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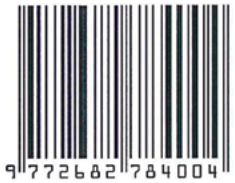

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THE DEVELOPMENT OF SCANSERVE – SMART QR-DRIVEN SUMMONS APPLICATION FOR STREAMLINED DISCIPLINARY CASE MANAGEMENT: A STEP TOWARDS A SMART CAMPUS

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ABSTRACT

To create a more efficient and technologically advanced campus environment, this paper presents the development of a Smart QR-Driven Summons Application for streamlined disciplinary case management. Leveraging the Mobile Application Development Life Cycle (MADLC) as the methodology, using Android Studio and Firebase, the system is designed to automate and enhance the traditional method of issuing and managing disciplinary summons within academic institutions. The proposed solution integrates Quick Response (QR) code technology, enabling the rapid generation, distribution, and tracking of summonses via mobile devices. This innovation not only reduces the administrative burden but also minimises errors associated with manual processes. A detailed system interface is presented to illustrate the application's functionalities and user experience. To evaluate the effectiveness and usability of the application, a System Usability Scale (SUS) test was conducted, yielding positive results that underscore the potential of the application in contributing to the development of a smart campus ecosystem. The findings demonstrate the application's capability to improve operational efficiency and user satisfaction, marking a significant step towards the digital transformation of disciplinary processes in educational institutions.

1. Introduction

With such tremendous growth in the usage of smart technologies, many universities are considering adopting the concept of a smart campus. A smart campus can be defined as deploying advanced information and communication technology (ICT) to enhance the effectiveness and efficiency of campus activities (Zhang, Yip, Lu & Dong, 2022). Traditional campuses have been transformed from paper-based to digital to smart campuses in the last three decades or so, depending on the location of the campus and resources (Alrashed, 2020).

Based on the literature, the enabling technologies for smart campuses include cloud computing, IoT, virtual reality (VR), AR, artificial intelligence (AI), and mobile devices. Zhang, Yip, Lu, and Dong (2022) have categorised them into 5 domains: data computing and storage technologies, IoT technologies, intelligent technologies, immersive technologies, and mobile technologies. In a unified view proposed by Alrashed (2020), the main components of smart campus management are communications with parents/students, reporting, and transparency. Qurtubi, 2022, highlighted that the provision of applications and content of campus services need to be implemented to support the convenience of students.

Campus regulations are crucial in promoting safety and security. By enforcing these rules, universities can create a safer environment, minimising risks to students and staff. Clear regulations provide mechanisms for resolving disputes and handling misconduct, essential for maintaining a peaceful and productive campus environment. Students and staff indirectly understand the expectations and consequences of their actions, ensuring that the academic and social environment remains conducive to learning and personal growth. The following are examples of rule violations within the campus: violations of dress code, unauthorised parking and unregistered vehicles, exceeding the vehicle speed limit, failure to wear helmets on campus, and possession of prohibited items.

The main problem of a paper-based summons system is its manual processing, which causes delays in issuing and delivering the summonses (Mohd Noor, 201). Manual entry and processing also increase the likelihood of mistakes, such as incorrect details on the summonses, misplacement of documents, or issuing summonses to the wrong individuals. Tracking paper summonses can be challenging, especially in large institutions. There is a higher risk of documents being lost, misplaced, or not delivered to the intended recipients (Abdullah, 2013). A more efficient, transparent, and secure system for handling disciplinary cases is needed.

By leveraging QR code technology coupled with mobile devices, the application aims to simplify and modernise administrative procedures, reduce manual data entry, and improve the overall efficiency of campus regulation management. This technological advancement will reduce administrative burden, contributing to a broader goal of creating a smart campus environment.

The main contribution of this project is the development of a smart QR-driven summons application to store campus rule violation case records and facilitate the offenders (students and staff) and the enforcement team in making quick and accurate checks on summonses.

2. Literature Review

The QR code technology, an essential component of the Smart QR-Driven Summons Application project, is a dynamic and efficient tool for encoding and decoding information. As Suwait (2016) explains, a QR code, short for "Quick Response," is a matrix bar code or two-dimensional code designed to store various types of data information. Recognisable by its square pattern of black modules on a white background, a QR code can contain text, URLs, or other data,

allowing quick decoding at high speeds. This technology has gained widespread popularity globally, with the prevalence of mobile phones equipped with cameras enabling seamless recognition of QR codes. Notably, QR codes can store substantial information, making them versatile for many applications.

The QR codes have been used widely, especially in tasks like payment and ticketing. Beyond these applications, QR codes offer many advantages, particularly in campus environments. According to Prasad et al. (2023), QR codes can significantly promote smart campuses by providing quick access to information. The numerous advantages of QR codes include their high data capacity, compact size, resistance to dirt and damage, adaptability to various scanning angles, and structured aggregation. These features collectively make QR codes an efficient and versatile tool for enhancing information accessibility and interaction within a campus setting.

The integration of QR technology in taking attendance can be seen in Vinoth, Gokulraj and Gopinath; Bakar et al., 2021; Agripa and Astillero, 2022), library management system (Din & Fazla, 2021), hostel residents management system (Olaiya, 2021), café food ordering (Masandig, Azhari, Hisham & Hisham, 2022), campus routing for indoor navigation (Padmaja et al., 2022), keyless entry system, and campus office management system (Dagtekin, Gümüş, & Olca, 2022). Examining similar summons systems or related works offers valuable insights when developing smart QR-driven summons applications. The comparison between the features in the existing similar summons systems and the proposed system can be seen in Table 1.

Table 1
Summary of comparison between the proposed system and existing systems

Features	***ScanServe – Smart-QR Driven Summons Application***	***MyBayar PDRM***	***MyJPJ***	***VROOM: Vehicle Registration and Summons on the Move (Selamat & Sim, 2016)***	***E-Summons UTM (Mohd Rashid & Patel, 2018)***	***UTP m-Summons System (Mohd Noor, 2011)***
Sign up/Login	✓	✓	✓	✓	✓	✓
Notification	✓	✓	✓	✓	✓	✓
Summons Payment	x	✓	✓	x	x	✓
Vehicle Registration	✓	x	x	✓	x	x
Summons Check	✓	✓	✓	x	✓	✓
Summons History	✓	✓	✓	x	x	✓
Summons Issuance	✓	x	x	✓	✓	✓
Image Evidence	✓	x	x	✓	x	✓
QR-code	✓	x	x	x	x	x

3. Methodology

Developing the Smart QR-driven Summons Application for managing campus regulation requires a structured approach that ensures efficient collaboration between developers, stakeholders, and end-users. MADLC is a proven methodology that guides the comprehensive development of mobile applications, emphasising features and design. MADLC's distinct phases

provide a systematic and organised progression that contributes to the application's functionality, user-friendliness, and overall success in addressing the challenges in campus regulation management. Vithani and Kumar (2014) highlighted MADLC's track record of success in the realm of Android mobile application development, making it a reliable approach to guide the development process of this application.

Figure 1. MADLC Phases

4. Proposed Framework

Figure 2 shows the system architecture framework of the Smart QR-Driven Summons Application, consisting of three main components, which are a mobile application for students and staff, a database, and an administrator interface. The administrator can register students and staff and generate a unique QR code linked to their personal information in the database. However, to facilitate the process, the developed system will be linked to a university's main database to directly obtain the data of all students and staff. This removes the tedious and time-consuming manual registration of each staff/student by the administrator. Enforcement officers known as 'Polis Bantuan' (PB) can identify students and staff by scanning the QR code on their phone or a sticker on their vehicle (for traffic-related rule violations). When issuing summonses, the PB can upload evidence like photos directly through the application, which generates a digital summons slip. Students and staff can view summons details on the application as well. All data, including summons history, is securely stored in the central database, accessible by authorised personnel through the administrator interface for tracking, reporting, and analysis.

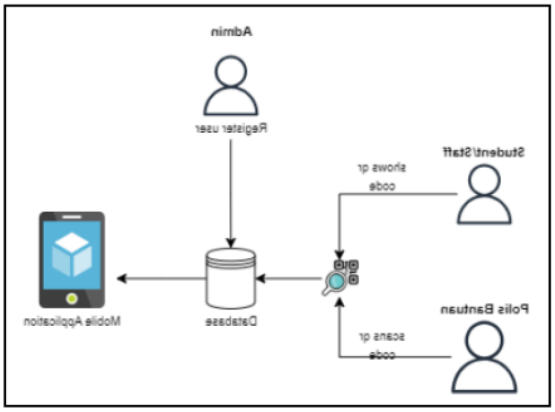

Figure 2. System Architecture Framework of Smart QR-driven Summons Application

As shown in Figure 3 below, the activity diagram for the summons process within the Smart QR-Driven Summons Application illustrates a seamless sequence of actions involving users, including students, staff, the PB, and the system. With a successful login, users are provided with a QR code, facilitating the input of personal details, subsequently stored in the system for access. The streamlined process lets users receive summons details promptly, concluding with a system notification of completed summoning and application closure.

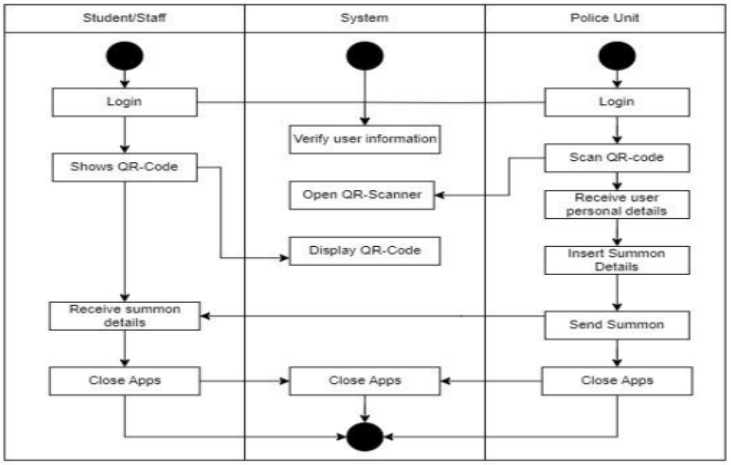

Figure 3. Activity Diagram of Smart QR-driven Summons Application

The Use Case Diagram for the Smart QR-Driven Summons Application for managing campus regulation (shown in Figure 4) is a comprehensive representation of the interactions between different actors (students/staff, administrators, and the PB) and the various functionalities of the application. It covers all the essential operations, including registering vehicles, receiving and viewing summonses, generating and scanning QR codes, and managing users, summonses, and vehicles. Each actor's role is clearly defined, showing how they engage with the system to accomplish specific tasks.

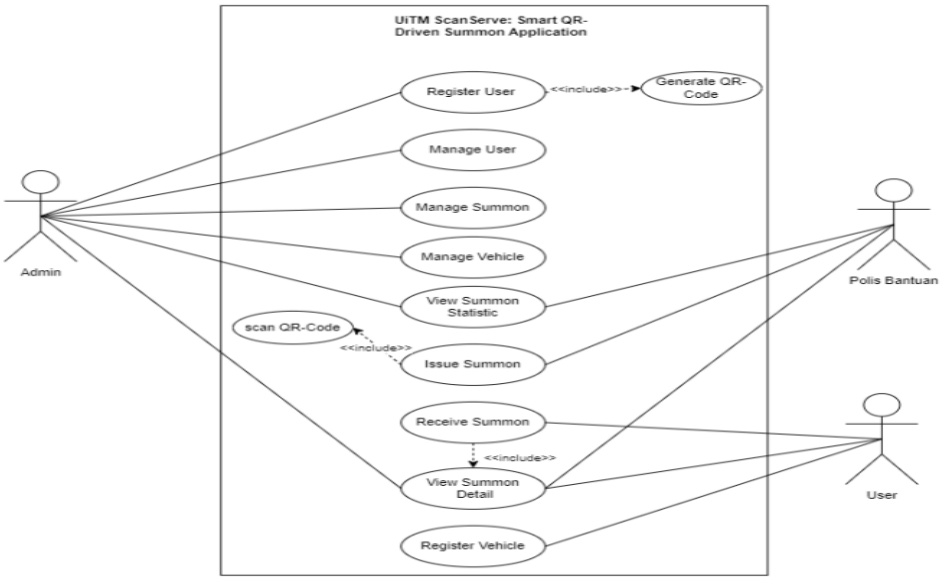

Figure 4. Use Case Diagram of Smart QR-driven Summons Application

5. Implementation

The first step during the initial phase of developing the Smart QR-Driven Summons Application is creating a project in Android Studio. This involves setting up a new project within the Android Studio IDE, which includes specifying the project's name, selecting the appropriate SDK, and configuring the project structure. After initialising the project, new Java classes are created to define the application's functionalities and structure. These classes encompass various application components, such as user interfaces (UI), data models, and logic controllers. Coding functionalities using the Java programming language are essential at this stage, where core features of the application are implemented. Additionally, necessary libraries and dependencies are imported into the project's files to enhance functionality and ensure smooth operation.

The UI can be developed for Android development using XML, a markup language designed explicitly for creating structured data and layouts within Android Studio. This approach allows developers to efficiently design and define the application's interface, including layouts, widgets, buttons, graphics, and text.

To deliver a reliable real-time database service from Google, integrating the Firebase Database is essential for this project. This integration allows the mobile application to handle and store all user data effectively. The project configuration includes adding the Firebase SDK to the file, establishing a connection to Firebase, and enabling access to its robust functionalities. This setup allows the mobile application to save and retrieve user data quickly, ensuring that the most recent information is synchronised across all linked devices in real time.

QR codes are generated for students and staff containing essential user information such as full name, email, and ID number. These QR codes are crucial when PB officers scan them to issue summonses efficiently. To implement this functionality, the ZXing library is integrated into the project's file to facilitate QR code generation. Upon registration of a student or staff member, the application automatically generates a unique QR code containing the specified user details. These

QR codes are stored in Firebase storage in image format. This approach ensures that the QR codes are securely saved and can be easily retrieved by users when needed.

To facilitate QR code scanning by the PB, the application integrates the ZXing barcode scanner library. This library enables the mobile device's camera to scan QR codes efficiently during summons issuance. The integration involves requesting permission to access the device's camera, ensuring seamless functionality without compromising user privacy. By leveraging the ZXing library, the application provides a user-friendly interface for scanning QR codes, enabling PB officers to quickly retrieve user information needed for issuing summonses.

6. System Interface

Figure 5 below shows the Landing and Login page of the ScanServe — Smart QR-Driven Summons Mobile Application. On this page, administrators, students, staff, and PB personnel log in using their official organisation's email addresses. For first-time users, the initial password is set to their email address, which can be changed after logging in. This secure and streamlined login process ensures that only authorised users can access the system, maintaining the integrity and confidentiality of the application's data and functions.

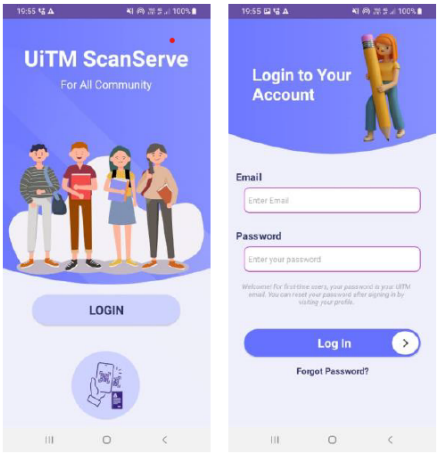

Figure 5. The Landing and Login Page of the ScanServe Mobile Application

Figure 6 shows the admin dashboard, which displays all of the features available to administrators. It includes a welcome message that greets users by their email address.

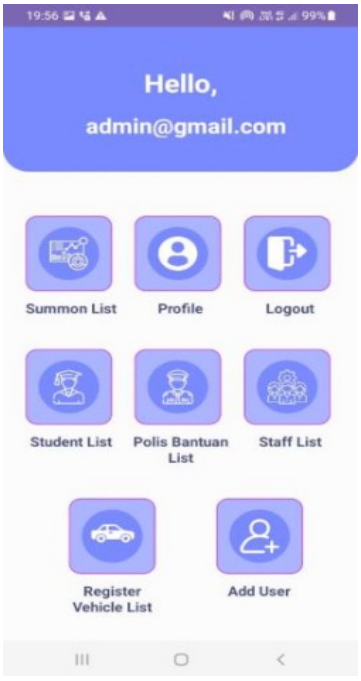

Figure 6. Admin Dashboard

Figure 7 shows the Registered Vehicle List page, displaying only the vehicles that users have registered. Administrators can view and search for vehicles by their plate number, ensuring all registered vehicles are accounted for within the system.

Figure 7. Registered Vehicle List

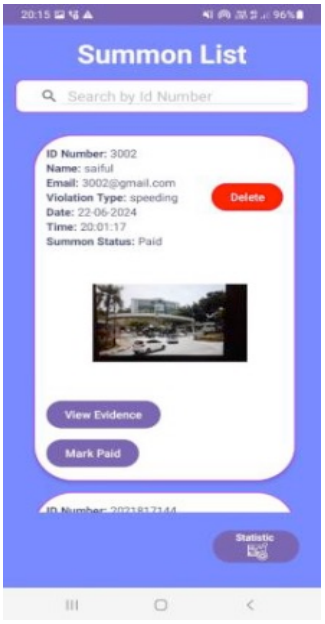

Figure 8. Summons List

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Figure 8 shows the Summons List page for administrators. Here, administrators can view a comprehensive list of all summonses issued by the PB. Administrators can update the status of each summons, marking it as paid if the user has settled the fine. Additionally, admins can search for summonses by user ID number and have the option to update the details of any summons in the list.

Figure 9 shows the QR Scanner page, which activates the PB camera to scan the QR codes of students or staff for summoning purposes. This feature simplifies issuing summonses by retrieving the stored details from the QR code. Figure 10 shows the generated information when the QR code has been scanned.

Figure 9. QR Scanner Page

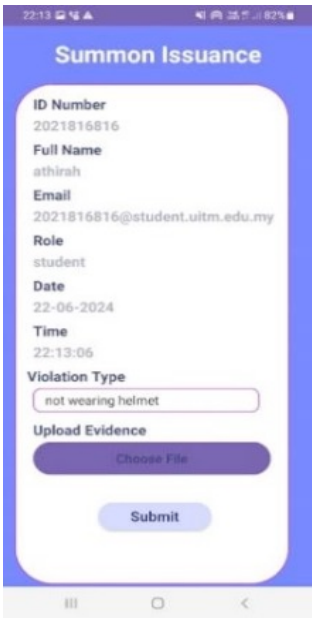

Figure 10.
Generated Data from QR Code

Figure 11 shows the Statistics page, where administrators can view the count of summonses for each violation type within a selected month and year. This feature helps in analysing trends and understanding the distribution of different types of violations over time.

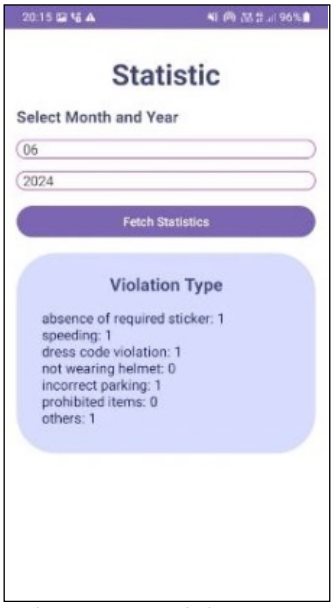

Figure 11. Statistics Page

Figure 12 showcases the user dashboard, featuring a welcoming message with the user's email and displaying the current count of summons associated with the user. The dashboard includes buttons for accessing all available functions and features a navigation bar at the bottom of the page for easy navigation.

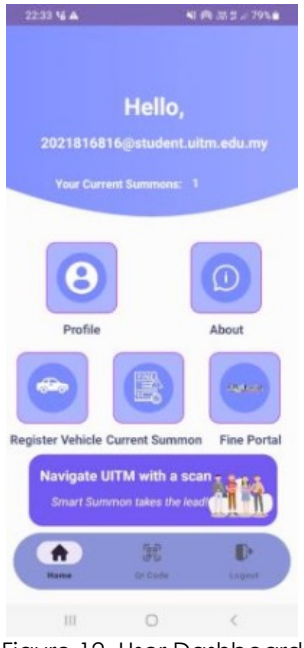

Figure 12. User Dashboard

Figure 13. QR Page

Figure 13 features the QR code page, displaying the QR code unique to users with their ID number. This QR code contains user details necessary for summoning purposes and can be saved as an image to the user's phone gallery for convenient access without logging into the application.

Figure 14 and Figure 15 illustrate the pages for registering a vehicle and viewing registered vehicles, respectively. Users can register their vehicles in the application by providing details and uploading an image of their license. After registration, users can access the User Vehicle page to view their previously registered vehicle details.

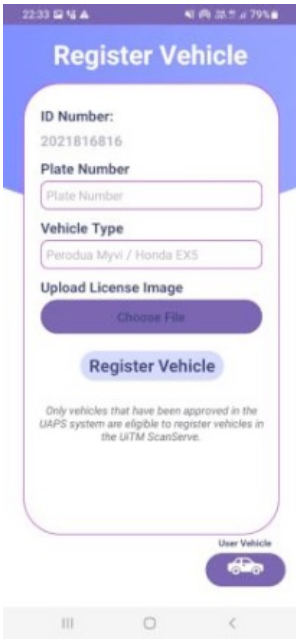

Figure 14. Vehicle Registration Page

Figure 15. User Registered Vehicle List

Figure 16 depicts the User Summons List page, displaying summons details specific to the logged-in user. Users can view the status of all summonses, which function as digital summons slips. Additionally, users can access the evidence provided by the PB, justifying why each summons was issued.

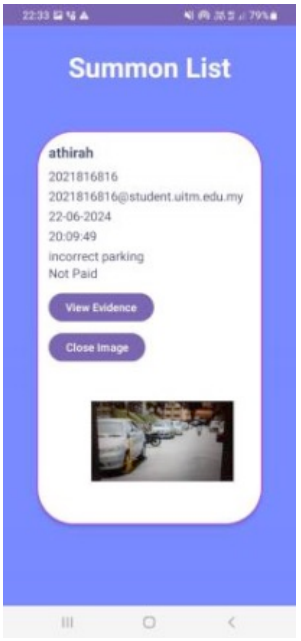

Figure 16. Summons List Page

7. Testing and Validation

After completing the implementation phase, the testing phase becomes crucial. This phase involves a comprehensive series of actions to research and analyse the actual levels of performance and quality of the project. Testing is essential to verify the actual versus expected results, ensuring the application undergoes a thorough testing before it is released to the user post-development. This process guarantees practical functionality and alignment with user requirements. The usability testing was performed by five users from the stakeholder groups — students, staff, and the PB. 80 percent of usability problems can be identified with a sample of five users, a principle known as the 'magic number' (Alroobaea & Mayhew, 2014). The selected users tested the application and then answered the provided questions via Google Forms. The list of questions used for the testing is shown below.

In evaluating the system's usability, the heuristics evaluation employs the SUS, a widely recognised tool consisting of a questionnaire with a scale ranging from 1 (strongly disagree) to 5 (strongly agree). Based on 10 standardised statements, this scale measures users' perceptions of the application's usability. The SUS helps quantify subjective user experiences and identifies areas for enhancement by assessing factors such as ease of use, integration of functions, and confidence in the system. The sample of SUS questions used is as follows:

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.

6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

8. Results and Discussion

The testing phase results based on user responses were classified into ease of use, integration of functions, and confidence in using the system and are presented in the following figures below:

8.1 Perception of System Complexity

The research findings on the Smart QR-Driven Summons Application's complexity are encouraging and significant. The responses in Figure 17 show that 60 percent of the users strongly disagreed (77 rated 1) that the system was unnecessarily complex, and 40 percent disagreed (rated 2). No users rated the complexity at levels 3, 4, or 5. These results indicate a consensus among participants that the application is simple, suggesting its straightforward and user-friendly design. This perception of simplicity is crucial for ensuring ease of adoption and effective use across different user groups within the university.

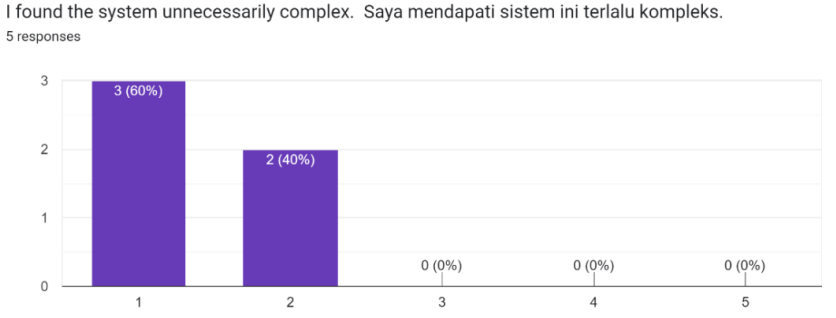

Figure 17. Evaluation of System Complexity

8.2 Ease of Use

As shown in Figure 18, 60 percent of participants rated the ease of use of this system as 4, and 40 percent rated it as 5, indicating a high level of agreement that the system is user-friendly. No participants rated the ease of use below 4, underscoring the application's intuitive design and accessibility.

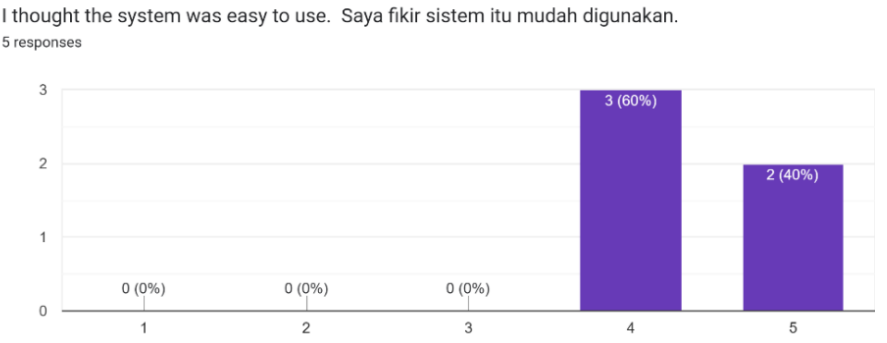

Figure 18. Ease of Use Evaluation

8.3 Integration of Functions

As shown in Figure 19, participants largely agreed that the various functions in the system were well integrated, with 80 percent rating it as 5 and 20 percent rating it as 4. No participants rated it below 4, indicating a strong perception of cohesion and seamless operation within the application's features.

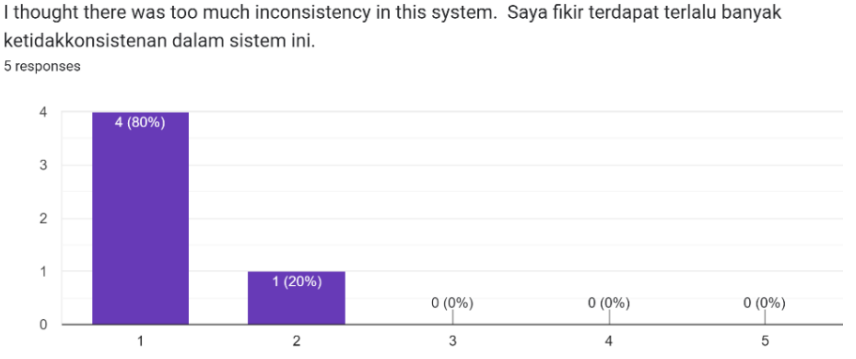

Figure 19. Integration of Functions

8.4 System Consistency

When asked about inconsistencies within the system, 80 percent of participants strongly disagreed, and 20 percent disagreed, as shown in Figure 20 below. No participants rated the system as inconsistent, highlighting a consensus that the application is consistent in its operation and presentation.

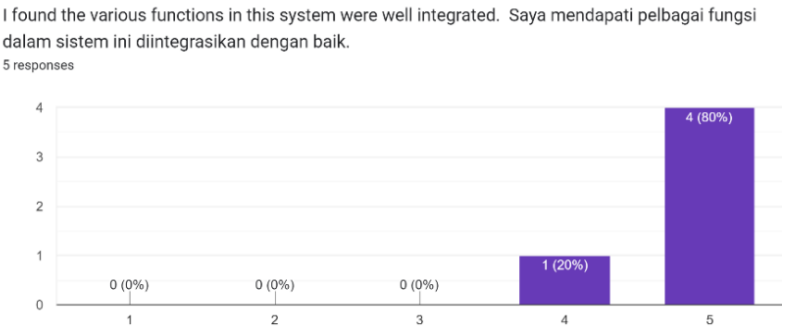

Figure 20. System Consistency

The application, designed to streamline this process using the QR code technology, received positive feedback from a diverse group of users, including students, staff, and PB personnel. Results from the SUS indicated high levels of user satisfaction, with users praising the application's ease of use, integration of functions, and efficiency improvements in summons management.

9. Limitations of the Study

The ScanServe — Smart QR-Driven Summons Application relies on QR codes for submitting cases. However, a QR code might fail to work, either from a technical perspective or due to user or environmental factors. The main reason might be poor image quality caused by the scanning device not being able to detect the code properly. Since QR code functionality relies on high contrast between the dark and light areas (typically black and white), if the code is printed or displayed with low contrast (e.g., dark grey on black), the scanner may not be able to distinguish the code pattern. The scanners may also struggle to detect the details necessary for decoding if the QR code displayed is too small. Environmental factors such as poor lighting conditions or excessive glare can make it difficult for a device's camera to focus and scan the QR code. This includes QR codes printed on glossy or reflective surfaces (e.g., laminated cards or screens with glare) that can cause light reflections that interfere with scanning. Furthermore, poor or no internet connectivity on the user's device can prevent the QR code from working, even if it scans properly.

10. Conclusion

The ScanServe — Smart QR-Driven Summons Application for managing campus regulation significantly advances how university communities handle regulatory processes. The system provides a user-friendly and efficient mobile application, encouraging greater user engagement and improving compliance with campus regulations. This application eliminates the need for manual paper-based methods, streamlining summons issuance process and reducing errors.

11. Future Work

Suggestions for potential enhancements to the developed system include the integration of a payment gateway, an appeal for a fine reduction menu, enhanced notification alerts, and data visualisation for statistical reports. Additional features, such as manually inputting a case ID or selecting the case from a dropdown list that encounters a QR code scanner failure will be considered.

11.1 Integration of Payment Gateway

Integrating a secure direct payment system within the application would significantly streamline the process for users, allowing them to pay fines directly through the application. This would eliminate the need for users to navigate to an external portal, thus enhancing convenience and reducing the likelihood of missed or delayed payments.

11.2 Appeal for a Fine Reduction Menu

Another recommendation is to extend the application's feature to handle appeals process. Although these tasks are typically conducted physically at the PB office, incorporating these functions into the application could streamline the process and significantly reduce administrative burdens.

11.3 Enhanced Notification Alerts

Implementing real-time notifications to alert users upon receiving a summons would significantly improve user awareness and responsiveness. While the current project setup using Firebase does not support this feature, incorporating a backend server capable of handling real-time communication could enable timely notifications, ensuring users are promptly informed about their summons status and making them feel more in control of the situation.

11.4 Data Visualisation for Statistical Reports

Enhancing data visualisation within the application using charts and graphs to represent statistical data would make the application more user-friendly. Visual representations of data on summons statistics, such as the number of summonses issued per violation type or trends over time, would provide users and administrators with more precise insights and facilitate better decision-making.

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Authors Contributions

Wan Fariza Wan Abdul Rahman: Conceptualization, Original draft preparation, Supervision, Writing, Reviewing and Editing. Nur Athirah Su'aidah Abu Samah: Investigation, Writing - Original draft preparation, Data curation, and Visualization

Conflict of Interest

The authors report no conflicts of interest.

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