RELATED WORKS

[6] Developed an RFID-integrated, web-based attendance system codenamed I-Attend, which was designed to enhance both accuracy and efficiency in secondary school environments. The system was implemented successfully and addressed the common challenges of time-consuming manual attendance, prone to error and difficult data retrieval. The system evaluations revealed a high level of user satisfaction, with a usability score of 4.71 out of 5 and overall functionality rated at 4.57. However, the limitations include a lack of longitudinal testing and scalability analysis, as well as reliance on subjective usability measures without performance data over extended real-world use.

[12] Presented RFID-based attendance monitoring system with real-time notifications. The system delivered real-time alerts to stakeholders, enhanced immediacy in attendance tracking. The provision of real-time notifications potentially improved parent/advisor engagement. Yet, critical performance indicators

such as detection reliability, delay times, or user satisfaction were omitted. It also failed to address limitations such as message overload, network dependency, or alert privacy considerations.

[1] Integrated RFID-controlled smart locks with real-time attendance logging, aimed at reinforcing school security while automating attendance. It represented an innovative fusion of access control and attendance systems. However, no empirical validation, deployment experiences, or performance analyses were provided. Also, it lacked insight into lock reliability, system maintenance requirements, or user compliance issues.

[10] Proposed a departmental RFID attendance model meant to reduce administrative overhead and improve accuracy. While the concept suggests potential cost efficiency and automation benefits, the work did not reveal empirical evidence of performance, user acceptance, or deployment outcomes. Therefore, its limitations lie in the absence of experimental validation, user interface assessments and examination of challenges such as card misuse or technical constraints.

[14] A location-based attendance system that leveraged the capabilities of mobile devices, particularly smartphones, to enhance attendance tracking for employees was proposed. Geofencing technique and its application in a mobile attendance application designed for Android devices were discussed. The Mobile Attendance System (MAS) developed integrated an Android smartphone, GPS technology, and a Wi-Fi access point, serving a clear purpose. By simply pressing a button on the smartphone, the system utilized the built-in GPS receiver to accurately identify staff members, facilitating real-time attendance logging. The International Mobile Equipment Identity (IMEI) number and GPS data from the smartphone were stored in a directory, potentially replacing existing reporting methods. Following its implementation, the application proved effective in managing staff attendance records, with further recommendations aimed at enhancing efficiency through system security and payroll automation.

[14] Proposed a secure QR code attendance system that integrated Advanced Encryption Standard (AES) for data encryption along with location validation and International Mobile Equipment Identity (IMEI) verification. AES was applied to encrypt attendance data embedded in QR codes before scanning, ensuring data confidentiality and integrity. Location validation was used to confirm that attendance recording must be within an authorized area, while IMEI verification helped identify the registered user device. The system workflow was modeled using activity diagrams and implemented using computer-based technologies. Experimental testing and evaluation demonstrated system security enhancement and reliability of QR code systems. It also indicates the effectiveness of that IMEI-based validation up to Android version 9 due to operating system restrictions. Overall, the system improved attendance accuracy and reduced the risk of fraudulent attendance activities.

[9] Design and implementation of a fingerprint-based student attendance management system was presented. The system employed biometric fingerprint authentication to accurately identify and verify students during attendance recording. The system was developed using the Software Development Life Cycle (SDLC) approach and integrated a digital fingerprint scanner with a database-driven application for secure data storage and retrieval. By replacing manual attendance processes with biometric authentication, the system could enhance accuracy, security, and efficiency while eliminating proxy attendance and reducing administrative workload. The results demonstrated that the fingerprint-based system provided a reliable and effective

solution for managing student attendance in higher educational institutions.

[5] Developed a web-based honorary teacher payroll information system, with the primary aim to design a system that could facilitate the payroll process for honorary teachers. This research employed a descriptive approach alongside a prototype development method, utilizing a structured system approach. The findings indicated that the system significantly streamline the payroll tasks. The system offered features for calculating salaries, personal loans, and teacher absences, while also enhancing the speed and accuracy of payroll report generation.

[6] A smart attendance system with Quick Response (QR) code was proposed and implemented. It aimed to track and record student attendance in lectures and exercises for all relevant courses to overcome the manual attendance issues. The system was expected to provide customized reports of eligibility calculations for the students at the end of semester examination. The back-end includes features that allowed the admin to manage the system to add new student to the system, track student's attendance, send warning message to a students about low attendance rate and provide customized reports for the eligibility calculation. The front end could allow students to scan the QR code and view the percentage of attendance. The result showed that the system could help to reduce paper work, human error, time waste, and avoid fake signatures. However, the system was developed to run on the web and not on mobile platform.

[3] The design, implementation and evaluation of a web-based payroll management system (WPMS) was presented. The system was implemented using HTML, PHP, JavaScript, jQuery, AJAX, and MySQL programming languages. The developed system could calculate monthly and annual employees' salaries efficiently and effectively. Additionally, it incorporated features for keeping record of employee's data including their pay, allowances, and deductions on monthly bases in the data mart. The system could also automatically generate pay slips, accurate reports and detailed statistics of employees. The system was tested using system usability scale tool and Nielson ratings. The result revealed that 87.8% score of usability was achieved.

2.1 Review of Secured Web Based Attendance System

2.1.1 Application Integration in the System

Application Programming Interfaces (APIs) is a set of protocols, routines, and tools that allow different software applications to communicate with each other [3] in the context of a Web-Based Attendance System with GPS Integration, the API serves as a bridge that allows various system components (such as the frontend, backend, GPS tracking module, and payroll system) to interact efficiently. Some of the integration in the system includes: Representational State Transfer (REST) a newer alternative to REST is GraphQL enables more flexible querying of data by allowing clients to request only the specific data they need. It can be used to efficiently query attendance data and integrate with other systems like HR platforms or LMS. Web-based attendance systems will integrate with relational databases (e.g., SQLite database) to store attendance data. Using standard SQL queries, these databases can be accessed by other systems (HR, payroll, LMS) for reporting, data analysis, or synchronization. Attendance data is often stored on cloud platforms like Amazon Web Services (AWS), Google Cloud Platform (GCP), or Microsoft Azure. These platforms offer secure, scalable, and reliable storage for attendance records. Web-based attendance systems can integrate with cloud storage via APIs to store or retrieve data as needed. One of the most common integrations for attendance systems is with payroll systems. Attendance data such

as hours worked, leaves taken, and overtime is integrated with payroll systems to ensure accurate and timely employee compensation. This integration reduces manual data entry and errors, improving efficiency.

For field employees or remote workers, geo-fencing technology could be integrated with the attendance system. Employees' attendance can be automatically marked when they enter a defined geographical area, and their GPS coordinates are logged in real time

Security Tools in the System

Security technology plays a critical role in ensuring the safety of digital environments and its importance continues to grow as more businesses and services rely on online and cloud platforms [11]. Security is a critical concern in web-based attendance systems because they handle sensitive data, employee attendance records, personal information, and sometimes even biometric data. Ensuring the confidentiality, integrity, and availability of this data is paramount. Here are some key security technologies that will be used in the web-based attendance systems:

Encryption in Transit (TLS/SSL): The systems use Transport Layer Security (TLS) or Secure Sockets Layer (SSL) protocols to encrypt data transmitted over the internet. This ensures that data, such as username, password, and attendance records, are protected from interception by third parties during transmission and **Encryption at Rest:** Sensitive data stored in databases or cloud storage is encrypted using algorithms like AES (Advanced Encryption Standard) to protect it from unauthorized access, even if the storage system is compromised. Notwithstanding the Firewall protection like **Web Application Firewalls (WAF):** The Web-based attendance systems are often protected by web application firewalls, which filter and monitor HTTP traffic between the User's browser and the system's server. WAFs can block malicious requests like SQL injection, cross-site scripting (XSS), or denial-of-service (DoS) attacks. Also **Network Firewall:** This is used to protect the system's backend from unauthorized access and ensured that only trusted networks or users can gain access to critical system components. However, Sensitive information, such as attendance data or personally identifiable information (PII) can be masked before being displayed in the user interface, ensuring that only authorized personnel can access full details.

Web-based attendance systems will integrate with other systems (HR, payroll, etc.). To ensure secure communication between systems, APIs (Application Programming Interfaces) must be protected. Techniques like API keys, OAuth for access control, and rate limiting are used to secure API endpoints from abuse or unauthorized access. The primary objective of user authentication and role management is to ensure secure access to the system, thereby permitting only authorized individuals to register, view, or alter attendance records. This feature is essential for maintaining the integrity and confidentiality of sensitive information within the organization. Thus, the system incorporated secure login mechanisms utilizing GPS technology, which can serve as a substitute for or complement traditional password methods. A significant feature of this system is Role-Based Access Control (RBAC), which delineates distinct permissions for various user categories, including employees, managers, and administrators. This stratification guarantees that only those with the appropriate authorization can access critical attendance and payroll information, thereby enhancing data security.

Finally, Geo-location technology refers to the use of geographic data and tools to identify the physical location of a device,

individual, or object on the earth's surface [4]. It uses various data sources, such as GPS (Global Positioning System), IP addresses, Wi-Fi networks, and cellular towers, to determine the latitude, longitude, altitude, and sometimes even the specific address of a target [13]. Geo-location technology is widely used in applications ranging from navigation and location-based services (LBS) to asset tracking, marketing, and security. By utilizing this technology, businesses and individuals can access real-time location information, which can enhance user experiences, improve logistics, and enable many other innovations.

2.3 RESEARCH GAPS

Accountability is very crucial in business and organizations and it requires highly secure and flexible system. In the work carried out by [4], some gaps were discovered, which included loopholes in security measures and system flexibility efficiency; hence, by introducing multi-factor security measures and system integration with the payroll system the existing gaps was address in the developed system.

3. MATERIALS AND METHODS

The Object-Oriented Analysis and Design Methodology (OOADM) was utilized, it emphasizes the implementation aspects of a system, using the outcomes from the analysis phase, which includes classes, use cases, and behaviors, to develop architectural solutions that satisfy the system's requirements. In the design phase, the refinement and definition of classes were crucial, as this involved determining the attributes, methods, and access levels necessary for coding. Encapsulation plays a vital role by concealing an object's internal state and mandating that all interactions occur through clearly defined methods. Furthermore, it is essential to establish how objects will interact, which includes defining the public interface of each class, outlining the methods and properties that other objects can access. Relationships between objects, such as inheritance and polymorphism were also defined; for instance, "Manager" class could inherit from an "Employee" class, while polymorphism allows for the treatment of different class objects as instances of a common superclass, facilitating method overriding or overloading. Detailed designs, represented through Unified Modeling Language (UML) diagrams were created to illustrate the system's structure and interactions. Finally, the design process involved refinement and prototyping, where iterative improvements were made to ensure the design aligned with the specified requirements.



Figure 1: Basic Steps of System Design Using OOADM by Booch (1996)

3.1 Analysis of the System

The evolution of technology has significantly transformed various organizational processes; employee attendance and

payroll management are no exception. The system is a web-based attendance system that integrated payroll management system using geo-location technology, aimed at automating and optimizing the attendance tracking and payroll generation processes. An attendance system integrates Global Positioning System (GPS) technology and Internet Protocol (IP) to accurately track employees' work hours, with predefined work timings, ensuring precise attendance records based on their geographical location [12]. It allows employees to clock in and out using their work personal computer (PC) equipped with GPS chipset, ensuring that attendance is recorded only when the employee is physically present at the designated workplace. This eliminates deceitful clock-ins and improves accountability. The web interface provides real-time data collection, offering easy access for both employees and administrators to track and manage attendance. Additionally, the system automates the payroll process, integrating attendance data with salary computation based on working hours, leave days, overtime, and other parameters. This could reduce manual errors, minimizes administrative workload, and ensures timely payroll disbursement.

3.2 Architecture of the System

The high-level architectural design was categorized into several fundamental components. The client-side, or front-end or server-side, GPS location and the database. The front-end could be a web or mobile application, which provided the platform for employees log-in, clock-in and clock-out, attendance review, and retrieval of payroll information. The admin web application provided a dedicated interface for administrators to manage employee data, generate reports, and handle attendance approvals or rejections. The back-end or server-side encompassed several critical functions essential for system operations. It managed authentication and authorization processes, facilitating user login and verification. The database layer was integral to the system, housing various types of data including employee's information, such as names, IDs, hourly rates, and other pertinent details.

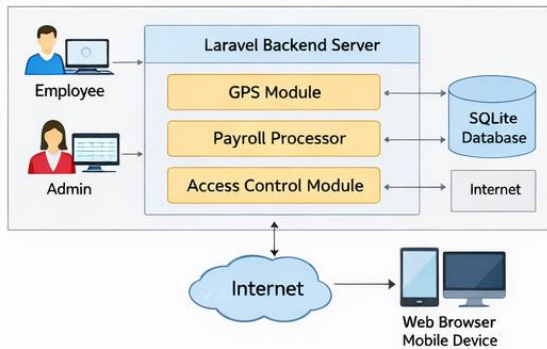


Figure 2: System Architecture Diagram

3.3 Algorithm of the System

- Step1: Start
- Step2: Login by staff (get the user ID and IP number)
- Step3: Searching for GPS location
 - 3.1 Read GPS coordinates for particular Staff
 - 3.2: Create polyline for the coordinates
 - 3.3: Get current GPS location for the staff
 - 3.4: If the staff within the boundaries or polyline
 - 3.5: send the user ID, to clock in and out module
 - 3.6: save attendance record into database.
 - 3.7: Notify the user for successfully clock -in or clock-out
 - Else

- Step 4: Clock-in and clock-out process not allowed Goto Step 2
- Step 4: Get attendance log list
- Step 5: If attendance is less than 90%
 - Deduct Salary
 - Pay full salary
- Step 6: End

3.4 SYSTEM DESIGN

A use case diagram for a web-based attendance and payroll system utilizing GPS technology delineates the primary interactions between various actors, such as users, and the system itself. This diagram illustrates the functionalities offered by the system and the manner in which users engage with these features. The System featured two main external actors: the employees and the admin. The employees primarily interact with the system to manage attendance.

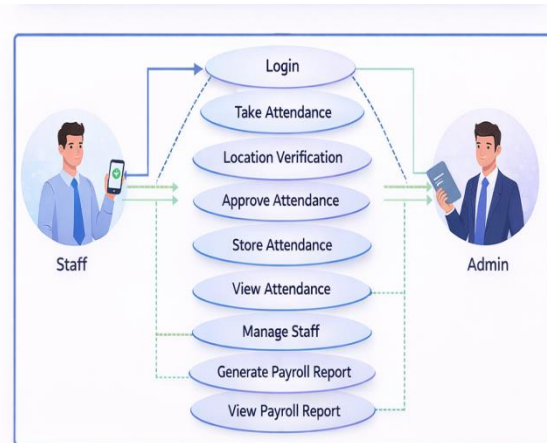


Figure 3: Use Case Diagram

4.1 Experimental Setup

The system was evaluated under controlled experimental conditions to assess its performance, accuracy, and scalability. Three datasets representing different organizational sizes were used:

- a. Small-scale: 20 users over 14 days
- b. Medium-scale: 100 users over 30 days
- c. Large-scale: 500 users over 60 days

The system was tested on a standard web environment using modern browsers under varying network conditions (stable, moderate delay, and low connectivity).

Performance evaluation focused on the following metrics:

- a. Attendance validation accuracy
- b. System response time
- c. Payroll computation accuracy
- d. System scalability under concurrent users

Simulated real-world scenarios included valid attendance, invalid location attempts, high user concurrency, and bulk payroll processing. developed system was evaluated to determine its effectiveness, reliability, and performance in handling attendance tracking and payroll automation using GPS-based verification. The evaluation was conducted through functional testing, performance testing, and user-based assessment.



Figure 4: System Home Page Showing Login and Registration Interface

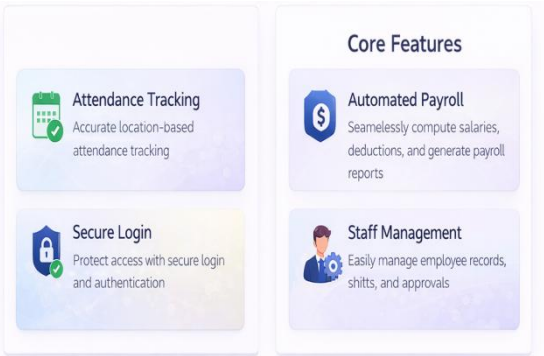


Figure 5: Core Features of the Log-in Page

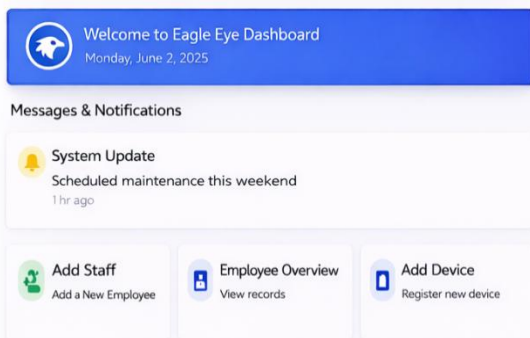


Figure 6: Admin Dashboard showing Admin Privileged

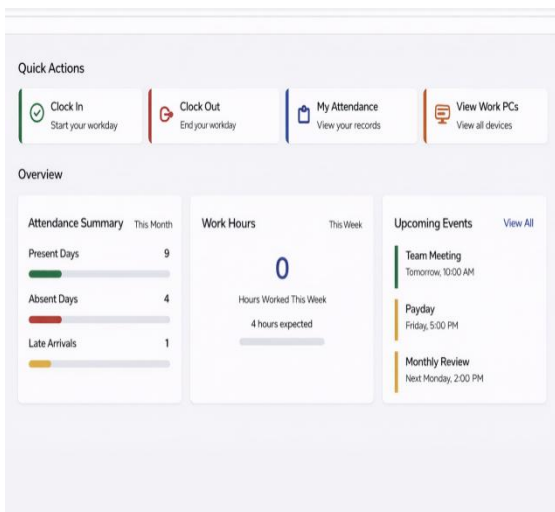


Figure 7: Showing Employee Attendance History

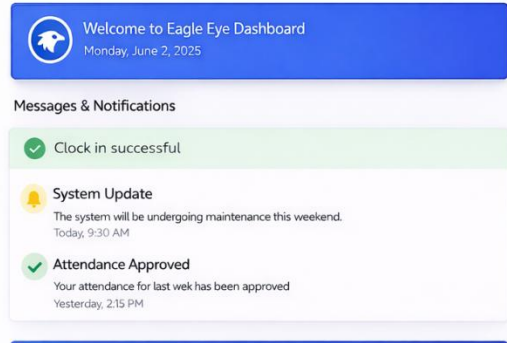


Figure 8: Employee Successful Clock-in

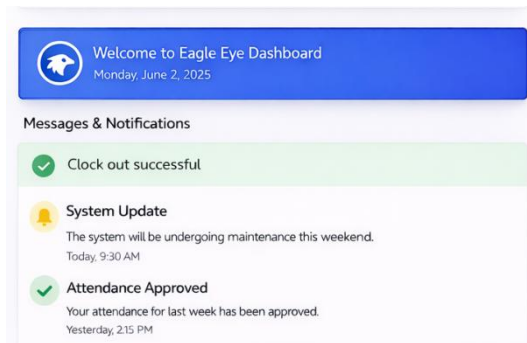


Figure 9: Employee successful Clock-out

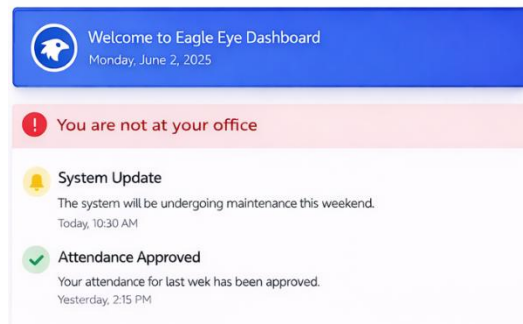


Figure 10: Employee attendance Denial

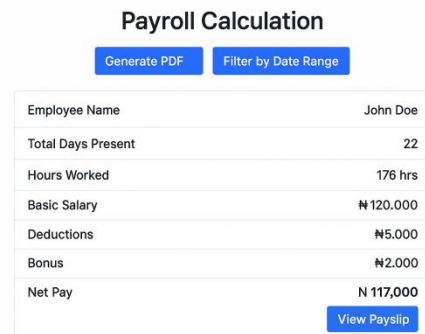


Figure 11: Showing Employee Pay slip

4.2 Results and Discussion

The developed system was evaluated to determine its effectiveness in attendance tracking and payroll automation.

4.2.1 Attendance Accuracy

The system achieved high accuracy across all datasets, with an average accuracy of 98% in validating user location during clock-in and clock-out operations.

Valid attendance attempts within the predefined geofence were successfully recorded, while unauthorized attempts outside the permitted area were rejected (Figures 8–10). This confirms the effectiveness of the GPS-based geo-fencing mechanism in preventing fraudulent attendance.

4.2.2 System Response Time

Performance testing showed:

Login response time: < 2 seconds

Attendance logging: 1–3 seconds

Payroll generation: < 5 seconds

These results indicate that the system is suitable for real-time applications and maintains acceptable performance even under moderate load conditions.

4.2.3 Payroll Computation Accuracy

The payroll module demonstrated 100% accuracy during testing. Salary calculations based on attendance records, overtime, and deductions were correctly generated without discrepancies (Figure 11).

This significantly reduces manual errors commonly associated with traditional payroll systems.

4.2.4 Scalability and Load Performance

The system maintained stable performance for up to 200 concurrent users. Beyond this threshold, minor latency was observed, indicating the need for future optimization through load balancing and caching techniques.

4.2.5 Security Evaluation

Security testing confirmed that:

Unauthorized login attempts were successfully blocked

GPS spoofing attempts were detected and rejected

Role-Based Access Control prevented privilege escalation

These results demonstrate that the system provides a robust multi-layered security framework.

4.2.6 Usability Evaluation

Users were able to complete attendance operations within a few seconds, indicating high system usability. The interface design supports ease of navigation and efficient task execution, reducing the need for extensive user training. System successfully implemented all core modules, including:

1. User authentication and authorization
2. GPS-based attendance validation
3. Automated payroll computation
4. Role-Based Access Control (RBAC)
5. Administrative dashboard and reporting tools

All tested functionalities performed as expected under standard operating conditions. Table 2 presents a summary of functional testing outcomes.

4.2.7 Comparative Performance Analysis

Compared to existing systems, the developed system demonstrated improvements in the listed features as illustrated in the Table 1:

Table 1 Comparative Performance Analysis

Feature	Existing Systems	Developed System
Attendance Accuracy	Moderate	High (98%)
Payroll Integration	Limited	Fully Automated
Fraud Prevention	Weak	Strong (GPS-based)
Accessibility	Device-dependent	Web-based (universal)
Security	Basic	Multi-layered

4.2.8 Addressing Identified Problems

At the outset of the project, several problems were identified in the existing attendance and payroll systems, such as:

a. Vulnerability to Fraud

The previous system allowed an employee to clock in or out for another employee, creating opportunities for fraud and abuse. With the introduction of GPS-based clocking in/out, the system ensured that employees can only clock in when they are physically present at the designated location such as office or work site. This dramatically eliminates the possibility of fraud.

b. Truancy and Time Flexibility

The previous system lacked defined working hours for clocking in, which led to employees clocking in or out at arbitrary times. With the new system, GPS validation and predefined geofencing (mapping an area within which employees must clock in) help enforce strict attendance policies. Employees can only clock in or out when they are within a defined geographic area at specified time, ensuring that the attendance logs are accurate and that employees are present at the required locations.

c. Salary Discrepancies

Another issue identified was salary discrepancies caused by inaccurate attendance records. By automating attendance tracking and linking it directly with the payroll system, discrepancies related to incorrect clock-in/out times, missed shifts, or overtime is minimized. The system uses real-time tracking and automated payroll calculations based on accurate attendance data, ensuring that employees are paid accurately according to the hours worked. This was a critical aspect, as employees' attendance and payroll data are highly sensitive.

4.2.9 Functional Testing

Each module was tested to validate that expected behaviors occurred under typical user scenarios. A sample of the test cases is shown in Table 2.

Table 2: System Functional Testing

Test Case	Description	Expected Result	Actual Result
TC01	Valid user login	Access granted	Pass
TC02	GPS-based clock-in	Location verified	Pass
TC03	Payroll computation	Accurate salary output	Pass
TC04	Invalid location attempt	Access denied	Pass

The results demonstrate that the proposed system significantly improves attendance accuracy, security, and payroll efficiency compared to traditional and existing automated systems. Unlike RFID and biometric systems, the integration of GPS-based validation ensures location authenticity, while the web-based architecture enhances accessibility. The system also outperforms existing solutions by providing seamless payroll integration, thereby reducing administrative overhead and improving operational efficiency.

5. CONCLUSION AND RECOMMENDATIONS

In summary, the deployment of the web-based attendance and payroll management system utilizing PHP Laravel and GPS technology effectively tackled the fundamental issues associated with conventional attendance and payroll systems. The system was designed with emphasis on automation, transparency, and real-time tracking, all of which played a crucial role in enhancing its efficiency and user acceptance. The incorporation of GPS capabilities facilitated precise location-based attendance recording, which significantly eliminated occurrences of proxy attendance record and time theft. Employees can only check in and out when they are physically present at the specified work location, thus enhancing the dependability of attendance records.

However, during the testing phase, the system was implemented in a simulated workplace setting. The outcomes demonstrated 98% accuracy rate in capturing the time and location of check-ins/check-outs. Payroll calculations derived from attendance data were automatically generated at the conclusion of each month, and system logs revealed no inconsistencies in salary calculations. The utilization of Laravel's inherent features such as Eloquent ORM, Blade templating, and authentication guaranteed secure and seamless operations. Additionally, the system could enable administrators to view, filter, and export attendance reports in real time, as well as access payroll summaries with graphical representations for analysis. This advancement could improve administrative oversight and alleviate the burden of manual payroll processing.

The adoption of this system presents numerous benefits for educational institutions such as schools, colleges, and universities. Corporate environments with remote, hybrid, and on-site work models as well as public and private organizations where attendance tracking is crucial for compliance, reporting, or performance monitoring can benefit from this system. Future improvements on this work can focus on refining GPS-based accuracy, and expanding scalability through cloud technology to accommodate larger number of users.

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