DESIGN AND DEVELOPMENT OF CAMPUS ROOM USE MONITORING APPLICATION BASED ON ANDROID WITH MAGNETIC DOOR LOCK IN THE DEPARTMENT OF INFORMATICS AND COMPUTER ENGINEERING UNM

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ABSTRACT

The condition of campus room doors that are often open has the potential for misuse of campus rooms that do not comply with the schedule set in the room and affect the security of the room facilities. This research aims to produce an Android-based campus room usage monitoring application using magnetic door locks at JTIK FT UNM as well as knowing the results of functional testing and performance testing or system performance. This research uses the Research and Development method with the Rapid Application Development development model with stages: needs analysis, system design, system building, validation, testing, and final product. The final product of this research is a system developed in an Android-based room usage monitoring application that is integrated with a magnetic door lock using the QR Code feature. In this case, the system utilizes the ESP32 microcontroller as a chip that receives and provides signals according to the program in the system. The test results obtained validation of the Android-based campus room usage monitoring application using magnetic door locks can be said to be valid and suitable for use.

Keywords: Android Application; Magnetic Lock; ESP32; QR Code

1. Introduction

The need for technology is very necessary in this era in accessing information quickly, precisely and accurately. Various agencies have started implementing application-based systems in their fields of work, in this case of course to increase work effectiveness and efficiency. A campus is an institution that requires good operational management because all teaching and learning activities and administration take place within the campus area [1]. To reduce the negative impact on students, several institutions have begun to develop academic and non-academic facilities that support academic activities, giving rise to complex internal learning cycles. One of the empowerment of campus facilities that must be implemented is the provision of comfortable and safe rooms. This room is used as a place for lecture activities which have been determined and managed by the campus, in this case including academic performance in monitoring management.

The monitoring process is carried out as part of daily lecture activities from the beginning of the lecture process to the end of the lecture semester. This monitoring activity is necessary to monitor ongoing course activities, including the location of instructors and students. During this time, monitoring results can be used to evaluate courses for the next semester [2]. As time goes by, monitoring activities utilize computers by starting to perfect various application software and other supporting programs to help work in various fields, one of which is managing archives in electronic format. Monitoring the use of rooms during lectures on campus is usually packaged in the form of a soft file archive which will be distributed to students to find out which rooms can be used during the lecture process.

A good campus must of course provide sufficient space for students when carrying out teaching and learning activities [3]. The room will be arranged according to the course schedule of the students who will use the room so that there is no overlap with other students' use of the room. Because of this, a well-structured administration system is needed, so that students can know whether the room they are going to occupy is empty or still occupied by other lectures. The process of checking lecture rooms at the Department of Informatics and Computer Engineering, Universitas Negeri Makassar is still manual, or in other words, to find out the condition of a room, it is done by checking the room directly at the location, which is considered to take a little time and energy for students. Apart from that, it is quite vulnerable to several risks, including delays in the data duplication process, data updates and data accuracy regarding room use which can cause miscommunication with students or lecturers who want to use the same room so that the lecture monitoring process does not run optimally.
This situation encourages the author to create a system that can be managed effectively, where the monitoring flow is carried out electronically to facilitate routine monitoring work so that it can be carried out more systematically and on time to produce relevant and quality information that can monitor the use of rooms on campus from from who uses the room and the room usage schedule, namely starting and until when the room is used through the application. This application will be connected to an electronic magnetic lock device on the room door which allows the room door to close and open automatically according to the registered database. This system replaces the current conventional key security system thereby minimizing misuse of space on campus. The room will be able to open according to the data stored in the system, otherwise the room will not open. This means that this system can be used to monitor rooms by carrying out controls and operating automatically via the application. In general, to open and close the door of a room on campus to see the condition of the room, you have to go directly to the room door. The problem is that sometimes in the morning many students have arrived but the room is not yet open because the room attendant has not arrived, resulting in delays in lectures. With this application, students can control the door using a smartphone with a tool to control the door via smartphone.

The designed application will display who is using the room and complete information regarding the lecture schedule in that room. This information can be seen by all users if they check the room via the application. So it is clear that in general the room is used by class A or B to carry out lectures. Then for the room usage system, each student as a room user who will use the room first scans the room's QR code via the application after that the system will check whether the user data is correct according to the stored database. The database referred to here is room scheduling data from the department administration. After the lecture is finished, students close the room again via the application. This application is designed to include a user database that is integrated with room usage scheduling data provided by the administration. Therefore, the magnetic lock electronic device system will work according to stored data commands. Magnetic lock will not carry out the command to open the door if the person carrying out the command is not the user data registered according to the schedule in the database. Only users who meet the schedule can open the door through the application.

2. Materials and Methods

a. Research Type

This research uses the "Research and Development" method with a Prototype Development Model. Research and Development (R & D) is a research and development method to produce certain products and test their effectiveness [4]. The product in question is an Android-based campus room usage monitoring application using magnetic door locks in the Department of Information and Computer Engineering at UNM.

b. Development Procedure

In designing this application, researchers used a prototype model which was considered better for solving problems that arose between users and analysts due to unclear user needs. Prototyping is a method of developing a system for testing its working model through a process of interaction and repetition quickly. This model is the part that designs an application in the development process. Prototyping is also called rapid application design or Rapid Application Design which is appropriate to the type of research used. The stages in prototyping are as follows:

1) Analysis of system requirements, at this stage, observing the rooms in the Department of Information and Computer Engineering at UNM which are used in the academic process. As well as observing student activities by monitoring or checking whether the room is empty or who is being used by whom and when. Apart from that, ensure the condition of the room so that it is not misused for unscheduled activities.

2) Design, making prototyping by making temporary designs that can be presented to users, such as creating input and output formats for applications.

3) Building prototypes, realizing designs that have been designed as a series of programs that focus on users such as input, output, Data Flow Diagrams (DFD), flowcharts, use case diagrams, sequence diagrams, activity diagrams and Entity Relationship Diagrams (ERD). In this case, researchers used Visual Paradigm software and flowgorithm.

4) Prototype evaluation, design validation for approval from users whether it is satisfactory or not. If it meets the user's wishes, the process will continue. If not, then revise by repeating the previous step.

5) Coding the system, at this stage, the approved prototyping will be converted into the programming language used, namely Java.

6) Testing the system, a system that has become ready-to-use software will go through a testing stage by testing the software in normal and abnormal conditions to identify the quality of the software.

7) System evaluation, users evaluate whether the system is ready to meet expectations or not. If not, then repeat the coding or testing steps. If it is satisfactory, then the software can be used.

8) Using a system, software that has passed the testing stages and is accepted by users means it is ready to use.
3. Results

a. MoRoom Application Design Results (Android Based Campus Room Usage Monitoring Application Using Magnetic Door Lock)

1) Use Case Diagram

The interaction or communication that occurs between the user and the system itself is called a use case diagram. The use case diagram for this system can be seen in Figure 1 below:

![Use Case Diagram](image1.png)

Figure 1. Use Case Diagram

2) User Interface

The user interface is part of an information system that requires interaction between the system user and the system through input and output processes. This application will display several pages that are presented attractively through the interface design process, starting from the login page, registration page, front page, profile page, and other pages along with features in the application.

The login page contains the user's email and password data. This data is obtained through the account registration process, the data will be stored in the database to be synchronized when logging into the application. User registration data consists of full name, email, NIM, major, study program, class, telephone, and of course password.

![Login and Registration Page](image2.png)

Figure 2. Login and registration page

The frontpage of the room usage monitoring application consists of a profile menu, room menu, check-in settings menu, and QR code scan menu. This page is the first display when the application is opened. Users can open their profile, access the available rooms by checking in the QR code. These rooms already contain lecture scheduling data, only users who have a lecture schedule in that room can access the room. When the user scans the QR code, the data will be checked to match the lecture database. If found, the user will successfully open the magnetic lock door which is connected to the application system on Android and there will be a room information notification. If it is not found there will be a notification that access is denied.
The profile page displays user information, namely full name, NIM, email, telephone, study program, major and class. Then there is a button to edit your profile and log out of your account. The profile edit display consists of information that appears on the profile page, where users can change their personal data information. The exit button will direct users back to account login.

This QR code scan menu is connected to the magnetic door lock with a room usage database stored by the administration. If the user accessing the scan does not match the schedule in the database then the door will not open. On the other hand, if the data is correct then the door can be opened. This system uses an ESP32 which is connected to a database, so the ESP32 will read the data and give a signal to the magnetic lock to open the door.
If user data is found in the database, an access notification will be received and the door can be opened. Likewise, there is a notification that access is denied.

The check-in settings display contains information about the room being used. Users who use the room close the magnetic lock again via the check-out button on this menu. Then the door will automatically be locked again. Room information contains room name, lecture day, lecture date, course, lecturer's name, class, class, entry and exit times.

This room history display will appear when the user views the room on the application home page. If the opened room is being used then room information will appear. If the room is not in use, the room cannot be opened and information cannot be found. The information display is the same as on the check-out page, only there is no check-out button because it contains general information that can be seen by all users.
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3) **Prototype**
   The prototype of this application interface was created with figma software. The interface prototype results can be seen in the following figma link: [http://bit.ly/Prototypemoroomfigma](http://bit.ly/Prototypemoroomfigma)

4) **Database**
   This system database was created with the name u8633137_moroom and several tables are connected to it, namely the `data_company`, `data_schedule`, `data_use`, `data_room`, `data_user`, `users` tables. The resulting image of the database that was built can be seen in Figure 9 below:

![Database Image](image1)

Figure 9. Database

The resulting database is then hosted in an admin panel to make it easier to manage data in the application. The admin panel can be accessed via the following link: [https://moroom.zavalabs.com/](https://moroom.zavalabs.com/)

5) **The Coding**
   The coding stage here is the stage of programming the application. The software used to develop the application is Android Studio. Starting from creating a new project. The development of this application consists of the mainifes section which contains the AndroidManifest.xml file, java which contains the Kotlin and Java source code, and res which contains all non-code resources such as UI and bitmap images. The coding of this application can be seen in the following image:

![Manifest.xml Code Image](image2)

Figure 10. Manifest.xml code
6) MoRoom Application

The final application design product is the MoRoom application with login, registration, home, profile, scanning and room usage history displays and can be used on smartphones. The final product results can be seen in the following image:

![Figure 12. Login and Registration Display](image1)

![Figure 13. Home and Profile Page](image2)
b. Magnetic Door Lock Circuit Results

1) System Circuit Schematic

This series of systems consists of several components starting from magnetic lock, adapter, power supply, relay, T-block, ESP32, transistor, resistor and capacitor. The system circuit schematic can be seen in Figure 14 below:

![System Circuit Schematic](image)

2) Program ESP32

To activate ESP on this system, a WiFi network connection feature is also required [5], so researchers need to first program the network that the system will use. The ESP32 program is programmed in the Arduino IDE with a WiFi network connection feature so that this system can be used with a WiFi network that has been programmed by the researcher. For the coding itself, in the void setup section you can set the WiFi network that the system will use. Meanwhile, the void loop is used to read room data programmed in the database. The ESP32 system program can be seen in Figure 16 below:

![Program ESP32 in Arduino IDE](image)

3) PCB (Printed Circuit Board)

This series of systems starts by connecting several system components starting from magnetic locks, ESP32, Relays, T-blocks, Transistors, Capacitors, resistors, adapters and cables. All these components are assembled and a PCB box is made so that the circuit looks simple and neat. The PCB Layout image and PCB schematic can be seen in Figure 17 below:
The final product of the system design is a series of magnetic door locks that are integrated with the MoRoom application. The system circuit can be seen in the following image:

Figure 18. Magnetic door lock circuit
c. System Test Results

1) Testing Voltage and Electric Current on the Magnetic Door Lock system

<table>
<thead>
<tr>
<th>No.</th>
<th>Aspect</th>
<th>QR Code Scan Test</th>
<th>Check Out Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Voltage</td>
<td>0 V</td>
<td>12 V</td>
</tr>
<tr>
<td>2</td>
<td>Current</td>
<td>0 V</td>
<td>213.4 mA</td>
</tr>
<tr>
<td>3</td>
<td>Magnetic Lock Condition</td>
<td>Not attached</td>
<td>Attached</td>
</tr>
<tr>
<td>4</td>
<td>Door Condition</td>
<td>Unlocked</td>
<td>Locked</td>
</tr>
</tbody>
</table>

2) Magnetic Door Lock System Network Connection Speed Testing

<table>
<thead>
<tr>
<th>No.</th>
<th>Aspect</th>
<th>Duration</th>
<th>ESP32 network condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Scan delay QR Code</td>
<td>3s</td>
<td>Bit Slow</td>
</tr>
<tr>
<td>2</td>
<td>Application Response check out delay</td>
<td>3s</td>
<td>Bit Slow</td>
</tr>
<tr>
<td>3</td>
<td>Magnetic Response Not Attached Delay</td>
<td>3s</td>
<td>Bit Slow</td>
</tr>
<tr>
<td>4</td>
<td>Magnetic Response Attached Delay</td>
<td>3s</td>
<td>Bit Slow</td>
</tr>
</tbody>
</table>

3) Relay Response Testing in Magnetic Door Lock System Circuits

<table>
<thead>
<tr>
<th>No.</th>
<th>Aspect</th>
<th>QR Code Scan Test</th>
<th>Check Out Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Relay Condition</td>
<td>Sounds</td>
<td>Sounds</td>
</tr>
<tr>
<td>2</td>
<td>ESP32 Status</td>
<td>“Opened”</td>
<td>“Closed”</td>
</tr>
<tr>
<td>3</td>
<td>Magnetic Lock Condition</td>
<td>Attached</td>
<td>Not Attached</td>
</tr>
</tbody>
</table>

4) Testing Database Response to QR Code Scans on Magnetic Door Lock System Circuits

Users who have a lecture schedule can scan the QR Code

<table>
<thead>
<tr>
<th>No.</th>
<th>Aspect</th>
<th>QR Code Scan Test</th>
<th>Check Out Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Notifications Applications</td>
<td>Check in successful - Room information appears</td>
<td>Check out berhasil</td>
</tr>
<tr>
<td>2</td>
<td>Database Response</td>
<td>“Used”</td>
<td>“Empty”</td>
</tr>
<tr>
<td>3</td>
<td>Magnetic Lock Condition</td>
<td>Not Attached</td>
<td>Attached</td>
</tr>
<tr>
<td>4</td>
<td>Door Condition</td>
<td>Unlocked</td>
<td>Locked</td>
</tr>
</tbody>
</table>
Users scan the QR Code in the room that has been opened

<table>
<thead>
<tr>
<th>No.</th>
<th>Aspect</th>
<th>QR Code Scan Test</th>
<th>Check Out Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Notifications Applications</td>
<td>&quot;Room in use&quot;</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Database Response</td>
<td>&quot;Used&quot;</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Magnetic Lock Condition</td>
<td>Not Attached</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Door Condition</td>
<td>Unlocked</td>
<td>-</td>
</tr>
</tbody>
</table>

Users who do not have a lecture schedule can scan the QR Code

<table>
<thead>
<tr>
<th>No.</th>
<th>Aspect</th>
<th>QR Code Scan Test</th>
<th>Check Out Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Notifications Applications</td>
<td>&quot;Schedule not found, please check your lecture schedule again&quot;</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Database Response</td>
<td>&quot;Empty&quot;</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Magnetic Lock Condition</td>
<td>Attached</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Door Condition</td>
<td>Locked</td>
<td>-</td>
</tr>
</tbody>
</table>

5) Testing the Response of Each Room to QR Code Scans on the Magnetic Door Lock System Series

Room A

<table>
<thead>
<tr>
<th>Room</th>
<th>Test</th>
<th>QR Code Scan Test</th>
<th>Check out Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Database status</td>
<td>&quot;Used&quot;</td>
<td>&quot;Empty&quot;</td>
</tr>
<tr>
<td></td>
<td>Magnetic lock Condition</td>
<td>Not Attached</td>
<td>Attached</td>
</tr>
<tr>
<td></td>
<td>Door Condition</td>
<td>Unlocked</td>
<td>Locked</td>
</tr>
</tbody>
</table>

Room B

<table>
<thead>
<tr>
<th>Room</th>
<th>Test</th>
<th>QR Code Scan Test</th>
<th>Check out Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Database status</td>
<td>&quot;Used&quot;</td>
<td>&quot;Empty&quot;</td>
</tr>
<tr>
<td></td>
<td>Magnetic lock Condition</td>
<td>Not Attached</td>
<td>Attached</td>
</tr>
<tr>
<td></td>
<td>Door Condition</td>
<td>Unlocked</td>
<td>Locked</td>
</tr>
</tbody>
</table>

Room C

<table>
<thead>
<tr>
<th>Room</th>
<th>Test</th>
<th>QR Code Scan Test</th>
<th>Check out Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Database status</td>
<td>&quot;Used&quot;</td>
<td>&quot;Empty&quot;</td>
</tr>
<tr>
<td></td>
<td>Magnetic lock Condition</td>
<td>Not Attached</td>
<td>Attached</td>
</tr>
<tr>
<td></td>
<td>Door Condition</td>
<td>Unlocked</td>
<td>Locked</td>
</tr>
</tbody>
</table>

Information:
Room A: R001 – Tech Room 1A
Room B: R002 – Tech Room 1B
Room C: R003 – Tech Room 1C

4. Discussion

a. Testing Voltage and Electric Current on the Magnetic Door Lock system

The conclusion obtained is that when scanning the QR Code, the voltage condition is 0V and the current is 0 A with the magnetic lock condition being detached/not attached. Meanwhile, when checking out the application, the voltage is 12 V and the current is 213.4 mA with the magnetic lock attached.

b. Magnetic Door Lock System Network Connection Speed Testing

The conclusion obtained is that when the system is running, the network condition is quite slow, which affects the speed of QR Code scanning, check out response, and magnetic response, each of which has a 3 second delay before responding. This results in the door responding slowly to open and close.
c. Relay Response Testing in Magnetic Door Lock System Circuits
The conclusion obtained is that when you scan the QR Code and the relay conditions sound, this means the magnetic lock has been successfully released. Then when checking out in the application and the relay beeps again, this means the magnetic lock has successfully reattached.

d. Testing Database Response to QR Code Scans on Magnetic Door Lock System Circuits

Users who have a lecture schedule can scan the QR Code
The conclusion obtained is that if the user has a schedule in the room and scans the QR Code then the application will display room information, the room status in the admin dashboard database becomes "in use", the magnetic lock is released and the door can be opened. Then when the user checks out on the application, the room status in the admin dashboard database returns to "empty", the magnetic lock is attached again and the door can be locked.

Users scan the QR Code in the room that has been opened
The conclusion obtained is that if the user has a schedule in the room and scans the QR Code then the application will display room information, the room status in the admin dashboard database becomes "in use", the magnetic lock is released and the door can be opened. Then when the user checks out on the application, the room status in the admin dashboard database returns to "empty", the magnetic lock is attached again and the door can be locked.

Users who do not have a lecture schedule can scan the QR Code
The conclusion obtained is that if a user who does not have a schedule scans the QR Code, the notification will appear in the application "Schedule not found, please check your lecture schedule again", the room status in the admin dashboard database remains "Empty", the condition of the magnetic lock remains attached and the door is locked.

e. Testing the Response of Each Room to QR Code Scans on the Magnetic Door Lock System Series

Room A
The conclusion obtained is that when you successfully scan the QR Code on the application in room Tek 1A with room code R001, the room status in the database becomes "in use", the magnetic lock is released and the door can be opened. Then when checking out, the room status in the database returns "empty", the magnetic lock re-attaches and the door can be locked.

Room B
The conclusion obtained is that when you successfully scan the QR Code on the application in room Tek 1B with room code R002, the room status in the database becomes "in use", the magnetic lock is released and the door can be opened. Then when checking out, the room status in the database returns "empty", the magnetic lock re-attaches and the door can be locked.

Room C
The conclusion obtained is that when you successfully scan the QR Code on the application in the embedded systems lab room with the room code R008, the room status in the database becomes "in use", the magnetic lock is released and the door can be opened. Then when checking out, the room status in the database returns "empty", the magnetic lock re-attaches and the door can be locked.

5. Conclusions
An Android-based campus room usage monitoring application using magnetic door locks is an innovation that can be considered as a solution to prevent or minimize misuse of campus rooms that do not comply with the scheduling made by the administration [6]. This application works as an IoT-based room key, so students can open the room through the application and adjust it to the student's lecture schedule. Apart from that, this application system can help students as a medium for lecture room information. By getting information through the application, it can be said to be efficient in saving energy and time in searching for lecture rooms [7]. Through the application, information is displayed that the room is being used or is empty.

The test results of the Android-based campus room usage monitoring application using magnetic door locks can be said to be functionally successful and the performance is as expected [8], namely making it easy to get information to students through the application, and the system successfully runs as an IoT-based room lock using the integrated Scan QR Code feature, with the student's lecture schedule.

Researchers carried out testing of this application system by installing the system in one of the campus rooms, namely the Embedded Systems Lab room on the 3rd floor of the Department of Informatics and Computer Engineering. So the room becomes a test room for students to use the system. The results obtained are in accordance with the functional and performance aspects of the system [9], where students can open the room door with the QR Code scan feature in the application according to the student's lecture schedule in that room. If a student does not have a lecture schedule in that room, then the room door will not open. Apart from that, students can also see information about the room being used in the application. So it can be said that this application system was successfully designed according to the researchers' expectations.
References


