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Design of a Meeting Attendance System Based on Dynamic QR Code with Universally Unique Identifier (UUID v4)

Kholifah Dwi Annurrahma[-1], Sayekti Harist Suryawan[-2], Abdul Rahim[-3]

Informatics Engineering
Faculty of Science and Technology
Universitas Muhammadiyah Kalimantan Timur
2111102441106@umkt.ac.id[-1], shs500@umkt.ac.id[-2], ar622@umkt.ac.id[-3]

Abstract

Manual attendance systems are still widely used in various institutions, including the Quality Assurance Agency of Muhammadiyah University of East Kalimantan (LJM UMKT), despite their limitations such as vulnerability to data manipulation, slow recapitulation, and paper dependency. This study aims to design and implement a digital meeting attendance system using dynamic QR Codes generated with UUID version 4, combined with GPS-based location validation. The system was developed using the prototyping method through stages of requirements analysis, UML-based system modeling, technical design with Flask and MySQL, prototype development, testing, and evaluation. System testing was carried out using the black-box method to verify functional performance, while evaluation was conducted using the Technology Acceptance Model (TAM), focusing on three constructs: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), and Behavioral Intention to Use (BI). The testing results demonstrate that the system runs stably and effectively validates attendance based on time and location. Evaluation with 16 respondents indicated high user acceptance, with PU at 94.6%, PEOU at 88%, and BI at 96%. These findings suggest that the QR Code-based attendance system with UUID v4 significantly improves efficiency, accuracy, and security in recording meeting attendance and has strong potential for broader implementation in educational institutions and organizations.

Keywords: Digital Attendance, Dynamic QR Code, UUID v4, Location Validation, Prototyping, TAM

Abstrak

Sistem presensi manual masih banyak digunakan di berbagai institusi, termasuk Lembaga Jaminan Mutu (LJM) Universitas Muhammadiyah Kalimantan Timur, meskipun memiliki sejumlah kelemahan seperti rawan manipulasi data, lambat dalam rekapitulasi, dan boros arsip kertas. Penelitian ini bertujuan merancang dan mengimplementasikan sistem presensi rapat digital berbasis QR Code dinamis menggunakan UUID versi 4 dengan validasi lokasi berbasis GPS. Pengembangan sistem dilakukan dengan metode prototyping melalui tahapan analisis kebutuhan, pemodelan sistem menggunakan UML, perancangan arsitektur berbasis Flask dan MySQL, pembuatan prototipe, pengujian, serta evaluasi. Pengujian dilakukan menggunakan metode black-box untuk memastikan fungsi sistem berjalan sesuai kebutuhan, sedangkan evaluasi dilakukan menggunakan model Technology Acceptance Model (TAM) yang meliputi tiga konstruk, yaitu Perceived Usefulness (PU), Perceived Ease of Use (PEOU), dan Behavioral Intention to Use (BI). Hasil pengujian menunjukkan sistem berfungsi stabil dan mampu memvalidasi presensi berdasarkan waktu serta lokasi. Evaluasi terhadap 16 responden menghasilkan tingkat penerimaan pengguna yang tinggi, dengan skor PU sebesar 94,6%, PEOU sebesar 88%, dan BI sebesar 96%. Hasil ini menunjukkan bahwa sistem presensi berbasis QR Code dinamis dengan UUID v4 dapat meningkatkan efisiensi, akurasi, serta keamanan pencatatan kehadiran, serta berpotensi untuk diimplementasikan lebih luas pada institusi pendidikan maupun organisasi lainnya.

Kata kunci: Presensi Digital, QR Code Dinamis, UUID v4, Validasi Lokasi, Prototyping, TAM

INTRODUCTION

The rapid advancement of digital technology has significantly influenced various sectors, including attendance recording systems. Attendance is a critical element in organizational activities, particularly meetings, which serve as platforms for coordination, evaluation, and collective decision-making (Neha Kamble,

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Dhanashri Waghmare, Surajkaumar Desai, 2023). However, many institutions still rely on manual attendance methods, typically using paper-based signatures, which are prone to errors, data manipulation, and inefficiency (Yusuf, 2023).

At the Quality Assurance Agency of Muhammadiyah University of East Kalimantan (LJM UMKT), the current attendance system remains conventional, relying on manual signatures (Yusuf, 2023). This approach presents challenges in legibility, slow recapitulation, and paper waste, while physical archives are vulnerable to loss or damage. Therefore, a more modern and efficient digital solution is needed (Asvin, Suradi, & Syarwani, 2021).

The implementation of Quick Response (QR) Code technology offers a promising alternative in digitizing attendance systems, due to its simplicity and ability to store data in a scannable two-dimensional format via mobile devices (Syahputra & Rahayu, 2024). Nevertheless, static QR Codes are still widely used, despite their vulnerability to misuse—for example, the same code can be reused or shared without control over location and time (Agripa & Astillero, 2022; Kee, 2021).

To address these issues, this study proposes the development of a digital attendance system using dynamic QR Codes based on UUID version 4 (Universally Unique Identifier). These QR Codes are valid only for a limited period during the meeting session and are reinforced with GPS-based location validation, ensuring that attendance can only be marked within the designated radius.

The research employs a prototyping method, which enables incremental system development through iterative feedback. System evaluation uses the Technology Acceptance Model (TAM), focusing on users' perceived ease of use and perceived usefulness.

This research aims to design a secure, efficient, and user-accepted digital attendance system. The contribution of this study is expected to improve operational efficiency at LJM UMKT and serve as a reference for broader implementation of adaptive digital attendance systems in other institutions.

RESEARCH METHODS

Types of research

This study is a software engineering research using a prototyping approach. The prototyping method allows for incremental system development through iterative feedback. This method is suitable for developing a digital attendance system that needs to be validated directly by user requirements.

Time and Place of Research

The study was conducted from January to July 2025 at the Quality Assurance Agency of Muhammadiyah University of East Kalimantan (LJM UMKT). The institution was chosen as the case study due to its continued use of manual attendance for meetings.

Research Target / Subject

The research subjects included meeting participants, administrative staff, and system administrators within LJM UMKT. Subjects were selected purposively based on their direct involvement in the attendance process and data management.

Procedure

This study adopts an iterative prototyping method, starting from the development of an initial system model and refined into a final version through user feedback. This approach aims to ensure functional accuracy and ease of use in the implementation of a digital attendance system (Nur, Waita, & Asa, 2023).

Figure 1. Research Stages of the Prototyping Method

The stages of the prototyping method used in this study include:

1. Analysis of Requirements

This stage includes observation and interviews to identify issues in the manual attendance system and to formulate the system requirements. The process is also supported by a GAP analysis between the manual system and the proposed digital system.

2. System Modeling

At this stage, the system was modeled using *Unified Modeling Language* (UML) to describe the system flow, interactions, and structure. The diagrams created include:

- Use Case Diagram, to represent the actors and their interactions with the system.
- Activity Diagram, to model process flows such as login, QR Code generation, and attendance validation.
- Class Diagram, to illustrate the main data structure, including user entities, meetings, attendance records, and UUID v4.

3. System Design

After the needs analysis and system modeling were completed, the next step was technical system design. This included user interface wireframes and a client-server architecture using Flask and MySQL. The design served as the foundation for prototype development in the next stage.

4. Prototype Development

Based on the design and modeling, a digital attendance system prototype was developed using Python (Flask) and MySQL. Key features include authentication, dynamic QR Code with UUID v4, and location validation based on coordinate points.

5. Testing

Black-box testing was conducted to ensure system functions met specifications, including QR Code scanning, location validation, time limits, and duplicate attendance detection.

6. Evaluation

Evaluation used the TAM model with three constructs: PU, PEOU, and BI (Wicaksono, 2022). Responses were collected via a 5-point Likert questionnaire and analyzed descriptively to refine the system.

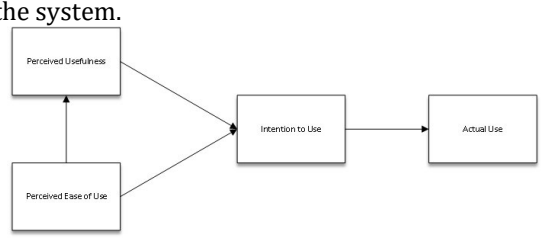

Figure 2. Model TAM

7. Prototype Refinement

Improvements were made iteratively based on testing and evaluation, focusing on the interface, location validation, and usage flow to ensure system stability and responsiveness.

8. Final Implementation

The system was fully implemented at LJM UMKT in July 2025 through a real meeting simulation, proving its readiness for operational use.

Data, Instruments, and Data Collection Techniques

This study used both primary and secondary data. Primary data were obtained through observation, interviews, and TAM-based questionnaires. The instruments included interview guides and 5-point Likert-scale questionnaires. Secondary data came from documentation of manual attendance systems and relevant literature. All data were collected directly at LJM UMKT.

Data analysis technique

Qualitative data were analyzed descriptively to define system requirements. Quantitative data from the TAM questionnaires were analyzed using descriptive statistics to evaluate user perceptions of the system.

RESULTS AND DISCUSSION

Interview and Observation Results

Observations and interviews conducted at LJM UMKT revealed that the attendance system remains manual, slow, and error-prone due to the use of handwritten signatures on paper and physical archive storage. This condition no longer meets the institution's need for efficiency and accuracy. Therefore, these findings serve as the primary basis for developing a digital attendance system that is efficient, secure, and well-integrated.

Analysis of Requirements

Requirements analysis was conducted to design a digital attendance system to replace the manual process, which is slow, error-prone, and inefficient. Based on the GAP analysis, a system using dynamic QR Codes and UUID v4 is considered more efficient, secure, and accessible. Table 1 summarizes the comparison between the current manual system and the proposed digital system.

Table 1. GAP Analysis Between Manual and Digital Systems

Aspect	Manual System	Digital System
Attendance	Paper-based signature	Dynamic QR Code scan
Security	Susceptible to proxy sign	UUID, location, and time validation.
Recapitulation	Manual, slow	Automatic, real-time
storage	Pyhsical archives	Digital, backup-ready

Functional requirements are defined based on user roles, where admins manage users and attendance records, staff generate QR Codes and monitor sessions, and participants scan QR Codes to record their presence, as shown in Table 2.

Table 2. Functional Requirements

Role	Main Features
Admin	Manage users and meetings, view attendance
staff	Create meetings, display QR Codes, monitor logs

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Participant	Login, scan QR, view attendance history

Non-functional requirements include usability, portability, security, and maintainability, as summarized in Table 3.

Table 3. Non-Functional Requirements

Aspect	System Implementation
Usability	Simple and intuitive user interface
Portability	Accessible via browser without installation
Security	Attendance validates with UUID and GPS coordinates
Maintainable	Modular structure to support future development

The usage scenario involves user interaction workflows tailored to each role. Admins log in to manage users and generate reports, staff create and share QR Codes for meetings, and participants scan the codes to record their attendance. Each role interacts with the system through a distinct yet integrated process.

System Modelling

The system was modeled using the Unified Modeling Language (UML) to illustrate the structure, interactions, and behavior of the system. The diagrams used include the use case diagram, class diagram, and selected activity diagrams to represent essential processes.

1. Use Case Diagram

The use case diagram describes the interaction between users and the system based on roles and access rights. There are three main actors: admin, staff, and participant. Admins manage users and attendance data, staff generate QR Codes and monitor participation, while participants log in and perform attendance by scanning QR Codes.

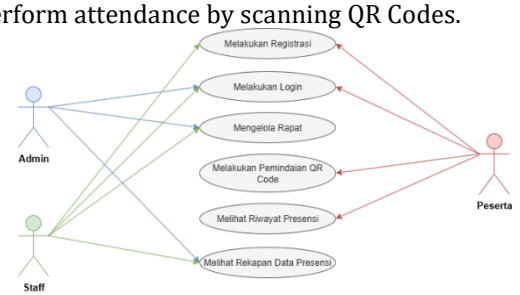

Figure 3. Use Case Diagram - Admin and Staff, Participant

2. Activity Diagram

Activity diagrams were developed to model the flow of key system processes based on user roles. The selected diagrams cover the main activities: registration, login, meeting creation, QR Code scanning, attendance history access, and attendance recap.

- User Registration

The registration process is carried out by both participants and staff through the presensi application.

a) Participant Registration

Participants access the application, fill out the registration form, and their data is stored in the database. The system confirms success and redirects them to the dashboard without requiring a login.

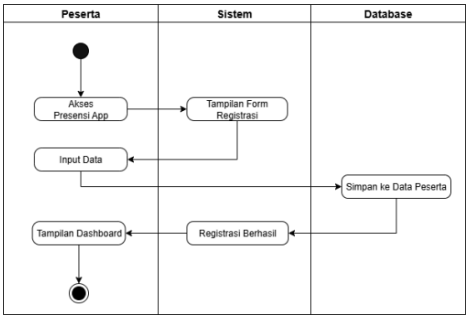

Figure 4. Activity Diagram Registration Participants

b) Staff Registration

Staff select their role, complete the registration form, and their data is saved in the staff database. After successful registration, staff are directed to the login page.

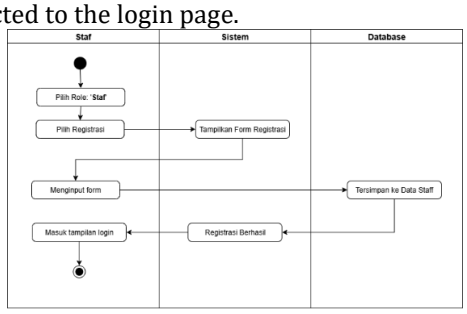

Figure 5. Activity Diagram Registration Staff

- User Login

Represents the authentication process for all user roles to access the system dashboard.

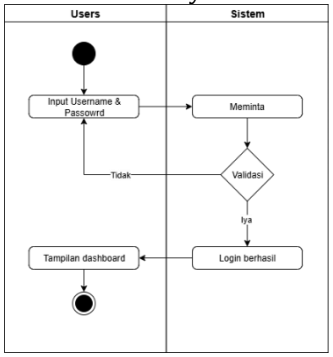

Figure 6. Activity Diagram User Login

- Create Meeting

Outlines the process of adding a new meeting, generating a dynamic QR Code, and saving the data.

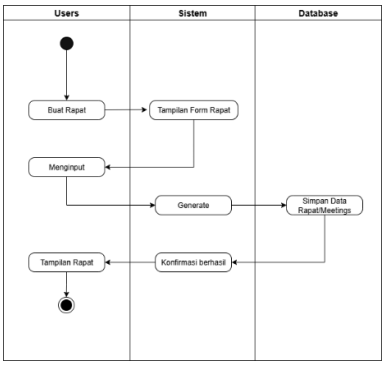

Figure 7. Activity Diagram Create Meeting

- QR Code Scanning

Illustrates how participants scan the QR Code during a meeting and how the system validates their presence using UUID and location.

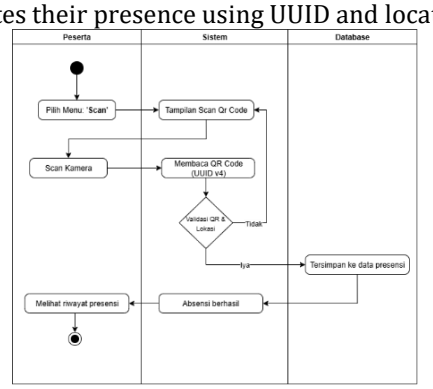

Figure 8. Activity Diagram QR Code Scanning

- Attendance Recap

The Attendance Recap activity diagram illustrates the process where users select the Recap menu, after which the system displays attendance data and provides participant attendance information in real time.

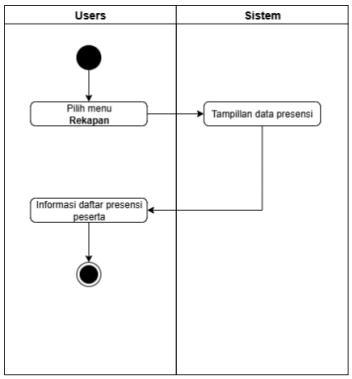

Figure 9. Activity Diagram Attendance Recap

3. Class Diagram

The class diagram outlines the system's data structure and the relationships among core entities, including User, Admin, Staf, Participant, Meeting, and Attendance. The User class acts as the authentication base, while the Meeting and Attendance classes handle scheduling, QR generation, and check-in recording.

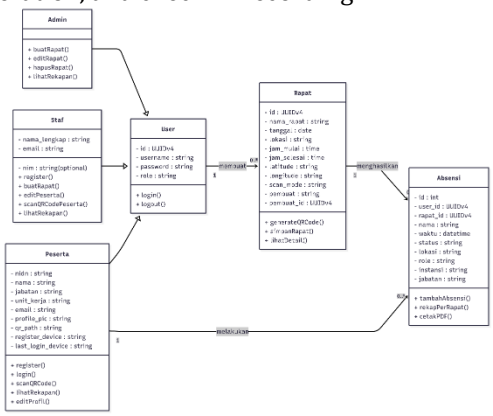

Figure 10. Class Diagram

System Design

1. User Interface Design

The user interface was designed using wireframes to ensure accessibility and usability for all user roles. Key screens include the:

- Login Page

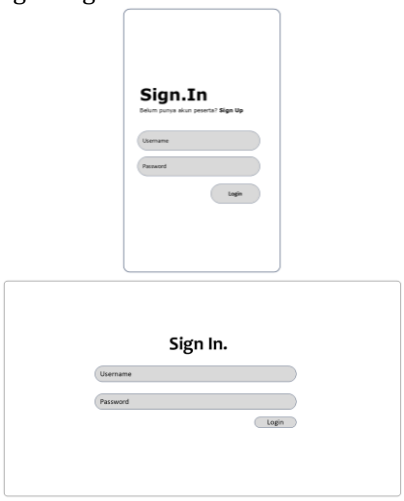

Figure 11. Login Page

- Participant and staff registration

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Figure 12. Participant and Staff Registrasion

- User Dashboards

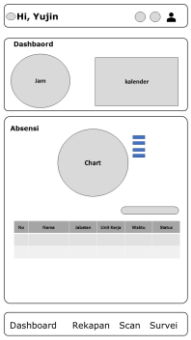

Figure 13. Dashboard Participant

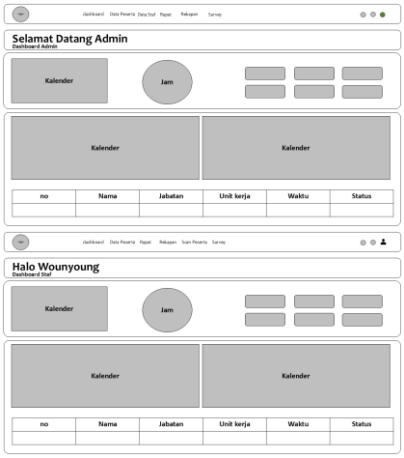

Figure 14. Dashboard Admin and Staff

- Create Meeting

Figure 15. Meeting Creation Form

- QR Code Scanning

Figure 16. QR Code scanning interface

- View Attendance History

Figure 17. View Attendance History

- Attendance Recap

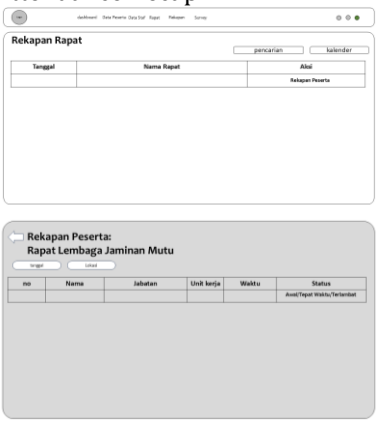

Figure 18. Attendance Recap

2. System Architecture

The system uses a client-server architecture with Flask as the backend framework. Users access the system via browser, while data is stored in MySQL and temporarily cached using JSON. Libraries such as uuid, qrcode, and geopy support the core functions. The architecture is shown in Figure 9.

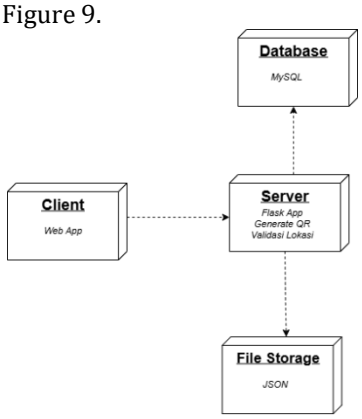

Figure 19. Deployment Diagram.

Prototype Development

The prototype was developed using Flask and MySQL to test core system functions without user interface styling, including:

- Role-based login
- Meeting creation
- QR Code generation (UUID v4)
- Attendance via QR scan
- GPS location validation
- Attendance data storage

This prototype served as the foundation for testing before final implementation.

System Testing

System testing was conducted using the blackbox method to ensure all features function as expected under valid and invalid input scenarios. The test results are shown in Table 4.

Table 4. System Testing Results

Feature	Test Scenario	Result
Participant registration	Valid data	Passed
Staf registration	Valid data	Passed
Invalid registration	Empty form/ duplicate email	Failed
Successful login	Correct email & password	Passed
Failed login	Incorrect email or password	Failed
Generate QR Code	Valid meeting schedule input	Passed
Valid QR scan	Active QR, correct timw & location	Passed
Invalid location scan	Outside allowed GPS radius	Failed
Expired QR scan	Scanned after QR expiration time	Failed
View attendance history	Access attendance record	Passed
View attendance recap	Admin/staff access recap data	Passed

The results confirm that all features work as intended. The system successfully handles various input conditions and is ready for further implementation.

Evaluation System

The evaluation assessed user acceptance of the QR Code-based attendance system using the Technology Acceptance Model (TAM), which includes three constructs: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), and Behavioral Intention to Use (BI). These constructs measure how useful, easy to use, and likely the system is to be adopted by users.

A total of 16 respondents completed a questionnaire using a 5-point Likert scale. The average results for each indicator are shown in Table 5.

Table 5. Average Score per TAM Indicator

Indicator Code	Average	Percentange
PU1	4.8	96.0%
PU2	4.6	92.0%
PU3	4.8	96.0%
PEOU4	4.6	92.0%
PEOU5	4.4	88.0%
PEOU6	4.2	84.0%
BI7	4.8	96.0%
BI8	4.8	96.0%

The average for each TAM variable is summarized in Table 6.

Table 6. Average per TAM Variable

Variable Code	Average	Percentange
PU	4.73	94.6%
PEOU	4.4	88.0%
BI	4.8	96.0%

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Figure 20. TAM Evaluation Chart

The evaluation results indicate that users find the system highly useful, easy to use, and show strong intention to continue using it as an effective and efficient attendance solution.

Refening Prototype

The prototype was improved based on testing results and user feedback. Enhancements included QR Code scanning stability, location validation, attendance recording, and user interface refinement. Security features were also strengthened. Improvements were made iteratively until the system was ready for final implementation.

Implementation

The e-Presensi system based on QR Code and UUID v4 was implemented using Flask and MySQL. Key features include user authentication, meeting management, QR Code scanning with location validation, and attendance recaps. UUID v4 ensures each QR Code is unique, time-limited, and secure for one-time use.

- Participant Interface

Figure 21. Participant Login Page

Users log in using their registered email and password.

Figure 22. Participant Registration Page

Form to create a new account by entering name, email, and password.

Figure 23. Participant Dashboard

Displays ongoing or upcoming meetings.

Figure 24. QR Code Scanning Page

Participants scan a QR Code, verified with GPS and UUID v4.

Figure 25.Attendance Recap Page

Shows attendance list and status (early, on time, late).

- Admin and Staff Interface

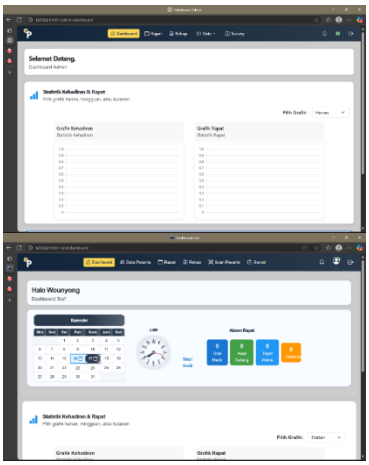

Figure 26.Admin and Staff Dashboard

Shows meeting statistics, participant count, and navigation menu.

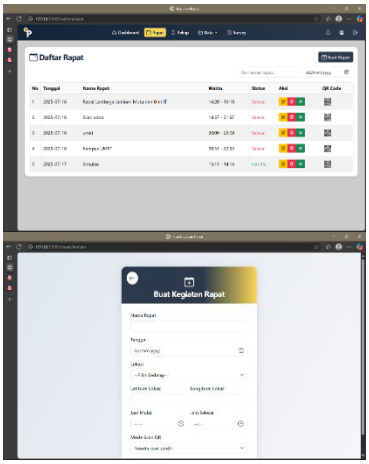

Figure 27. Meeting List & Input Form

Displays the meeting list and a form to add new meetings. Once submitted, the system automatically generates a dynamic QR Code using UUID v4.

Figure 28. Example of Meeting QR Code

This QR Code is dynamically generated using UUID v4 and is valid for a single meeting session with a limited active period.

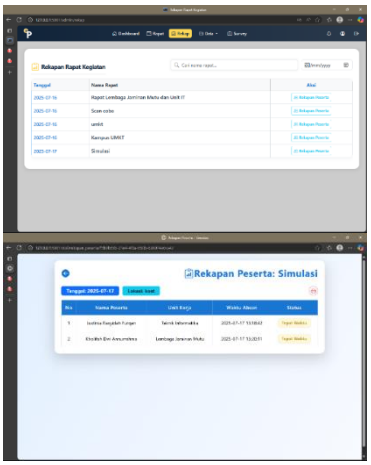

Figure 29. Attendance Recap

Displays a list of attendees along with their arrival status, such as "Early Arrival", "On Time", and "Late".

Discussion

The QR Code and UUID v4-based attendance system effectively addressed issues in manual attendance, improving accuracy and security. All features ran smoothly for admin, staff, and participants.

TAM evaluation results showed high user acceptance in terms of ease of use, usefulness, and intention to use, indicating that the system is ready for implementation and further development.

CONCLUSIONS AND SUGGESTIONS

Conclusion

This study has successfully developed a digital meeting attendance system using dynamic QR Codes based on UUID v4 with integrated GPS validation and MySQL–JSON data storage. The system was built using the prototyping method and evaluated through the TAM model. Testing confirms that all system functions meet both functional and non-functional requirements. Key features, including multi-role login, meeting management, QR scanning, and real-time attendance logging, were implemented and performed effectively at LJM UMKT. The results also show strong user acceptance, indicating that the system is feasible for wider implementation..

Suggestion

This system offers significant benefits in enhancing the speed, accuracy, and security of meeting attendance. It also supports digital transformation in administrative processes within institutions. For future development, it is recommended to integrate real-time notifications,

automated scheduling, and analytics dashboards to support data-driven decision-making. Further studies can explore integration with institutional platforms or expansion for classroom attendance and broader organizational use

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