

## Utilization of Mobile Technology for Nearest Tourist Destination Recommendations in Sleman Regency Using the Haversine Formula

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### ABSTRACT

The tourism sector in Sleman Regency, Yogyakarta, experiences a high volume of visitors, especially to cultural and natural attractions. However, the current systems for finding and navigating tourist destinations rely on manual search processes and lack integration, leading to suboptimal user experiences. This study aims to address these limitations by developing a mobile-based tourist destination recommendation system that provides an efficient, categorized, and navigable user experience. The system categorizes destinations into four main type that is nature, temple, family, and education, and users to explore locations based on their preferences. By employing the Haversine formula, the system recommends destinations based on proximity. Additionally, users can purchase tickets directly through the app, enhancing convenience, while a bug reporting feature enables continuous improvement based on user feedback. This integration of interactive and practical features aims to improve visitor satisfaction and streamline the tourism experience in Sleman Regency, contributing positively to the local tourism industry. The system operates with three main user roles that are Tourist, Tourist Admin, and Superadmin.

**Keywords:** *Sleman tourism, Mobile application, Destination recommendation, Haversine formula*

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### INTRODUCTION

Sleman Regency, located in the Special Region of Yogyakarta, is a prominent tourism destination in Indonesia, attracting millions of domestic and international tourists annually (Niu, 2023). In the first 2023, the Sleman Tourism Office recorded nearly 4 million tourist visits, with the majority drawn to cultural sites such as temples, museums, and traditional villages, followed closely by interest in natural attractions (Fatimah et al., 2022). The increasing tourism demand highlights the need for a more interactive, user-friendly approach to enhance the visitor experience and facilitate easier access to tourist information (Manalu et al., 2023). However, current systems for finding, selecting, and navigating tourist destinations in Sleman Regency lack integration, forcing visitors to

manually search for destinations and use separate applications for navigation, such as Google Maps (Ary et al., 2023). This approach is time-consuming and often hinders tourists from fully exploring available options efficiently.

The primary issue identified in this research is the absence of an integrated system that offers destination recommendations based on user proximity and interest categories. Additionally, the lack of a built-in ticket purchasing feature and bug reporting for the ease and quality of the visitor experience (Mishra et al., 2023). This research, therefore, aims to develop a mobile application that addresses these gaps by implementing a location-based recommendation system using the Haversine formula, along with features for ticket booking and bug reporting, to enhance convenience and interaction for users (Muhammad Dawamul Mughni & Putri Aisyiah Rakhma Devi, 2023).

The scope of this research is limited to developing a mobile application targeting tourists interested in visiting locations within Sleman Regency, Yogyakarta. The application will provide a categorized search feature, with options such as nature, temple, family, and educational destinations, as well as recommendations based on the nearest-distance calculations (Lubis et al., 2024). Furthermore, the system will offer in-app navigation assistance, ticket purchasing, and a bug reporting feature to ensure continuous improvement of the application.

This study aims to improve the overall experience of tourists visiting Sleman Regency by providing a streamlined and efficient tool for destination discovery, trip planning, and on-the-go navigation. Specific objectives include: enhancing tourist convenience through location-based recommendations, supporting trip planning by providing detailed information and categorized destinations, facilitating ticket purchasing to reduce on-site wait times, and enabling users to report technical issues for system improvement (Santiyasaa et al., 2022). The expected benefits are to reduce the time required for tourists to plan their visits, improve visitor satisfaction, and provide a robust platform for the tourism sector in Sleman Regency to grow in a structured and user-centric way (Yochum et al., 2020).

To develop an effective mobile-based tourist recommendation system, it is essential to explore existing studies and methodologies in similar fields (Ilarri & Trillo-Lado, 2024). The following review highlights previous research that has contributed valuable insights into the development of recommendation systems and mobile applications for tourism (Abbasi-Moud et al., 2021). (Nur Anisa & Wibowo, 2022) conducted research on the implementation of a Machine Learning model for recommending tourist attractions within an Android mobile application. The study utilized the Waterfall development model, encompassing data processing, visualization, and model construction using RecommenderNet. Key features of the model included the division of data into training and testing sets, model compilation, training processes, and model storage for integration with the mobile application.

(Hermawan & Rosyid, 2020) designed an Android mobile application for a tourist location information system in Gresik Regency, employing an Item-Based Collaborative Filtering method. The application featured a recommendation system that presented new users with the highest-rated tourist destinations based on user interactions. Additionally, it offered functionalities such as navigation, comprehensive tourist information, location-specific recommendations, and a feedback collection mechanism for users (Syaripudin et al., 2021). This study is particularly relevant as it demonstrates the application of collaborative filtering techniques in the development of a user-centric tourism app, which aligns with the objectives of this research to incorporate personalized recommendations and navigation tools.

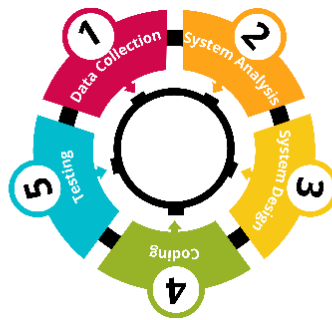
(Rahmawita Munzir & Iriadi, 2021) developed an Android-based tourism application for Pekanbaru, Riau Province, aimed at facilitating tourists in accessing information and finding routes to attractions. The system was divided into a web-based platform for administrators and a mobile app for tourists. Key features included data management for tourist sites, search functionalities for tourist information, accommodations, culinary options, and travel routes. The application was evaluated through black-box testing, yielding a 100% success rate, and user acceptance testing (UAT), which showed an 85% approval rating. This study underscores the importance of robust system design and testing to ensure high usability and user satisfaction, aspects that are integral to the development of a reliable and efficient mobile-based recommendation system.

In comparison, the system proposed in this research offers unique features, including a recommendation algorithm that uses the Haversine formula for proximity-based suggestions and category-specific searches such as nature, temples, family, and education (Prakasa Viragupty et al., 2024). Additionally, it integrates ticket booking and bug reporting functionalities to enhance user interaction. This comprehensive approach addresses the gaps identified in previous studies and aims to improve user engagement in the context of Sleman Regency tourism.

## **METHOD**

The research workflow for developing the tourist destination recommendation system follows an Agile methodology, allowing flexibility and iterative improvements across phases (Gulo et al., 2023). Beginning with Data Collection, Agile supports continuous user feedback integration, ensuring the gathered data remains relevant to evolving needs. In System Analysis and System Design, requirements and architectural blueprints are refined incrementally to match emerging insights. During Coding, Agile facilitates phased development, enabling early testing and adjustment of features (Meckenstock, 2024). Finally, primarily black box testing is iteratively conducted,

validating each module's functionality to meet user expectations effectively, as illustrated in Figure 1 below.



**Figure 1: Research Diagram**

## **FINDING AND DISCUSSION**

In this study, the development of a tourist destination recommendation system uses the Agile methodology, to make continuous improvements based on user feedback. The process begins with data collection and system requirements analysis, followed by system design, coding, and testing in an iterative cycle. This approach ensures that the features developed, such as proximity-based recommendations and ticket bookings, can be adjusted and improved as user needs evolve.

### **1. Data Collection**

First, primary data was collected through interviews with tourists and stakeholders in the tourism sector. These discussions aimed to understand the needs and preferences of users as well as identify the challenges faced in obtaining information about tourist destinations in Sleman. Tourists were asked about their experiences in searching for and accessing information about tourist attractions, desired features in mobile applications, and difficulties encountered during their visits. In addition, interviews with local tourism officials and business owners provided valuable insights into tourism trends, favorite attractions, and potential improvements to the existing system.

And then, Secondary data were then obtained from various sources, including statistics and reports on tourism activities in Sleman, which provide information on visitor demographics, favorite destinations, and visitor trends. A detailed examination of visitor statistics in 2017 was conducted to gain a deeper understanding of tourism in Sleman Regency, which reflects the attractiveness of the area as a tourist destination. The latest data on foreign tourist arrivals in Sleman were obtained from the Central Statistics Agency (BPS).

### **2. System Analysis**

In the system analysis phase, the functional requirements of the mobile-based destination recommendation system were meticulously identified and defined (Teixeira et al., 2024). This phase is essential as it delineates the critical features and capabilities that the system must possess to fulfill the needs of various user roles, including the super admin, tourism admin, and tourists. By analyzing user requirements and interactions, the system can be designed to deliver a seamless and efficient experience. The following

section outlines the functional requirements of the system, categorized into input requirements, process requirements, and output requirements.

a. Input Requirements:

The super admin has access to forms for logging in and registering within the system. This role involves overseeing and managing system users and their respective roles. The tourism admin can complete forms for logging in, registering, and inputting data about tourist destinations that will be displayed to tourists. Tourists can input data through various forms, including logging in, registering, booking tickets for tourist destinations, reporting bugs, and searching for destinations.

b. Process Requirements

The super admin is capable of performing several actions, such as logging in, validating admin accounts to manage tourism data, and logging out of the system. Admins can log in, register accounts, scan QR codes for tourist tickets, manage data related to tourist destinations, and log out. Tourists can log in, register, view navigation instructions to tourist destinations, book tickets, and log out of the system.

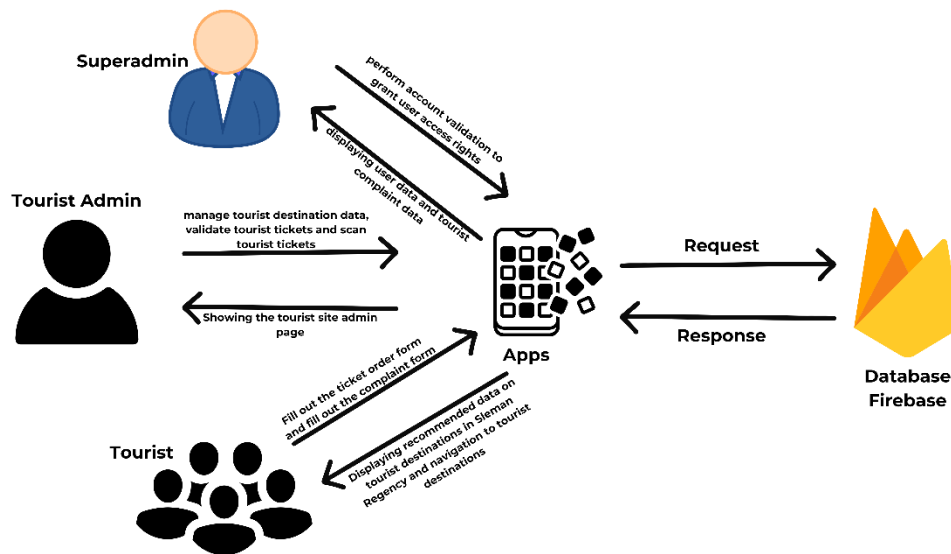
c. Output Requirements

The super admin can view user role data and review bug reports submitted by tourists, enabling effective management of system issues. The tourism admin can access tourist ticket information, manage destination data, and receive updates on ticket payments made by tourists. Tourists are able to view detailed information about destinations, categorized by type (e.g., nature, temple, family, education) and sorted by proximity using the Haversine formula, as well as check their purchased tickets (Ward & Sencer, 2023).

### **3. System Design**

#### **a. Architecture System**

The diagram depicts a simplified architecture of the system in which a user interacts with an application connected to Firebase, serving as the backend service. The flow of information commences when the user initiates actions, such as sending requests or entering data. These actions are managed by the application, which functions as the intermediary layer between the user and Firebase. The application processes the user's requests and communicates with Firebase to either store or retrieve data. Firebase, functioning as a cloud-based backend, offers services such as real-time data storage, authentication, and file storage. Subsequently, the application presents the retrieved data or confirms the successful processing of the request back to the user. This interaction exemplifies a typical client-server model, wherein Firebase oversees backend operations while the application manages user interactions and data presentation, as illustrated in Figure 2 below.

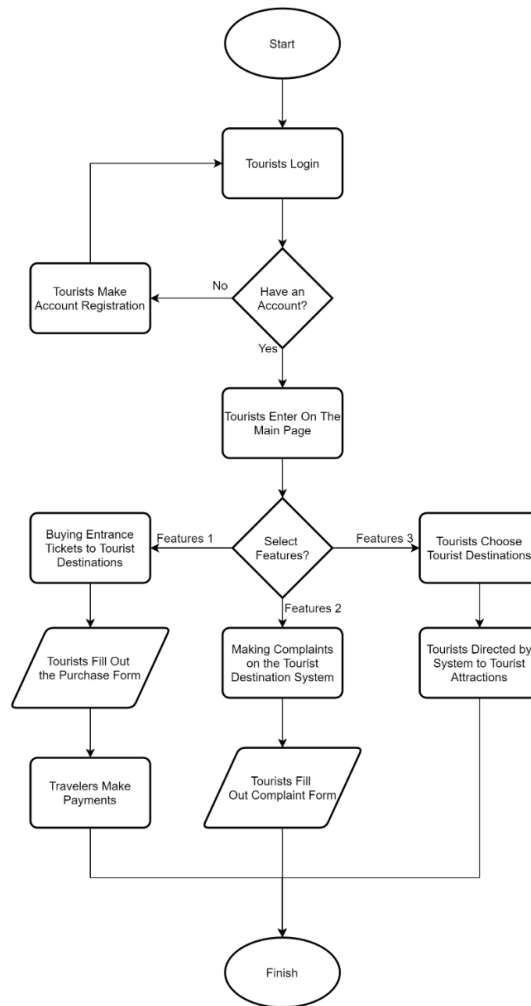


**Figure 2: Architecture System**

**b. Tourist System Flowchart**

The flowchart in Figure 3 illustrates the journey of a traveler within a tourism management system, highlighting key interactions and decision points throughout the process. The journey begins with the traveler accessing the system and being prompted to log in. If they possess an existing account, they can enter their credentials; otherwise, they must create a new account by completing the registration process. Upon successfully logging in, the traveler is directed to the system's main page, where they can select from various features, such as purchasing entrance tickets to tourist destinations, exploring available attractions, or filing complaints regarding any issues encountered during their experience.

When the traveler chooses to buy entrance tickets, they are taken to a ticket purchase section to complete a form that details the number of tickets and relevant information, followed by making the necessary payment. Alternatively, if they wish to explore destinations, the system allows them to browse options and view details or booking information for selected attractions. Additionally, for those facing challenges or wanting to provide feedback, the system includes a complaint feature where travelers can submit detailed descriptions of their issues. This structured approach ensures a smooth experience for tourists in managing their travel needs, facilitating clear steps and features that enhance their interaction with tourism services while effectively logging grievances to improve service quality and user satisfaction.



**Figure 3: Tourist System Flowchart**

#### 4. Coding

The main feature is the application of the Haversine formula to calculate the distance between the tourist's location and the nearest tourist attraction (Daniel & Lasut, 2023). This formula accurately measures the shortest distance between two geographical points, taking into account the curvature of the earth, the following is the formula used in the source code, as like Figure 4 below.

```

private fun calculateDistance(lat1: Double, lon1: Double, lat2: Double, lon2: Double): Double {
    val r = 6371.0
    val dLat = Math.toRadians(lat2 - lat1)
    val dLon = Math.toRadians(lon2 - lon1)
    val a = sin(x dLat / 2) * sin(x dLat / 2) +
            cos(Math.toRadians(lat1)) * cos(Math.toRadians(lat2)) *
            sin(x dLon / 2) * sin(x dLon / 2)
    val c = 2 * atan2(sqrt(a), sqrt(x 1 - a))
    return r * c
}
  
```

**Figure 4: Coding Haversine Formula**

## 5. Testing

The discussion of the results of this study uses black box testing, namely testing carried out to test or observe whether the input and output of the software have functioned as expected, the following is a test of the authentication feature, as in table 1 below.

**Table 1: Testing Features Authentication**

No	Testing Activities	Test Case	Expected results	Test Results	Conclusion
1.	Username and password are not filled in.	Username (null) and password (null)	The system cannot proceed to the Home page and a notification appears "Empty Fields Are Not Allowed !!".	As Expected.	Pass.
2.	Username (match) and password (not match)	Username (tourist, tourist admin, superadmin) and password (tourist, tourist admin, superadmin)	The system cannot proceed to the main page and a notification appears saying "Wrong Email or Password"	As Expected.	Pass.
3.	Username (match) and password (match)	Username (tourist, tourist admin, superadmin) and password (tourist, tourist admin, superadmin)	The system can proceed to the main page.	As Expected.	Pass.
4.	On the registration page, the email and password have not been filled in.	Username (null), password (null) and password confirm (null)	The system cannot proceed to the Login page and a notification appears "Empty Fields Are Not Allowed !!".	As Expected.	Pass.

5.	When registering an account, the email is filled in but the password and password confirmation are different.	Username (tourist), password (tourist), confirm password (tourist)	The system cannot proceed to the login page and a notification appears saying "Password Is Not Matching"	As Expected.	Pass.
6.	Email (match), password (match), and confirm password (match)	Username (tourist), password (tourist), confirm password (tourist)	The system can proceed to the login page and a notification "Registration Successfully" appears.	As Expected.	Pass.

The results include the performance of the destination search feature, ticket booking process, report bugs, change passwords, change profile photos, and view purchased tickets. The following are the test results on the tourist role feature, as seen in Table 2 below.

**Table 2: Feature Testing on the Tourist Role**

No	Testing Activities	Test Case	Expected results	Test Results	Conclusion
1.	Enter the temple tourism category page	Click on the temple tourism category menu	The system continues to the temple tourism category page	As Expected.	Pass.
2.	Enter the nature tourism category page	Click on the nature tourism category menu	The system continues to the nature tourism category page	As Expected.	Pass.
3.	Enter the educational	Click on the educational	The system continues to the	As Expected.	Pass.

	tourism category page	tourism category menu	educational tourism category page		
4.	Enter the family travel category page	Click on the family tourism category menu	The system continues to the family travel category page.	As Expected.	Pass.
5.	Enter the tourist destination details page	Click on one of the recommended tourist destinations	The system can display detailed pages of tourist destinations.	As Expected.	Pass.
6.	Go to the ticket booking page	Click on the ticket booking menu	The system can display a ticket order form	As Expected.	Pass.
7.	Displaying QR Code tickets to enter tourist destinations	Click the "Show QR Code" button	The system can display QR Codes for entrance tickets to tourist destinations.	As Expected.	Pass.
8.	Show proof of payment	Click the "Show Proof of Payment" button	The system can display proof of payment	As Expected.	Pass.
9.	The reporter name, bug title and bug description columns are not filled in.	Click the submit button	The system cannot send the bug report and a notification appears "Empty Fields Are Not Allowed !!"	As Expected.	Pass.
10.	The reporter name, bug title and bug description columns are filled in.	Click the submit button	The system can send the results of bug reports by tourists, a notification appears saying "Report Bug	As Expected.	Pass.

			Success” and the text column is empty.		
11.	Go to the edit photo profile	Click the change profile photo button	The system can change the user's profile photo	As Expected.	Pass.
12.	Make password changes	Click the change password button and a pop up with the new password column will appear.	The system displays a pop up column to change the password.	As Expected.	Pass.
13.	Log out of the account from the application	Click the logout button	The system can log accounts out of the system	As Expected.	Pass.
14.	Enter the tourist destination details page	Click the button to be directed to the tourist destination	The system can display maps to direct users to tourist destinations.	As Expected.	Pass.

The testing includes features of tourism data management, tourist ticket validation, and QR code scanning, which are evaluated based on management efficiency and validation accuracy. The following are the test results on the tourism admin role feature, as seen in Table 3 below.

**Table 3: Feature Testing on the Tourist Admin Role**

No	Testing Activities	Test Case	Expected results	Test Results	Conclusion
1.	Can see details of tourist destinations	Selecting a tourist destination based on uploading	The system can display detailed tourist destination data	As Expected.	Pass.

		tourist destination data.			
2.	Can add tourist destination data	Click the floating button with the plus logo	The system can add tourist destination data.	As Expected.	Pass.
3.	Search for tourist destination data in the search column	Fill in the search column with the name of the tourist destination you want to search for.	The system can display tourist destination data according to the keywords of the tourist attractions being searched for.	As Expected.	Pass.
4.	Tourist admin can change the payment status of tourist ticket bookings.	Select the payment status from "Waiting for Confirmation" to "Confirmed" and click the "Save Payment Status" button.	The system can change data in the database and display the latest payment status to tourists.	As Expected.	Pass.
5.	Can see proof of tourist payment	Click the "View Proof of Payment" button	The system cannot display proof of payment for ticket orders.	As Expected.	Pass.
6.	Log out of the account from the application	Click the logout button	The system cannot log the account out of the system	As Expected.	Pass.

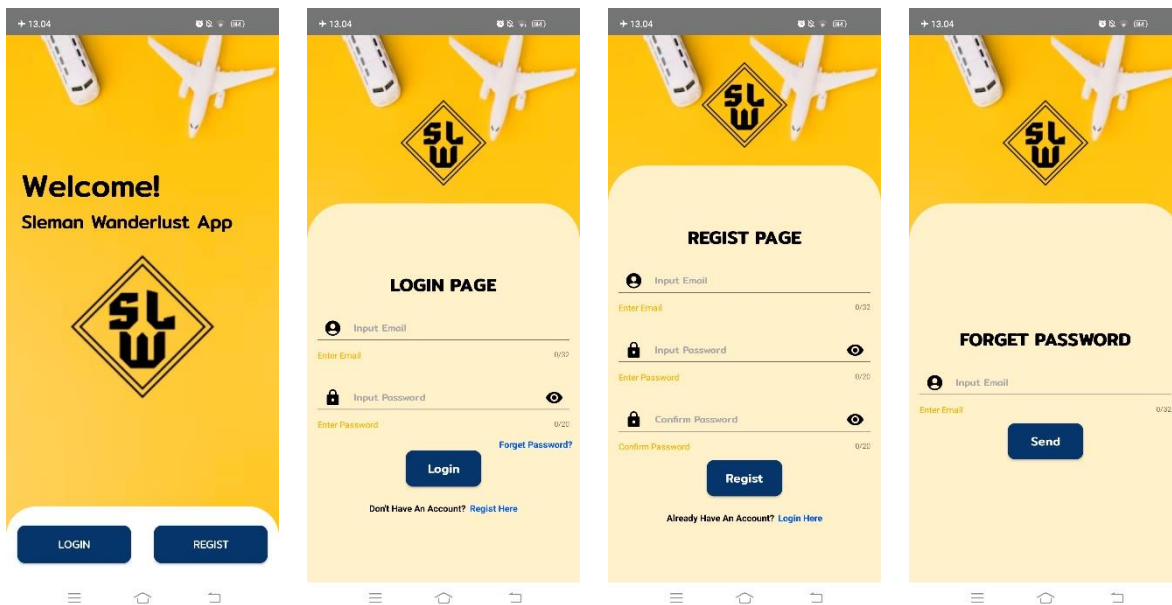
The testing focused on the feature of managing user roles, which was evaluated in terms of ease and speed in changing user roles by superadmins. The following are the results of testing on the super admin role feature, as seen in Table 4 below.

**Table 4: Feature Testing on the Superadmin Role**

No	Testing Activities	Test Case	Expected results	Test Results	Conclusion
1.	Tour admin can change the role of all users	Select the user role, namely tourist, tourist admin, and superadmin and click the "Save" button.	The system cannot change the user role in the database as access rights to enter the system.	As Expected.	Pass.

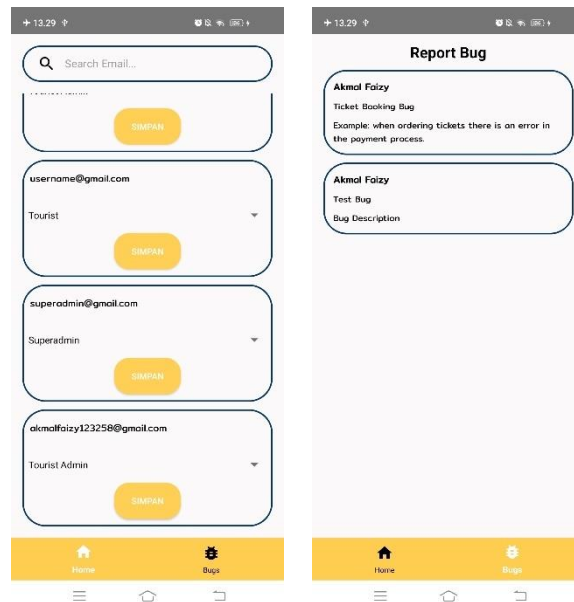
**DISCUSSION**

In the Results and Discussion section, the focus is on implementing the user authentication interface to ensure smooth system access. Figure 5 illustrates the interface, offering two main options: login or registration. The login page requires an email and password, while the registration page asks for personal details like name, email, and password to create an account. Additionally, a forgot password page allows users to reset their password via their registered email, ensuring easy account recovery.



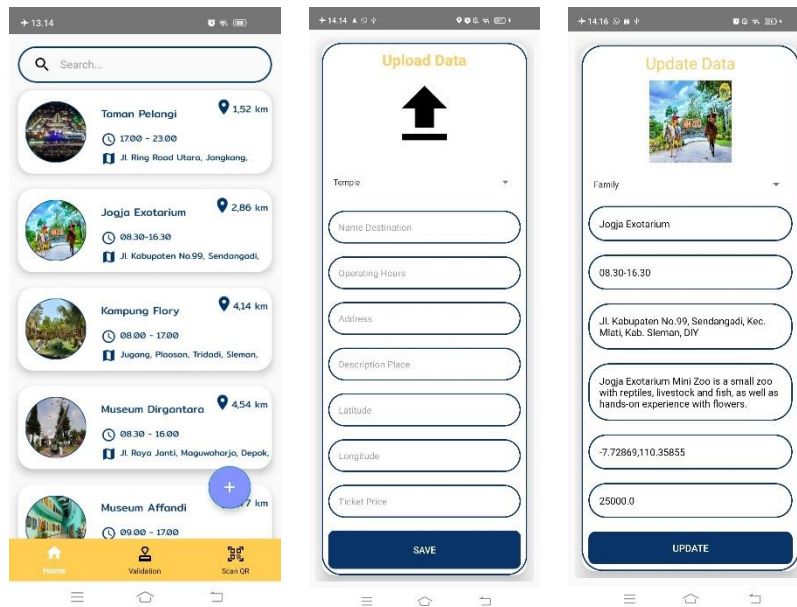
**Figure 5: Authentication Page User Interface**

In Figure 6, the user interface for the Super Admin role is showcased. This interface is essential for managing administrative tasks and overseeing the system's functionality. The home page provides Super Admins with the tools to manage user roles, allowing them to assign, update, or revoke permissions for different users within the system. Additionally, there is a dedicated page for managing bug reports submitted by users. This page allows Super Admins to view, assess, and track issues reported by the users, ensuring that the system runs smoothly and any technical problems are addressed promptly.



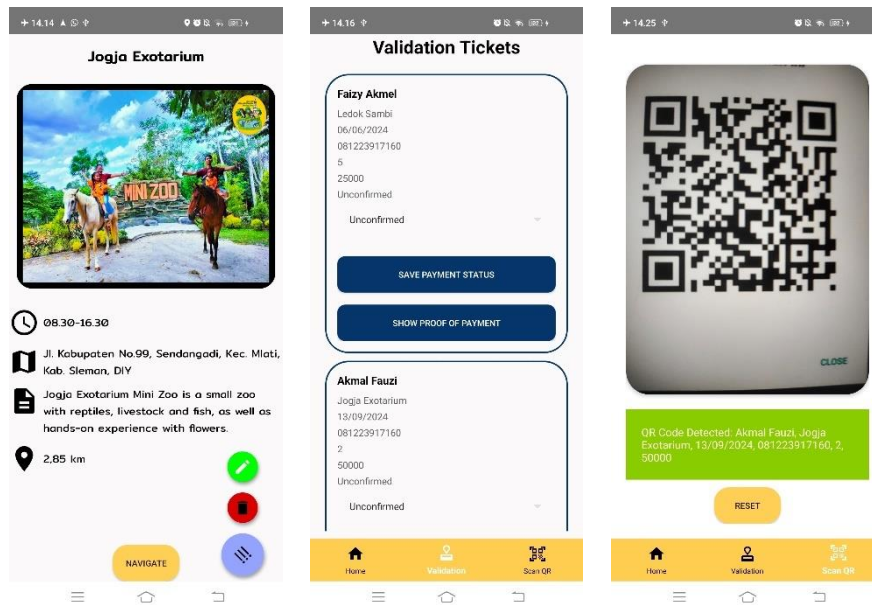
**Figure 6: Superadmin Page User Interface**

In Figure 7, the user interface for the Tourist Admin role is depicted, focusing on the home page designed to facilitate the management of tourism data. The Tourist Admin can view a comprehensive list of tourist attractions, providing a clear overview of existing entries.. Additionally, the home page includes an option to add new tourist destinations, directing the admin to the upload tourism data page. Here, the Tourist Admin can input essential details about new attractions, ensuring that the database remains current and informative. Furthermore, there is a dedicated page for updating existing tourist data, allowing the admin to modify or enhance information as needed.



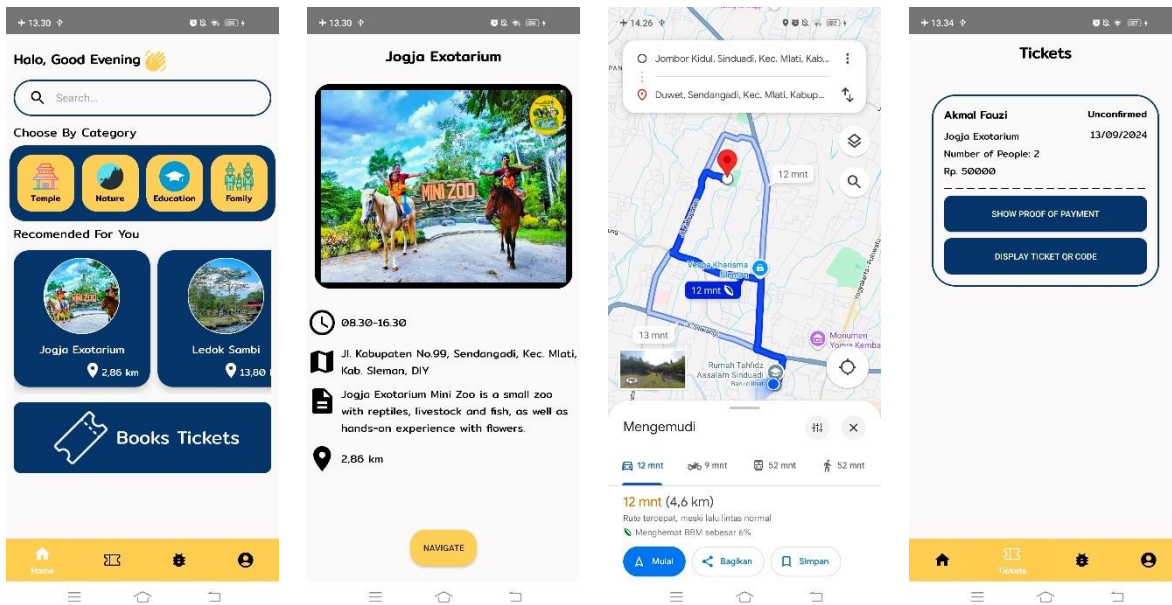
**Figure 7: User Interface of Home Page, Upload Tourism Data, Update Tourism Data (Tourist Admin Role)**

In Figure 8, the user interface for managing tourism data under the Tourist Admin role is presented. This interface closely resembles the detailed view available to tourists but includes specific functionalities tailored for administrative tasks. The primary distinction lies in the inclusion of a floating action button, which allows the Tourist Admin to perform critical actions such as deleting or editing tourist data. Moreover, the interface features a ticket validation section designed for the efficient processing of purchased tickets. This function enables the Tourist Admin to verify ticket authenticity; if the proof of payment is valid, the ticket status is updated to "unconfirmed." Additionally, the page incorporates a QR ticket scanning feature, empowering the Tourist Admin to scan tourists' tickets upon their arrival at a destination. Once scanned, the system retrieves essential ticket information, including the tourist's full name, destination name, entry date, phone number, number of individuals in the party, and total ticket price. This comprehensive functionality ensures a streamlined process for managing tourist data and enhancing the overall visitor experience.



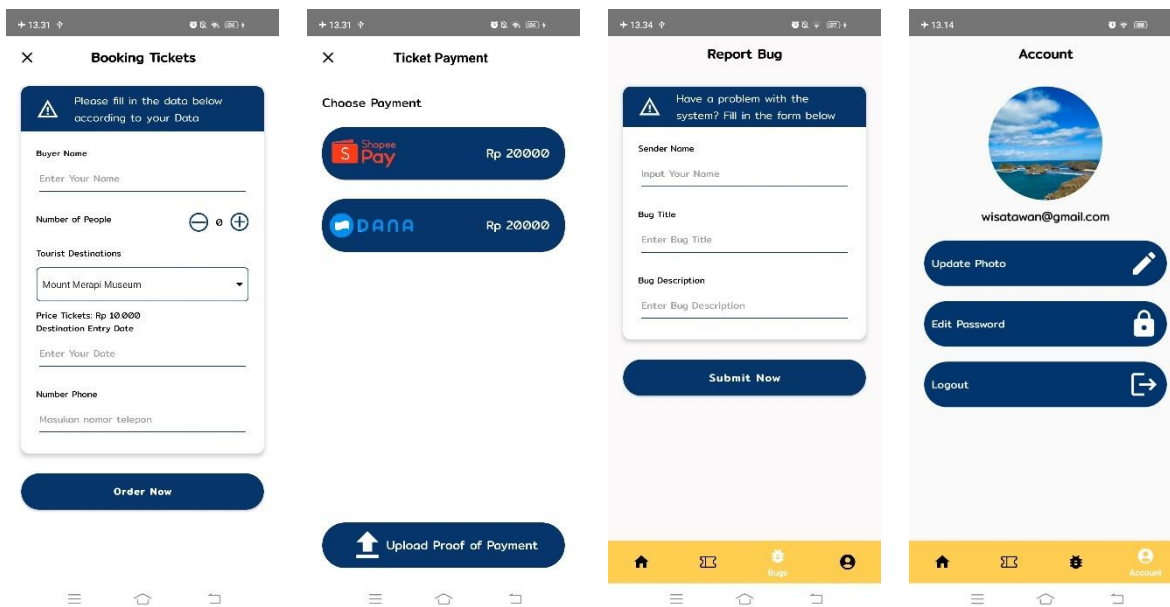
**Figure 8: User Interface Page for Manage Tourism Data, Ticket Validation, Scan Tourist Ticket QR (Tourist Admin Role)**

Figure 9 showcases the user interface for the Tourist role, focusing on the Home Page, which provides an overview of available tourist attractions. It includes a search bar for quickly finding destinations, and categorizes attractions into segments such as Nature, Temples, Family, and Education. Recommended destinations are highlighted based on proximity, using the Haversine formula to calculate the nearest options. Tourists can reserve tickets directly from this page, and upon selecting a destination, they are directed to a detailed page with a navigation map for real-time guidance. Additionally, the Tickets page allows tourists to view their bookings, display payment proof, and generate a QR Code for purchased tickets, which becomes available after the Tourist Admin updates the ticket status to "unconfirmed".



**Figure 9: Home Page User Interface, Tourist Attraction Details, Navigation Map, Tickets (Tourist Role)**

Figure 10 showcases the User Interface for the Tourist role's Ticket Booking Page, streamlining the ticket reservation process. Tourists enter their full name, the number of individuals, select a destination, choose an entry date, and provide a contact number. After completing this form, they proceed to the Payment page, where they select a payment method and upload proof of payment, ensuring a smooth transaction. The interface also includes a Report Bugs page for users to report issues by providing their name, a bug title, and a detailed description, contributing to app improvement. Lastly, the Profile page displays the user's profile picture and email, allowing for personalized updates, such as changing the profile picture, updating the password, and logging out.



**Figure 10: User Interface Of Ticket Booking Page, Ticket Payment, Report Bugs, Profile (Tourist Role)**

## CONCLUSION

In conclusion, this research successfully developed a mobile-based destination recommendation system aimed at enhancing the tourism experience in Sleman Regency. By integrating the Haversine formula for proximity-based recommendations and incorporating features such as ticket booking and bug reporting, the system effectively addresses the limitations of current manual search processes. The combination of primary and secondary data collection ensured that user needs were thoroughly understood, leading to a design that improves convenience and interaction for tourists. Comprehensive system analysis, design, coding, and rigorous testing validated the system's performance and user satisfaction. This approach not only streamlines trip planning and navigation but also supports continuous system improvements through user feedback.

This recommendation system sets a new standard for tourism applications in Sleman Regency by promoting user engagement and operational efficiency. By categorizing destinations and offering user-friendly functionality, the system fosters a more interactive and enjoyable experience for tourists. Future developments could expand on these features by incorporating real-time data and advanced recommendation algorithms to further enhance personalization and adaptability.

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