

The Development of SaveOcean: Beach and Coastal Cleanup Organizer Mobile Application

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DOI: <https://doi.org/10.30880/aitcs.2024.05.02.030>

Article Info

Received: 13 June 2024

Accepted: 28 September 2024

Available online: 15 December 2024

Keywords

beach cleanup, mobile application, Android platforms, Object-Oriented Analysis and Design (OOAD), organizers, volunteers

Abstract

Marine pollution poses a rising global challenge, exacerbated by disorganized beach cleanup efforts due to a lack of systematic platforms. This project introduces the "SaveOcean: Beach and Coastal Cleanup Organizer Mobile Application" aimed at streamlining cleanup initiatives and enhancing cleanup organization and volunteer engagement. Developed for Android platforms using Object-Oriented Analysis and Design (OOAD) methodology, a web-based approach, and tools like Android Studio and Firebase, the app serves organizers, volunteers, and administrators. The organizers are able to create a cleanup while the volunteers have the option to join for a cleanup. The administrators are responsible for approving or rejecting cleanup requests. The expected outcome is a structured platform that enhances beach and coastal cleanup activities, enables organizers to schedule cleanups, allows volunteers to join, and permits administrative approvals. The app is anticipated to lead to a healthier and more sustainable coastal environment, with increased awareness and participation in conservation efforts.

1. Introduction

Marine pollution is becoming an increasingly serious issue. Human activity along coastlines and inland is the primary source of pollution [1]. Beach cleanups are volunteer initiatives conducted regularly along shorelines worldwide. Reef Check Malaysia's ICC 2020 Report reveals that, with the participation of 3,500 volunteers from various regions of the country, an impressive 11 tonnes of trash were cleaned up from over 200 kilometers of coastline. In September 2020 alone, these efforts resulted in the collection of 24,493 plastic bottles [2]. They involve environmental organizations, community groups, and individuals who work together to gather litter from the beach. This not only enhances the beach's aesthetics and safety but also contributes to the overall health of coastal and oceanic environments. Coastal cleanup initiatives play a pivotal role in the fight against coastal pollution and environmental degradation. Beyond environmental conservation, these cleanup endeavors serve as a beacon of hope for coastal communities, offering a tangible way to actively contribute to the well-being of their local environments.

However, the current beach and coastal cleanup process lacks a systematic and structured platform for organizers to create and manage cleanup events. Volunteers, ranging from dedicated community members to students and environmental enthusiasts, participate in these cleanup events without a centralized platform to access event details. Armed with basic tools like gloves and trash bags, they work tirelessly to rid the coast of accumulated waste. The absence of a streamlined platform leads to challenges such as disorganized event planning, difficulties in tracking progress, and a lack of accurate data reporting. This hampers the ability to measure the true impact of these cleanup activities.

Inaccurate data not only undermines the credibility of cleanup reports but also hampers the ability to track progress and demonstrate the tangible benefits of these conservation initiatives. This, in turn, may impede efforts to secure the necessary funding and support for future cleanup events. Additionally, limited engagement with potential volunteers and the wider community presents another significant challenge. Without a structured approach to outreach, awareness of cleanup efforts remains restricted, potentially leading to fewer participants and a diminished impact on marine life and the environment.

In response to these challenges, we propose the development of a Beach and Coastal Cleanup Organizer Mobile App. This innovative digital platform aims to provide organizers with a structured platform to create and manage cleanup events, while also offering volunteers a centralized hub to access event details and participate in a more organized manner. By digitizing and automating these processes, the app seeks to eliminate data discrepancies and manual errors, ensuring accurate and reliable reporting. Additionally, the app will incorporate features to systematically engage potential volunteers, increasing community involvement and broadening the reach of cleanup efforts. Through this proposed solution, we envision a more efficient, engaging, and impactful approach to beach and coastal cleanup initiatives, ultimately leading to a healthier and more sustainable coastal environment.

2. Related Work

This section discussed the technology used to develop the proposed mobile application. The current process of beach and coastal cleanup is also studied in this section. Besides, the three similar existing systems, namely Clean Swell, OceanHero, and CleanUp mobile applications are compared in a tabular form.

2.1 Technology Used

The proposed mobile application is developed for the Android platform. Android Studio serves as the Integrated Development Environment (IDE) for Android development, utilizing the Java programming language and incorporating Firebase as the real-time database. For the web-based system designed for administrators, the software utilized is Visual Studio Code, using the HyperText Markup Language (HTML), Cascading Style Sheets (CSS), and JavaScript(JS) for development.

2.2 Existing Beach and Coastal Cleanup Process

The diagram of existing beach and coastal cleanup process will be shown in Appendix B. The cleanup process of Dreamworkshop organization begins with choosing a beach where the organizers want to conduct a cleanup. The organizers conduct research online to identify beaches in need of cleanup. Once the beach is selected, the organizers decide on a date and time based on weather forecasts and the availability of volunteers, such as weekends or public holidays. Additionally, the next step involves sharing and spreading information about the cleanup event to the public. The organizers create a poster containing details such as the cleanup location, date, time, and contact information. Volunteers interested in participating need to fill out a Google Form with their information. Moreover, three days before the cleanup, the organizers schedule a Zoom meeting to provide details about the cleanup process and safety instructions for all volunteers. During the meeting, volunteers are encouraged to prepare their supplies, such as gloves and trash bags. The organizers also arrange to provide supplies to volunteers who do not have them. Subsequently, the cleanup process takes place on the scheduled date and time. Finally, the cleanup is documented by capturing photos and videos to showcase the community's efforts. This documentation aims to attract more people who care about the environment to participate in cleanup activities and encourages individuals to contribute to environmental care for the earth.

2.3 Study of Existing Related Systems

The three similar existing systems are Clean Swell, OceanHero, and CleanUp. The Clean Swell mobile application is part of the Ocean Conservancy's International Coastal Cleanup initiative. It is a cost-free mobile application intended for volunteers participating in cleanups. Besides, OceanHero is a search engine that helps combat ocean plastic pollution. The app allows users to turn their web searches into opportunities to remove plastic waste from the ocean. Additionally, CleanUp is a mobile application that allows users to start a cleanup by uploading the trash collected images. The administrator will then reply the submission status whether the image is invalid or verified.

Table 1 System's Comparison

Features/System	Clean Swell	OceanHero	CleanUp	SaveOcean
1. User authentication via email and password	Yes	Yes	Yes	Yes
2. Create cleanup	Yes	No	No	Yes
3. Educational and environmental content	Yes	Yes	No	Yes
4. Cleanup event approval	No	No	Yes	Yes
5. Manage user profile	Yes	No	Yes	Yes
6. Volunteer registration	Yes	No	Yes	Yes
7. Operating system	Android	Android	Android	Android

Based on Table 1, it is clearly shown that all mobile applications have user authentication via email and password during the login process. Besides, Clean Swell and SaveOcean allow the organizers to create the cleanup while CleanUp and OceanHero are not able to create the cleanup. Only CleanUp does not provide the educational and environmental content features, another three existing mobile applications provides this features. Furthermore, CleanUp and SaveOcean have the features of cleanup event approval, the another two mobile applications do not have the features of cleanup event approval. Additionally, only OceanHero is not able to manage the user's profile. Clean Swell, CleanUp, and SaveOcean allow the users to update their profile. Moreover, it is obvious that only OceanHero does not involve the volunteer registration features. Clean Swell, CleanUp, and SaveOcean offer the volunteers to register for the cleanup. Lastly, the three existing mobile applications and the proposed mobile application are Android-based.

3. Methodology

This chapter explain the use of Object-Oriented Analysis and Design (OOAD) in this project and the activities that had been carried out in each phase.

3.1 Object-oriented Analysis and Design (OOAD)

OOAD is an internationally recognized technical approach used to handle an application-specific, business, or system model. It involves the creation of straightforward graphical diagrams to analyze and enhance product quality by implementing the object-oriented prototype method. There are four phases of the OOAD methodology, including the object-oriented analysis phase, object-oriented design phase, object-oriented implementation phase, and object-oriented testing phase.

3.1.1 Object-oriented Analysis phase

Object-Oriented Analysis (OOA) is the initial phase in software development that centers on understanding user requirements in terms of objects. The project commenced with a brainstorming session aimed at generating numerous ideas for the project title as many as possible. This session involved contemplating real-life problems, gathering ideas from social media, exploring previous Final Year Project titles for reference, and observing everyday situations. Furthermore, three project titles were selected from the brainstormed ideas, and create three draft project proposals. This ensures having backup titles available in case of any challenges during the title defense session. These three drafts were then reviewed by the supervisor, and a discussion on the project proposals took place in an online meeting using Microsoft Teams.

The interview sessions are conducted in order to obtain the information and determine the system requirements from the stakeholders. The data obtained during the interview session regarding the system requirements for the proposed system undergo analysis and are transformed into clearly defined system functions. An interview session with beach and coastal cleanup organizer, Ms Lai Hsu Huei from the individual organization, namely Dreamworkshop and the volunteer, Mr Loh Rui Hua were conducted. The interview session were conducted online via Zoom and Google Meet platforms. Several questions regarding the beach and coastal cleanup were asked to both organizers and volunteers. The interview data provided by the organizers and volunteers were collected. Functional and non-functional requirements were analyzed in this phase.

In addition, during this phase, a comprehensive literature review of the project was conducted. This involved extensive reading of articles, journals, books, and research papers to gather information and data relevant to the project. Additionally, the information could be also gathered from websites through Internet browsing. The study of existing related systems was conducted to make comparisons with the proposed system. The distinctions and similarities between three existing related systems and the proposed system were identified and documented in

a comparison table. To ensure the project is completed on time, a project plan was scheduled. The project plan was represented in the form of Gantt Chart that created using Microsoft Project. The Gantt Chart is shown in Appendix A.

3.1.2 Object-oriented Design phase

The object-oriented design phase is a key stage in the software development process that comes after the object-oriented analysis phase. In this phase, the process of designing the user interfaces and database were conducted. The wireframes of the mobile application user interface design were drawn using Figma as a draft. For the database design, database schemes and data dictionaries related to the module's functionality are documented for the system development. Additionally, The information gathered from the results of the requirement gathering and analysis activity is depicted in a Unified Modeling Language Diagram (UML Diagram). UML diagrams provide a visual representation of different aspects of a system, making it easier for stakeholders to understand the design, structure, and behavior. According to the journal authored by Koç et al. in 2021, the types of UML diagrams includes class diagram, use case diagram, sequence diagram, and activity diagram [3]. The UML diagrams are designed to enhance understanding of the structure and illustrate the information of the proposed mobile application. The software of Lucidchart and Draw.io are used to create the UML diagrams.

3.1.3 Object-oriented Implementation phase

Object-oriented implementation is a stage in software development where the design model and structure developed in object-oriented analysis and object-oriented design are transformed into executable code using the appropriate programming language. In this phase, the design and structure of the software are converted into actual code using an Object-Oriented Programming Language (OOP). Android Studio serves as the Integrated Development Environment (IDE) for Android development, utilizing the Java programming language and incorporating Firebase as the real-time database. For the web-based system designed for administrators, the software utilized is Visual Studio Code, using the HyperText Markup Language (HTML) for development. Additionally, a prototype of the proposed system is built for each module, ensuring that the mobile application satisfies user requirements.

3.1.4 Object-oriented Testing phase

Object-oriented testing represents the final phase in software development, concentrating on verifying and validating the functionality of the software system. This stage ensures the verification of the actual code and the performance of the object-oriented system. In this phase, error and bug checking processes are implemented. Testing is conducted on the developed mobile application based on a test plan to ensure it operates without errors. The database undergoes testing to confirm data storage, updates, and access functionality. Corrections are made if any errors or defects are identified. Interface testing is conducted to verify that the SaveOcean: Beach and Coastal Cleanup Organizer Mobile Application is user-friendly.

3.2 System Development Workflow

Table 2 shows the software development activities and their task, each phase has its own assignment and output that need to produce during the entire project development. Besides that, the output had been completed within the specific days.

Table 2 Software Development Activities and Their Task

Phase	Task	Output
Object-oriented analysis	<ul style="list-style-type: none"> Engage in brainstorming sessions to generate ideas. Prepare a draft of the project proposal. Consult with the supervisor on the project proposal. 	<ul style="list-style-type: none"> Project title Project proposal draft Revised project proposal Final project proposal Interview questions User requirements

Table 2 Software Development Activities and Their Task (continued)

	<ul style="list-style-type: none"> Finalize project proposal. Prepare interview questions. Conduct interview with organizer and volunteer. Determine the system requirements. Study the existing related systems. Compare existing related system with the proposed system. 	<ul style="list-style-type: none"> Functional and non-functional requirements Existing related systems were studied. Differences and similarities between existing related system and proposed system are compared.
Object-oriented design	<ul style="list-style-type: none"> Design UML diagrams. Design user interfaces. Design database. 	<ul style="list-style-type: none"> Use case diagram, class diagram, sequence diagram, activity diagram Wireframes Data dictionary User interfaces System modules and functionalities System connects with database.
Object-oriented implementation	<ul style="list-style-type: none"> Develop system interfaces. Develop system modules. Establish a connection with the database. 	<ul style="list-style-type: none"> System workflow and functionalities were tested. Bugs and errors were fixed. Test Plan results
Object-oriented testing	<ul style="list-style-type: none"> Conduct system testing. Debug and fix errors. Conduct testing according to Test Plan 	

4. Design

The general system architecture, functional and non-functional requirements, Unified Modelling Language (UML) diagram, interface and database design of the proposed mobile application will be discussed in this chapter.

4.1 General System Architecture

System architecture refers to the high-level structure and organization of a complex system, defining how its components interact and cooperate to achieve the system's objectives. It encompasses the design principles, patterns, and decisions that shape the system's structure, behavior, and functionality. The general system architecture of the proposed mobile application shown in Appendix C.

4.2 Unified Modelling Language (UML)

UML diagrams provide a graphical representation that helps software developers, system architects, and stakeholders understand, design, and communicate various aspects of a system's structure, behavior, and interactions.

4.2.1 Use Case Diagram

According to the journal by El-Attar published in 2019, use case diagrams, a component of the UML (Unified Modeling Language) set of diagrams, serve as the forefront requirements-oriented diagram within the UML framework [4]. The use case diagram of the proposed mobile application shown in Appendix D and Appendix E.

4.2.2 Sequence Diagram

According to the journal by Al-Fedaghi in 2021, the UML sequence diagram stands as the second most frequently used UML diagram, illustrating the interactions and message exchanges between objects over time [5]. The sequence diagram of the proposed mobile application shown in Appendix F and Appendix G.

4.2.3 Activity Diagram

An activity diagram is a type of behavioral diagram in the Unified Modeling Language (UML) that illustrates the dynamic aspects of a system by modeling the workflow and business processes within the system (Vpadmin, 2023). The activity diagram of the proposed mobile application shown in Appendix H and Appendix I.

4.2.4 Class Diagram

The UML diagrams were predominantly utilized for design and modeling purposes, with class diagrams being the most frequently employed. A class diagram is a type of static structure diagram in the Unified Modeling Language (UML) that represents the structure of a system by illustrating the classes, interfaces, collaboration, associations, and their relationships within the system. The class diagram of the proposed mobile application shown in Appendix J.

4.3 Interface Design

Interface design refers to the process of designing the visual layout and functional elements of a software application, website, or any digital product that allows users to interact with it [6].

4.3.1 User Login Interface Design

Figure 1(a) shows the welcome page. This page provides options for users to either sign up or log in, directing them to the respective pages. Besides, figure 1(b) shows the sign up page. To create a new account, users are required to enter their username, email, password, and confirm password. Figure 1(c) shows the login page. To access the application, users need to enter their registered email and password. Upon successful authentication, users will be directed to the home page. Further interface designs of the application are attached in Appendix K.

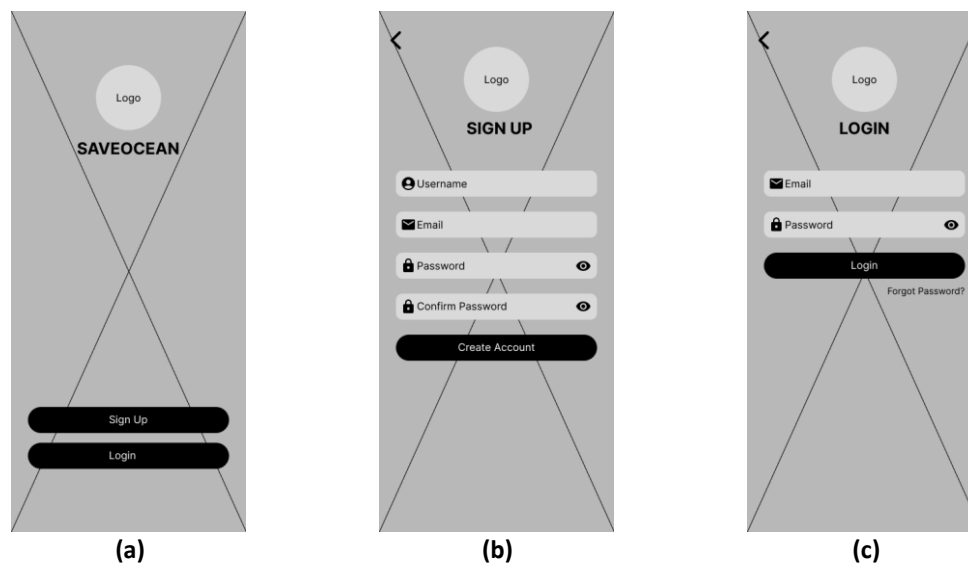


Fig. 1 (a) Welcome Page; (b) Sign Up Page; (c) Login Page

4.3.2 Administrator Login Interface Design

Figure 2(a) shows the administrator login page. This is the first and main page of the SaveOcean administrator system before launching the system functional modules. The administrator needs to enter email and password to login into the system. Forgot password feature is provided for administrators to reset their password if they have forgotten. Further interface designs of the administrator system are attached in Appendix L.

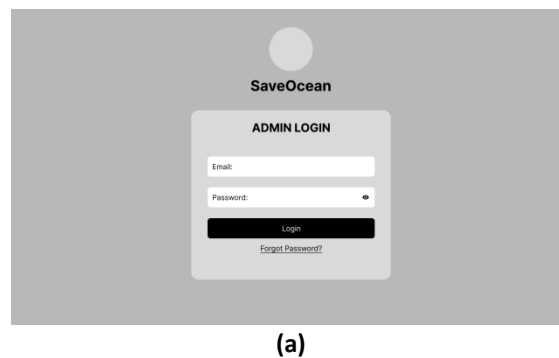


Fig. 2 (a) Administrator Login Page

5. Implementation and Testing

This section will discuss the implementation and testing of the SaveOcean mobile application with its administrator system.

5.1 Implementation

The output interface will be shown in this section.

5.1.1 User Interface

Figure 3(a) shows the welcome page. This page provides options for users to either sign up or log in, directing them to the respective pages. Besides, the Figure 3(b) shows the sign up page. To create a new account, users are required to enter their username, email, password, and confirm password. A "Create Account" button is available for users to click and register a new account. Figure 3(c) shows the login page. To access the application, users must enter their registered email and password. Upon successful authentication, users will be directed to the application's home page.

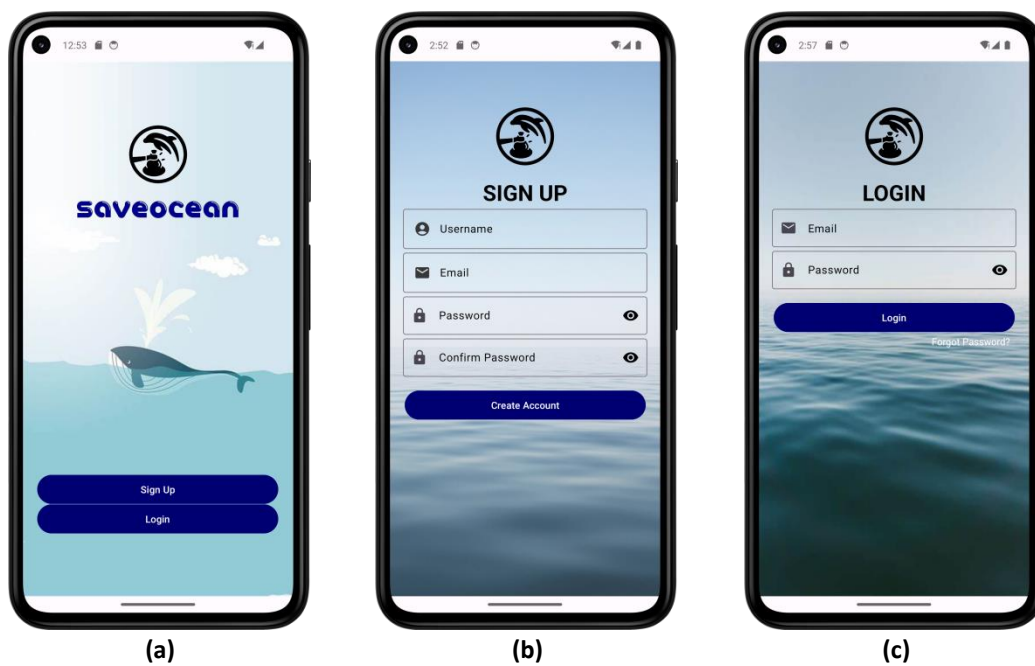


Fig. 3 (a) Welcome Page; (b) Sign Up Page; (c) Login Page

After successfully logging in, users are directed to the home page shown in figure 4(a). This home page showcases available cleanups, detailing the group name, program name, date, start time, end time, number of volunteers, supplies needed and contact number. For volunteers interested in participating, a "Join" button is available, leading them to a join cleanup page (figure4(b)). The home page features a search bar that allows users to search for specific cleanups by entering keywords. Besides, the application features a bottom navigation bar with options such as Home, Information, Create Cleanup (plus icon), My Cleanup, and Profile. Additionally, figure 4(b) shows a join cleanup page for volunteers. To join a cleanup, volunteers need to provide full name, phone number and select a supplies prepared from a drop down list. Username and email are retrieved from database. Moreover, figure 4(c) shows create cleanup page for organizers. To create a cleanup, organizers need to enter group name, program name, date, start time, end time, number of volunteers, contact number and select a supplies needed from a drop down list.

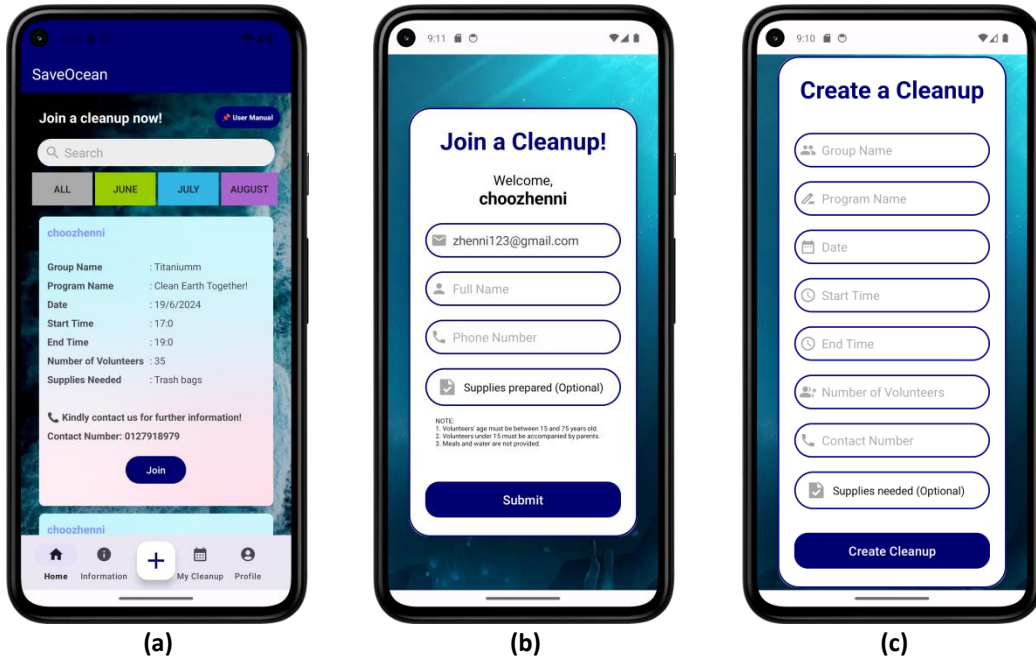


Fig. 4 (a) Home Page; (b) Join Cleanup Page; (c) Create Cleanup Page

Figure 5(a) shows the organized cleanup page. Once a cleanup is successfully created, it will be displayed on this page. Organizers are able to view the status of created cleanups, whether they are processing, approved, or rejected by the administrator. By clicking the “View” button, organizers are able to view the joined volunteers list (figure 6(a)) and checked-in volunteers list (figure 6(b)), along with the volunteers’ details for that particular cleanup. Furthermore, figure 5(b) shows the joined cleanup page. Once a volunteer has joined a cleanup, the details of that cleanup will be displayed on this page. Upcoming cleanups will be displayed in the “Upcoming Cleanups” section, while past cleanups will be stored in the “History” section. Volunteers have the option to check-in for the cleanup within three days and able to reject the cleanup at any time to confirm their attendance. Only checked-in volunteers will receive a participation certificate (figure 6(c)) by clicking the “Cert” button once the cleanup is completed. Figure 5(c) shows the educational and safety content page. This page presents some articles for organizers and volunteers about the educational and safety content related to the beach and ocean.

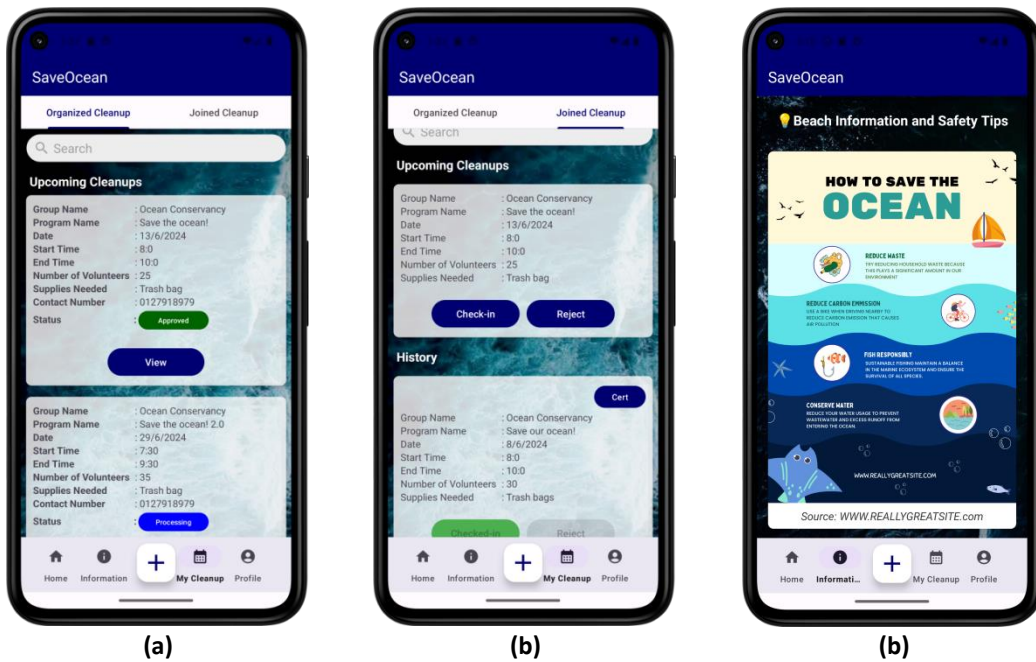


Fig. 5 (a) Organized Cleanup Page; (b) Joined Cleanup Page; (b) Educational and Safety Content Page

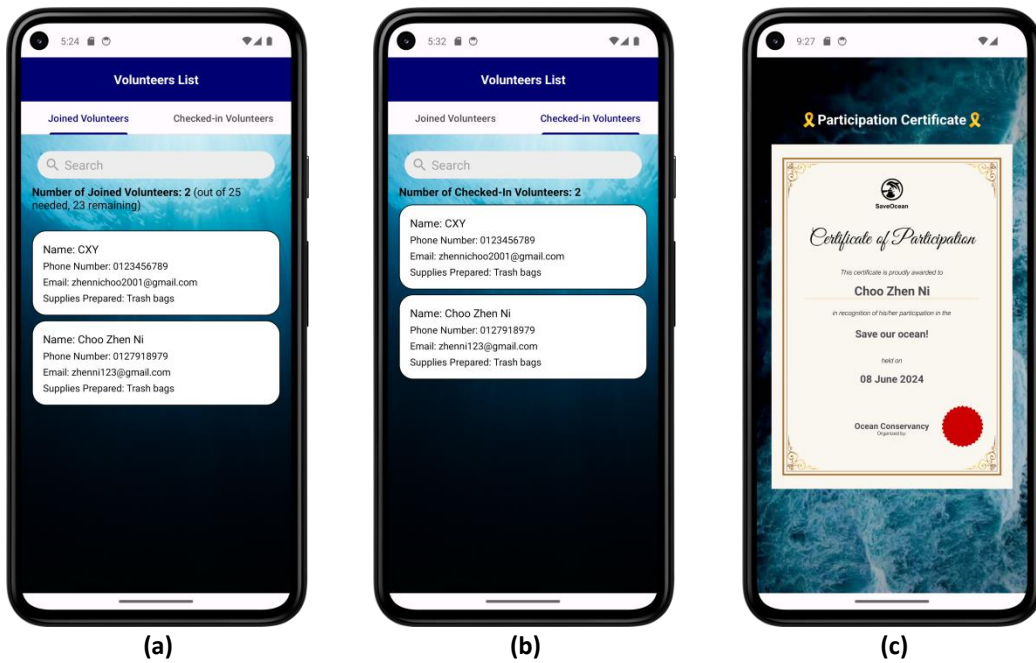


Fig. 6 (a) Joined Volunteers List Page; (b) Checked-in Volunteers List Page; (c) Participation Certificate Page

Additionally, figure 7(a) shows the profile page. The username and email will be displayed on this page. Users are able to update their username and password by clicking the “Edit Profile” button. Then, users will be redirected to the edit profile page (figure 7(b)). To change the password, users need to click on the “Change Password” button, and a dialog box for changing the password will pop up. The change password dialog box is shown in figure 7(c).

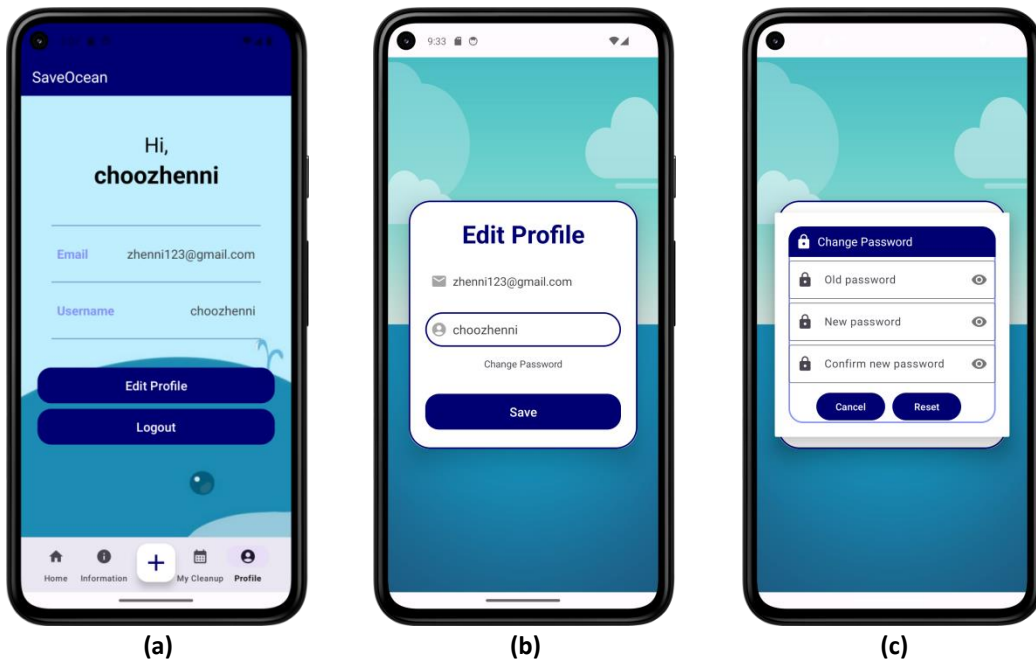


Fig. 7 (a) Profile Page; (b) Edit Profile Page; (c) Change Password Dialog Box

5.1.2 Administrator Interface

Figure 8(a) shows the administrator login page. The administrator needs to enter the email and password to login into the system. Forgot password feature is provided for administrators to reset their password if they have forgotten. Figure 8(b) shows the administrator profile page. The administrator are able to update the image, username, and password by clicking the edit icon and "Change Password" button.

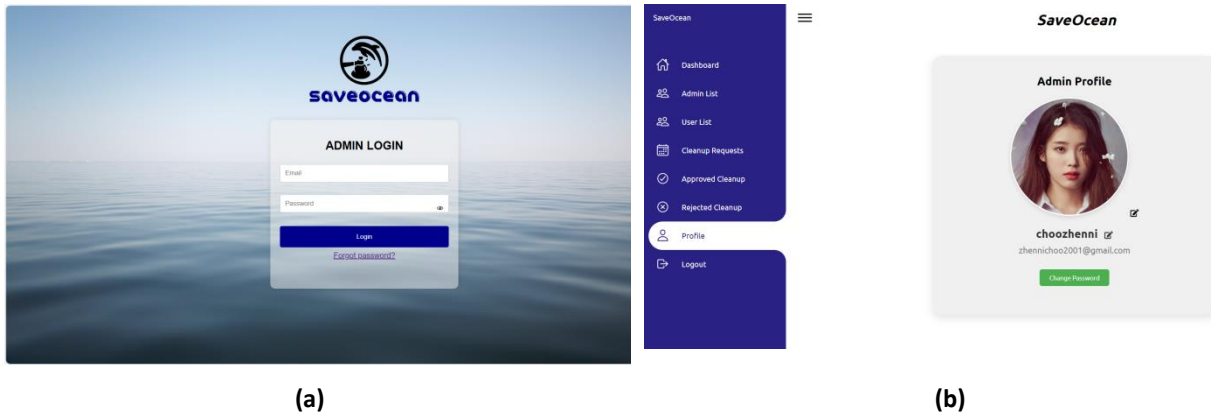


Fig. 8 (a) Administrator Login Page; (b) Administrator Profile Page

Besides, Figure 9(a) shows the administrator dashboard page. The dashboard allows administrators to review cleanup data in statistical form. From the figure 9(a), total cleanup requests, total approved cleanups, total rejected cleanups, total users, total volunteers and total administrators are calculated in a card view based on the real-time database. Furthermore, overall approved cleanups according organizations, comparison between the total number of joined volunteers and checked-in volunteers, total approved cleanups in 2024 by months, and a comparison between overall number of organizations and volunteers are displayed in histograms and pie charts for visual analysis based on real-time database. Moreover, figure 9(b) shows the approved cleanup page. This page stores approved cleanups history in a calendar form, making it easier for administrators to quickly review the approved cleanups based on day. Additionally, if a day has approved cleanups, that day will turn orange, and each approved cleanup will be represented by a green dot. When administrators click on the day that has approved cleanups, a message with its details will pop up.

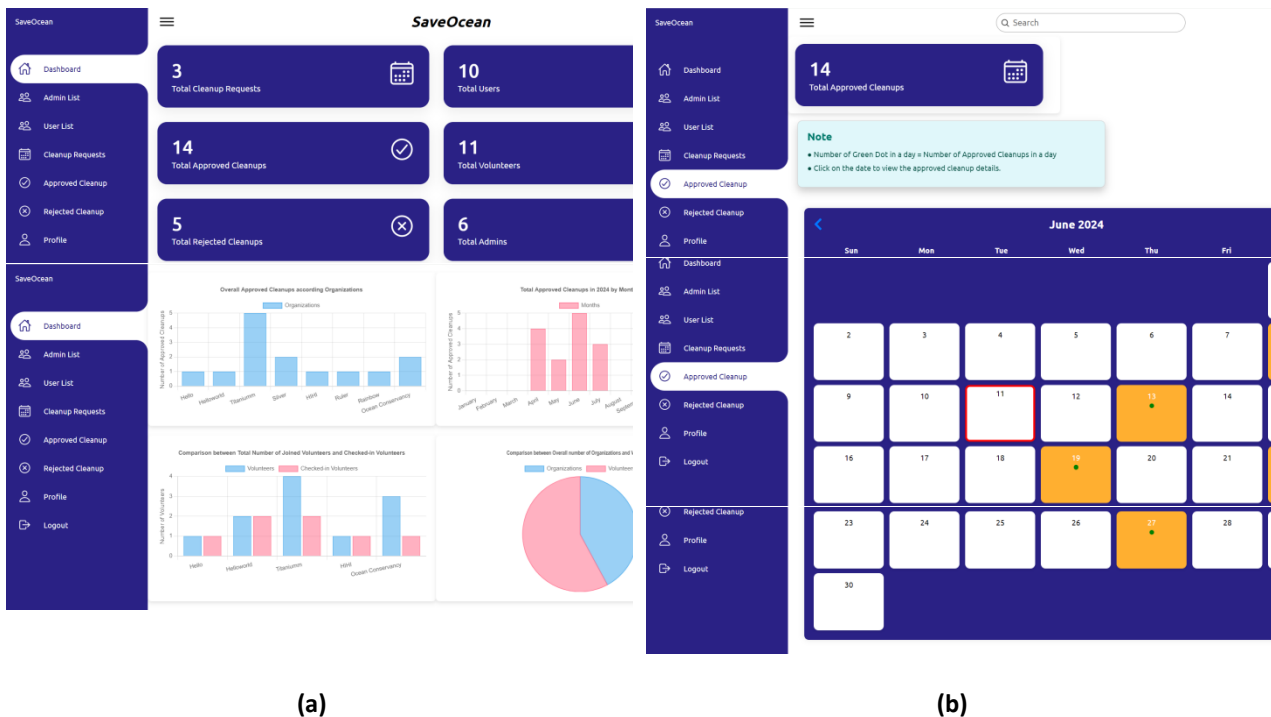


Fig. 9 (a) Administrator Dashboard Page; (b) Approved Cleanup Page

Figure 10(a) displays the administrator list page. On this page, administrators are able to view administrator list, add new administrator accounts and delete administrator accounts. Figure 10(b) shows the user list page. Administrators are able to view user list, add new user accounts and remove user accounts if needed.

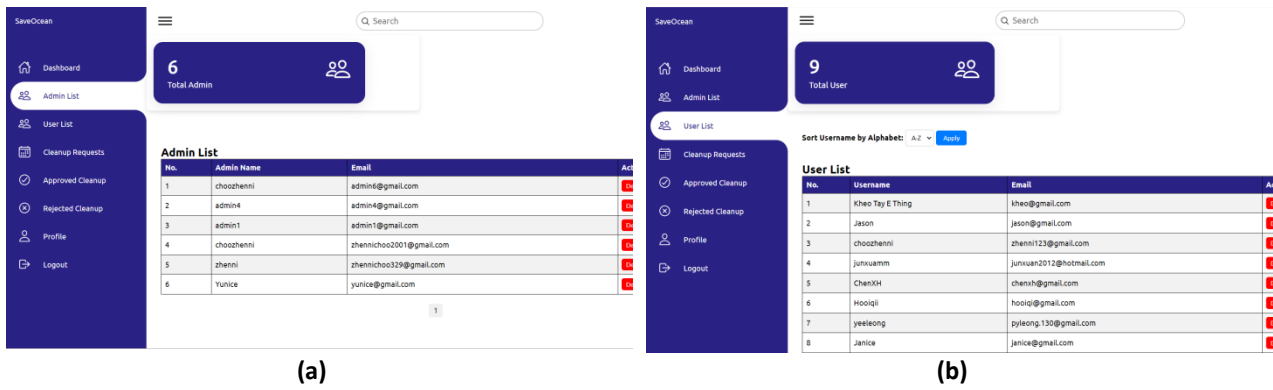


Fig. 10 (a) Administrator List Page; (b) User List Page

Figure 11(a) shows the cleanup requests page. This page allows administrators to review cleanup details as requested by organizers in tabular form. The cleanup details table includes no., user email, group name, program name, date, start time, end time, no. of volunteer, supplies needed, contact number and action. Additionally, administrators are allowed to approve or reject individual cleanup requests by clicking the button. Figure 11(b) shows the rejected cleanup page. Once the administrator has rejected the cleanup requests, the rejected cleanups will be stored on this page.

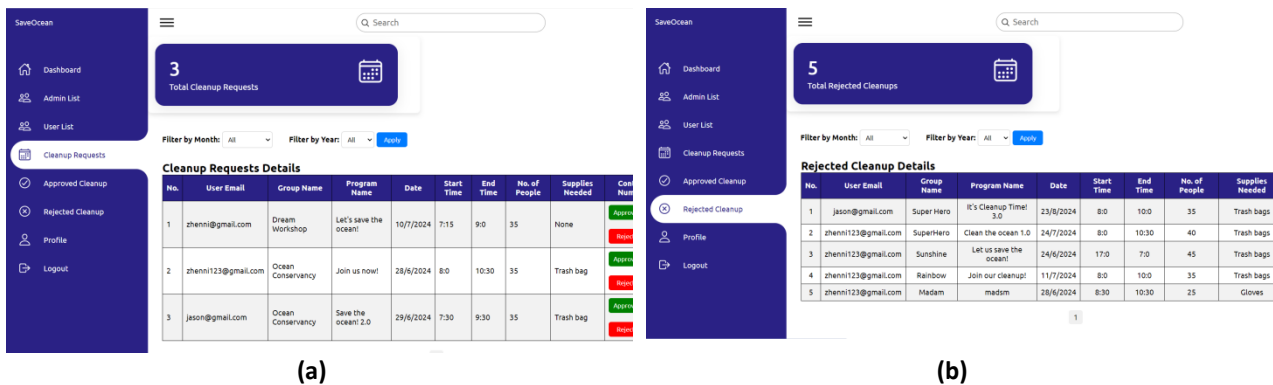


Fig. 11 (a) Cleanup Requests Page; (b) Rejected Cleanup Page

5.2 Testing

The testing phase is the process of verifying the functionality of the system to ensure it meets the requirements. Testing plays a crucial role in achieving and evaluating the quality of a software product [7]. Additionally, testing also ensures the system performs well according to user requirements.

5.2.1 Test Plan

The testing process is carried out according to the test plan to test each functionality of the developed system and ensure each module can perform well based on the expected results. Table 3 shows the test plan results.

Table 3 Test Plan Results

Module	Test Case	Expected Result	Actual Result
1. User authentication	<ul style="list-style-type: none"> Users are able to sign up for a new account. Users are able to login into the system using authenticated email and password. 	<ul style="list-style-type: none"> Users are authenticated successfully and users information can be saved to Firebase. Users are able to login into the system using authenticated email and password. 	Pass

- Once the sign up process is successful, a message "Signup Successfully." will be displayed

Table 3 Test Plan Results (continued)

		to users.	
2. Cleanup creation	<ul style="list-style-type: none"> • Organizers are able to create cleanup events by entering group name, program name, date, start time, end time and contact number. They are allowed to set volunteer limits and specify the necessary supplies such as gloves, trash bags. 	<ul style="list-style-type: none"> • Created cleanup is successfully saved to Firebase. • Once the process is successful, a message "Your cleanup was created successfully!" will be displayed to organizers. 	Pass
3. Cleanup registration/ participation, check-in or reject	<ul style="list-style-type: none"> • Volunteers are able to join a cleanup by entering their personal details such as full name, phone number and supplies prepared. • Volunteers are able to check-in to the cleanup to confirm their attendance within three days of the cleanup. • Volunteers are able to reject the cleanup at any time. 	<ul style="list-style-type: none"> • Volunteers information are successfully saved to Firebase. • Volunteers are successfully to check-in the joined cleanup within three days or reject the joined cleanup at any time. • Volunteers are not able to check-in the joined cleanup for more than three days. • Checked-in volunteers information are successfully saved to Firebase under the correct cleanup. 	Pass
4. Educational and safety content	<ul style="list-style-type: none"> • Both organizers and volunteers are able to view the beach information and safety content. 	<ul style="list-style-type: none"> • Both organizers and volunteers are able to view the beach information and safety content. 	Pass
5. Joined volunteers list and checked-in volunteers list	<ul style="list-style-type: none"> • Organizers are able to view joined volunteers list and checked-in volunteers list for each organized cleanup. 	<ul style="list-style-type: none"> • Organizers are able to view joined volunteers list and checked-in volunteers list for each organized cleanup. 	Pass
6. Participation certificate	<ul style="list-style-type: none"> • Once the cleanup is completed, the checked-in volunteers will receive a participation certificate. 	<ul style="list-style-type: none"> • Checked-in volunteers will receive a participation certificate after the cleanup is completed. • Rejected volunteers will not receive a participation certificate. 	Pass
7. Profile management	<ul style="list-style-type: none"> • Organizers, volunteers, and administrators are able to manage their profile such as update username and password. 	<ul style="list-style-type: none"> • Organizers, volunteers, and administrators are successfully update their username and password. 	Pass
8. Cleanup requests approval or rejection	<ul style="list-style-type: none"> • Only administrators are authorized to approve or reject cleanup requests made by organizers. 	<ul style="list-style-type: none"> • The cleanup will be published into application home page after the administrator approved the cleanup request. • The rejected cleanup will not publish on application home page. 	Pass
9. Approved/rejected cleanups history	<ul style="list-style-type: none"> • Administrators are able to view history of approved and rejected cleanups. 	<ul style="list-style-type: none"> • The cleanup will be stored into approved cleanup history in administrator system via a calendar form after the 	Pass

administrator approved the cleanup request.

- The cleanup will be stored into

Table 3 Test Plan Results (continued)

10. User and administrator list management	<ul style="list-style-type: none"> • Administrators are able to manage users and administrators, including adding new users and administrators and deleting user and administrator accounts. 	<p>rejected cleanup history in administrator system after the administrator rejected the cleanup request.</p> <ul style="list-style-type: none"> • Administrators are successfully to manage users and administrators, including adding new users and administrators and deleting user and administrator accounts. 	Pass
11. Dashboard/statistical report	<ul style="list-style-type: none"> • Administrators are able to view the statistical report on the dashboard based on real-time database. 	<ul style="list-style-type: none"> • Administrators are able to view the statistical report on the dashboard based on real-time database. 	Pass

6. Conclusion

The achievement of overall objectives, system advantages and disadvantages, and recommendations for improving this mobile application in future work are discussed in this section.

6.1 Achievement of Overall Objectives

Based on the first objective, design a SaveOcean: Beach and Coastal Cleanup Organizer Mobile Application using an Object-Oriented Analysis and Design (OOAD) methodology, the application was successfully designed using OOAD methodology, which facilitated a modular and scalable architecture. This methodology allowed for clear definition and organization of the system’s components, ensuring that each part of the application was systematically planned and effectively integrated.

The second objective is to develop SaveOcean: Beach and Coastal Cleanup Organizer Mobile Application that is able to run on Android platforms, along with an administrator system using a web-based approach. The development of the SaveOcean application was completed for Android platforms, ensuring compatibility and optimal performance on a wide range of Android devices. Additionally, an administrator system was developed using a web-based approach, allowing for remote management of the application’s backend functionalities. This dual-platform approach ensured comprehensive coverage of user needs and administrative controls.

The third objective is to test the functionality and usability of the developed SaveOcean: Beach and Coastal Cleanup Organizer Mobile Application to ensure there are no errors. The application underwent extensive testing to verify its functionality and usability. A detailed testing plan was executed to identify and resolve any errors, bugs, or usability issues. This rigorous testing ensured that the application operates smoothly and reliably, providing a robust and user-friendly experience for all users.

6.2 System Advantages

The advantages of the developed system showcases various features and functionalities that contribute to system effectiveness and user satisfaction. The key advantages of the system are listed:

- i. The application acts as a central hub for organizers and volunteers to participate in cleanup event.
- ii. The application provides a user manual for both application users and administrators.
- iii. The application allows organizers to create a cleanup.
- iv. The application allow volunteers to join a cleanup.
- v. The administrator system allows administrators to approve or reject the cleanup requests.
- vi. The application provides educational and safety content to application users.
- vii. The application allows users to view their upcoming and past organized cleanups, upcoming and past joined cleanups.
- viii. The application allows organizers to view joined volunteer list and checked-in volunteer list for each organized cleanup.
- ix. The application allows volunteers to confirm their attendance by checking-in for a joined cleanup within three days or rejecting to join at any time.

- x. The application provides a participation certificate to volunteers after a cleanup is completed.
- xi. Both the application and administrator system allows users to update their username and password.

6.3 System Disadvantages

The disadvantages of the developed system highlight specific areas where it could be improved in future work. While the system offers various functionalities, it also has some notable shortcomings that impact its overall effectiveness and user experience. The identified disadvantages of the system are listed:

- i. The system lacks of multi-factor authentication (MFA) function to enhance security.
- ii. Organizers are able to select any time when creating a cleanup using a time picker.
- iii. The educational and safety content is static, meaning it cannot be added, updated, and deleted manually.

6.4 Recommendations

Several recommendations can be made to improve this system in the future. Recommendations for future work are important as they will lead to a better and more efficient experience for every user when using the SaveOcean mobile application. The recommendations that can be made are:

- i. The application is suggested to implement a multi-factor authentication (MFA) function to enhance security.
- ii. The application is suggested to provide available time slots for organizers to use when creating a cleanup.
- iii. The educational and safety content is suggested to be made dynamic, allowing administrators to add, edit, or delete it.

Acknowledgement

The authors would like to thank the Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia for its support.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

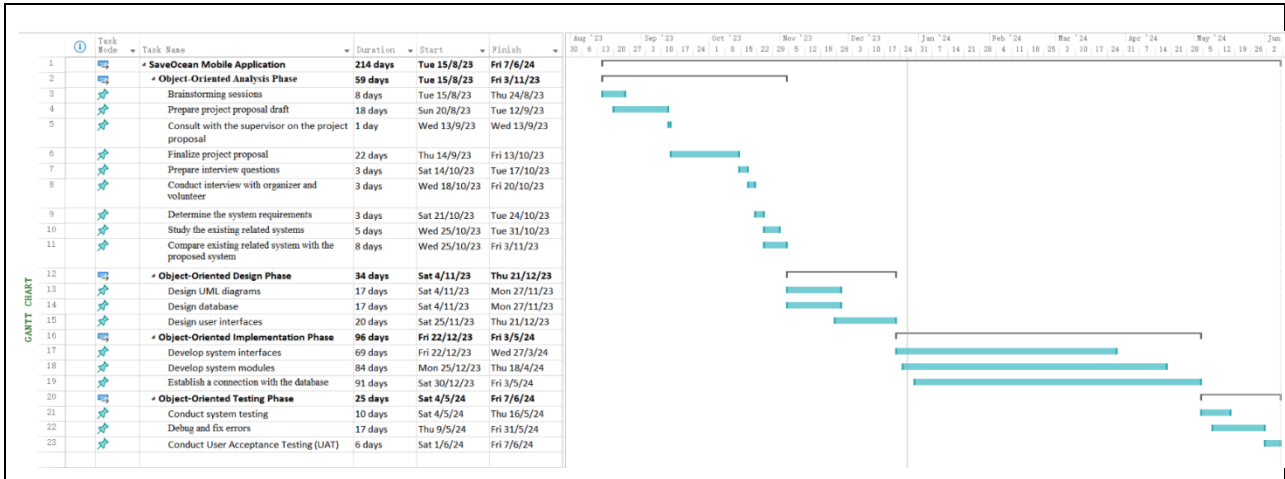
The authors confirm contribution to the paper as follows: **study conception and design:** Choo Zhen Ni, Rozanawati Darman; **data collection:** Choo Zhen Ni, Rozanawati Darman; **analysis and interpretation of results:** Choo Zhen Ni, Rozanawati Darman; **draft manuscript preparation:** Choo Zhen Ni, Rozanawati Darman. All authors reviewed the results and approved the final version of the manuscript.

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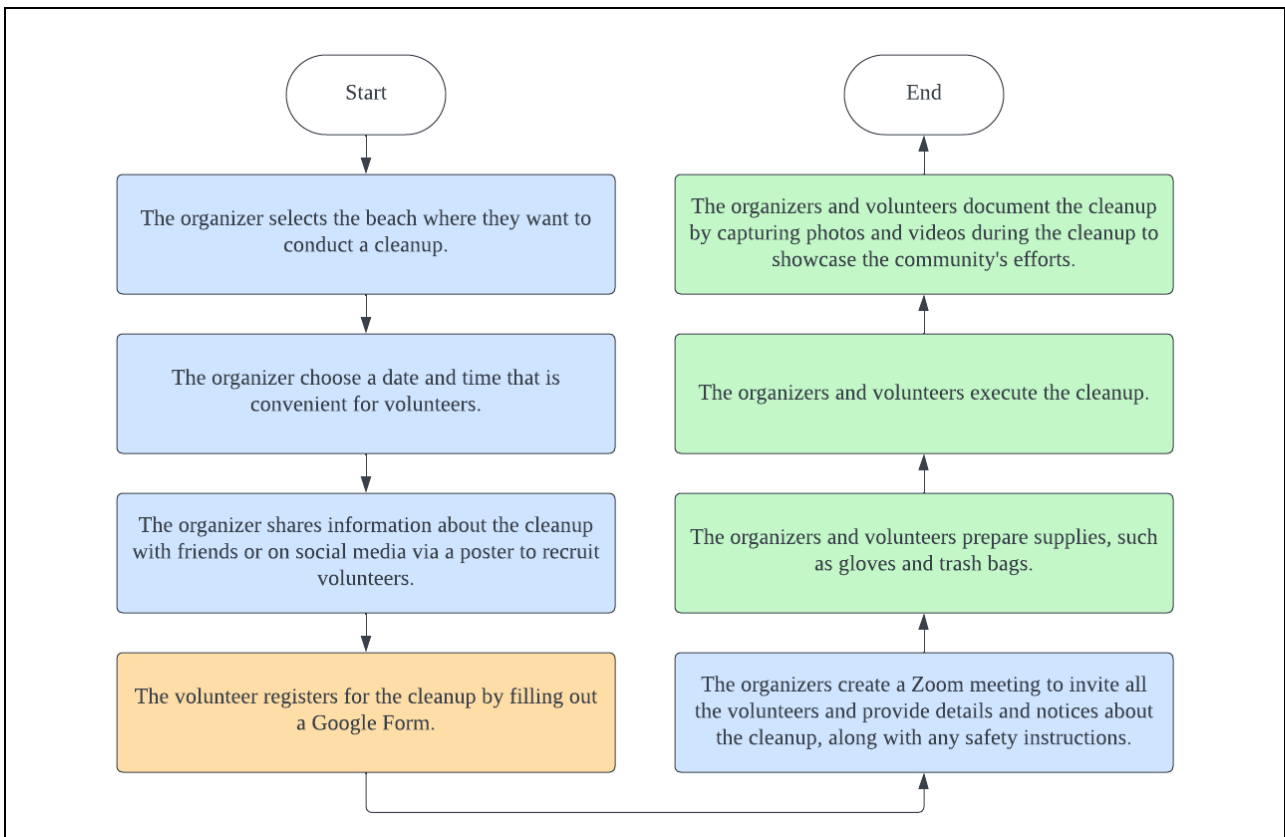
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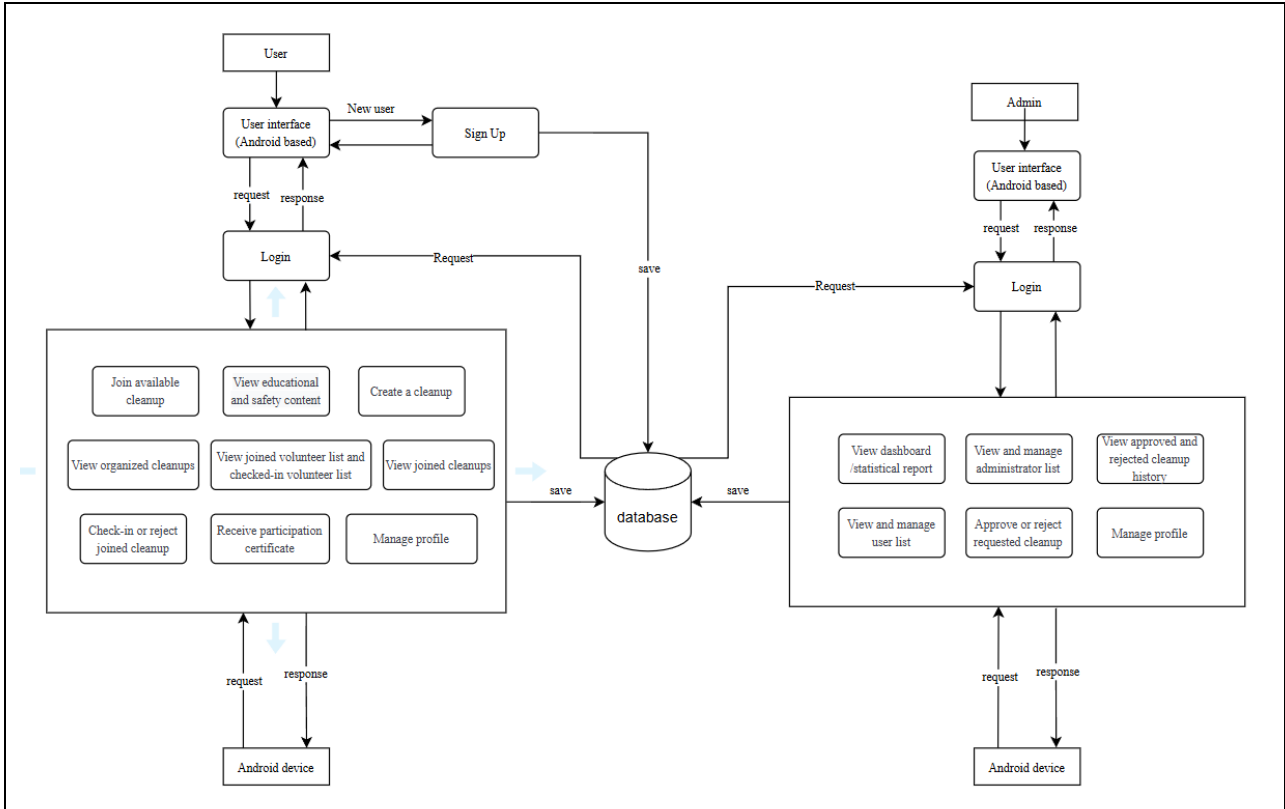
Appendix A: Gantt Chart



Appendix B: Existing Beach and Coastal Cleanup Process

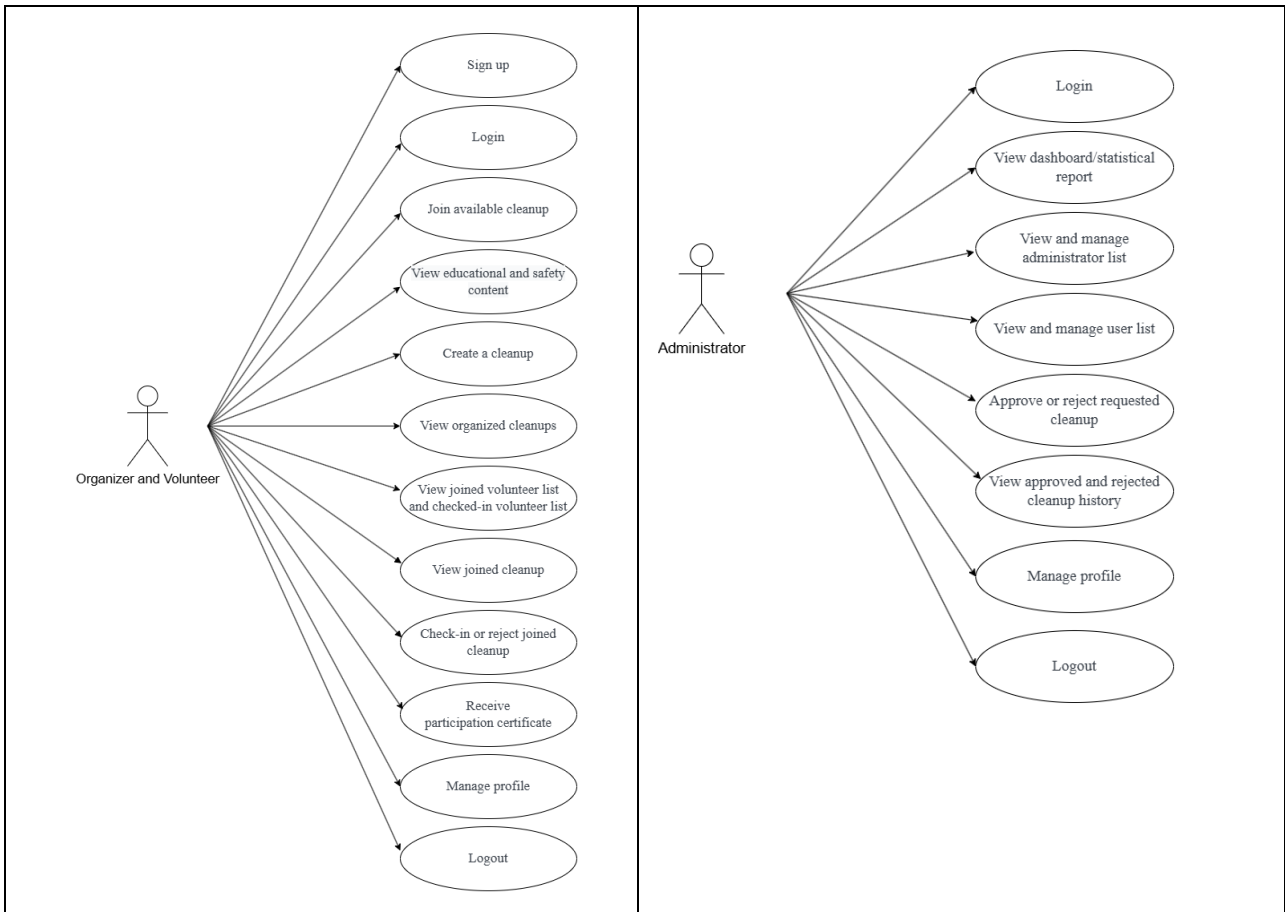


Appendix C: General System Architecture

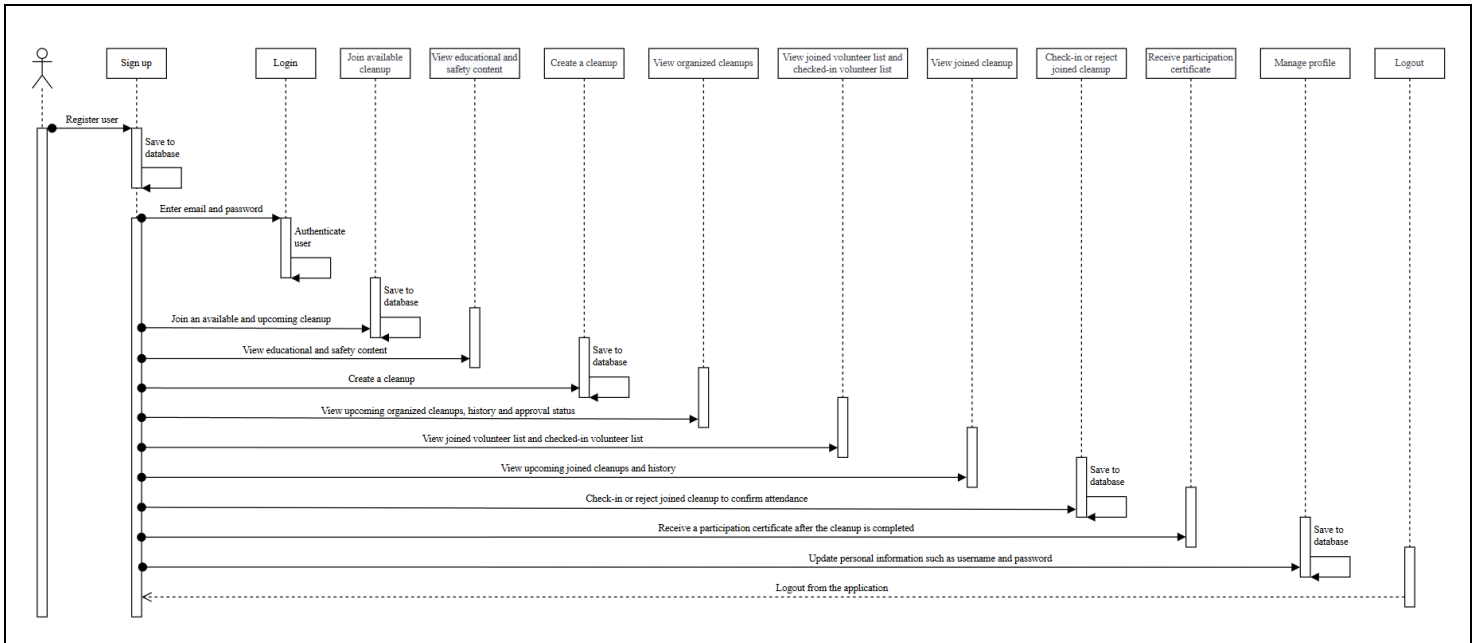


Appendix D: Use Case Diagram for Users

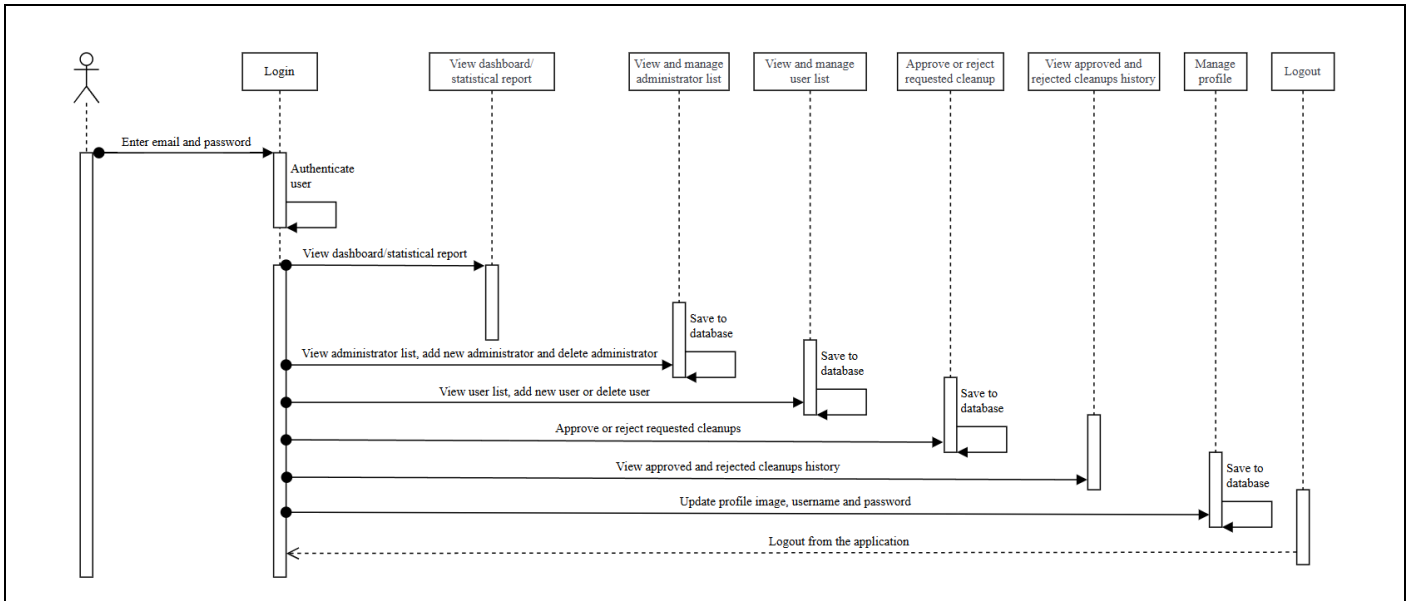
Appendix E: Use Case Diagram for Administrators



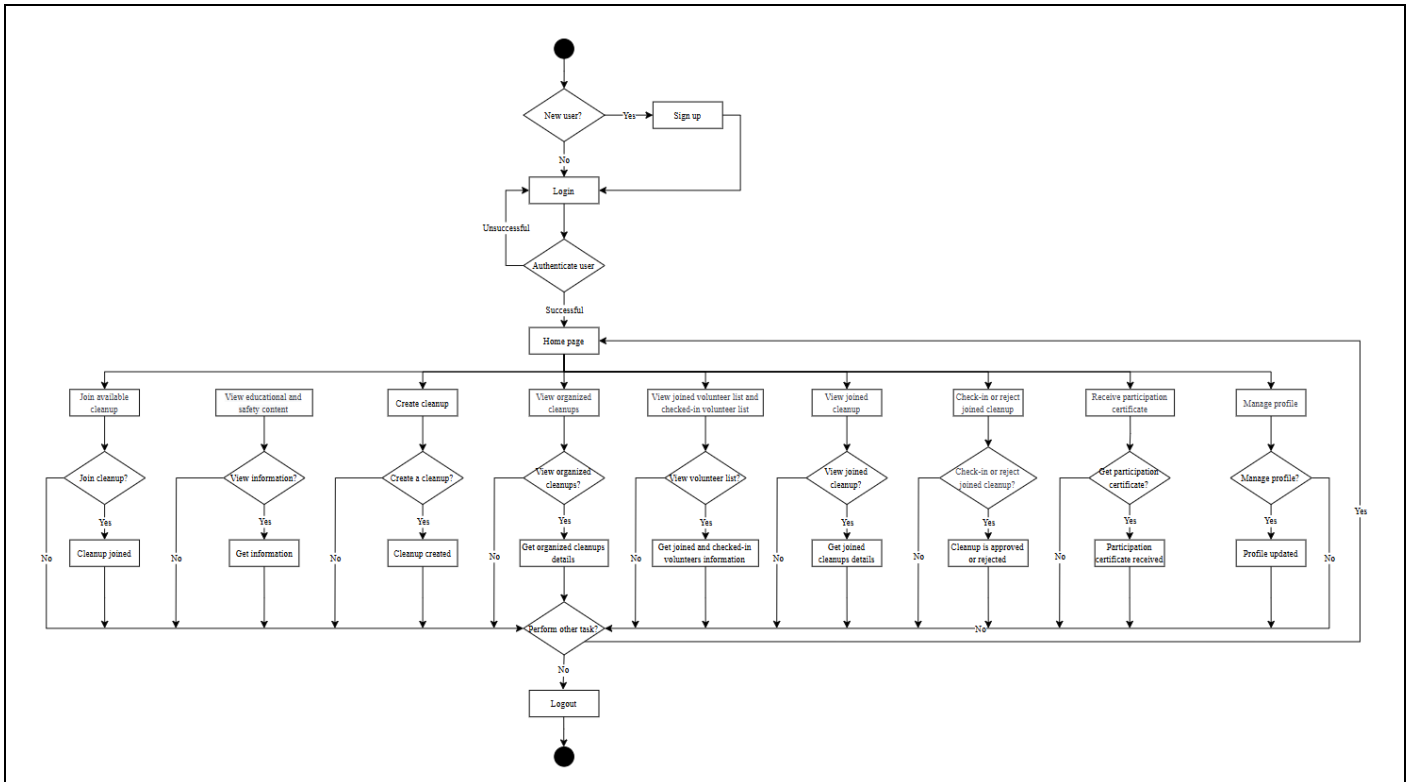
Appendix F: Sequence Diagram for Users



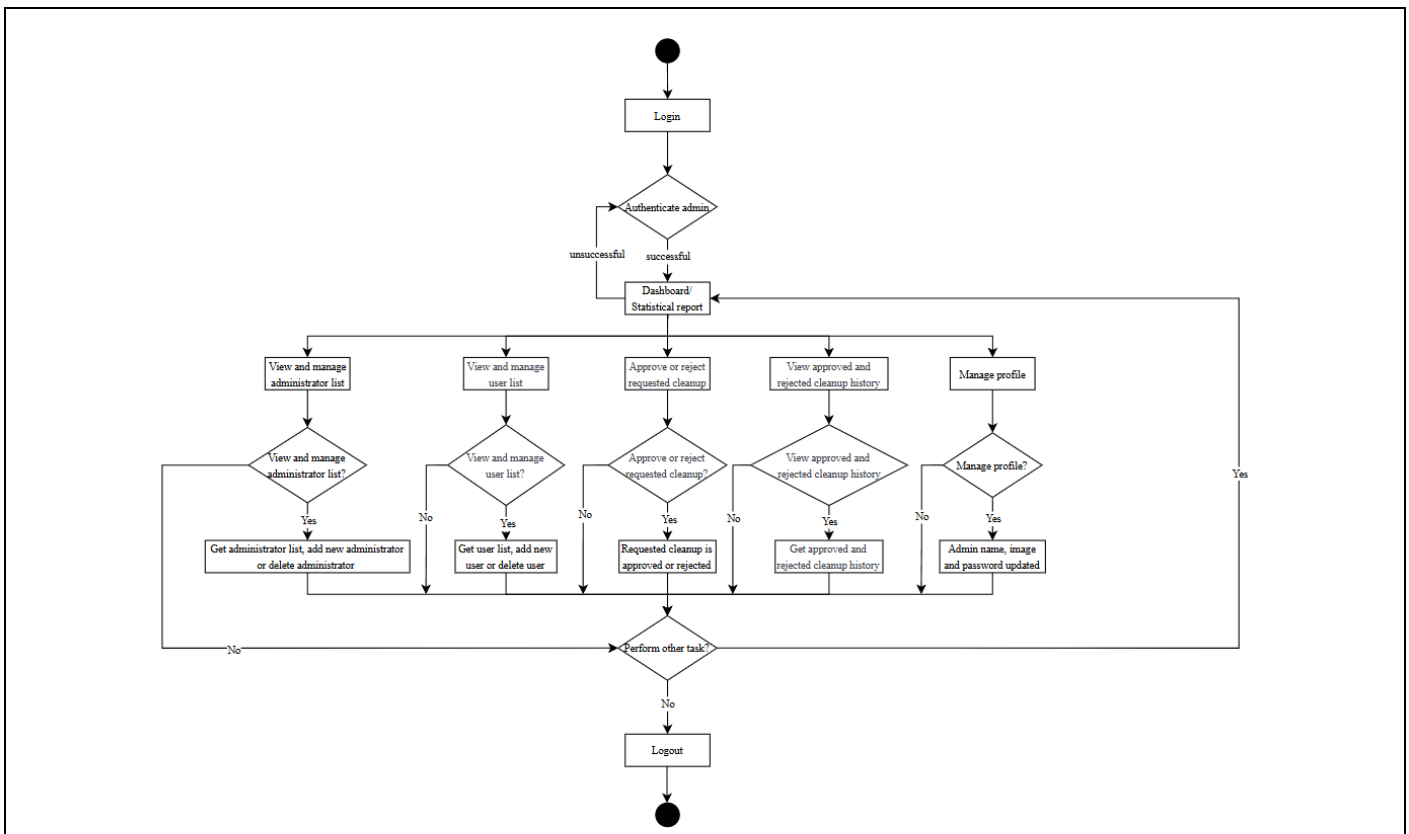
Appendix G: Sequence Diagram for Administrators



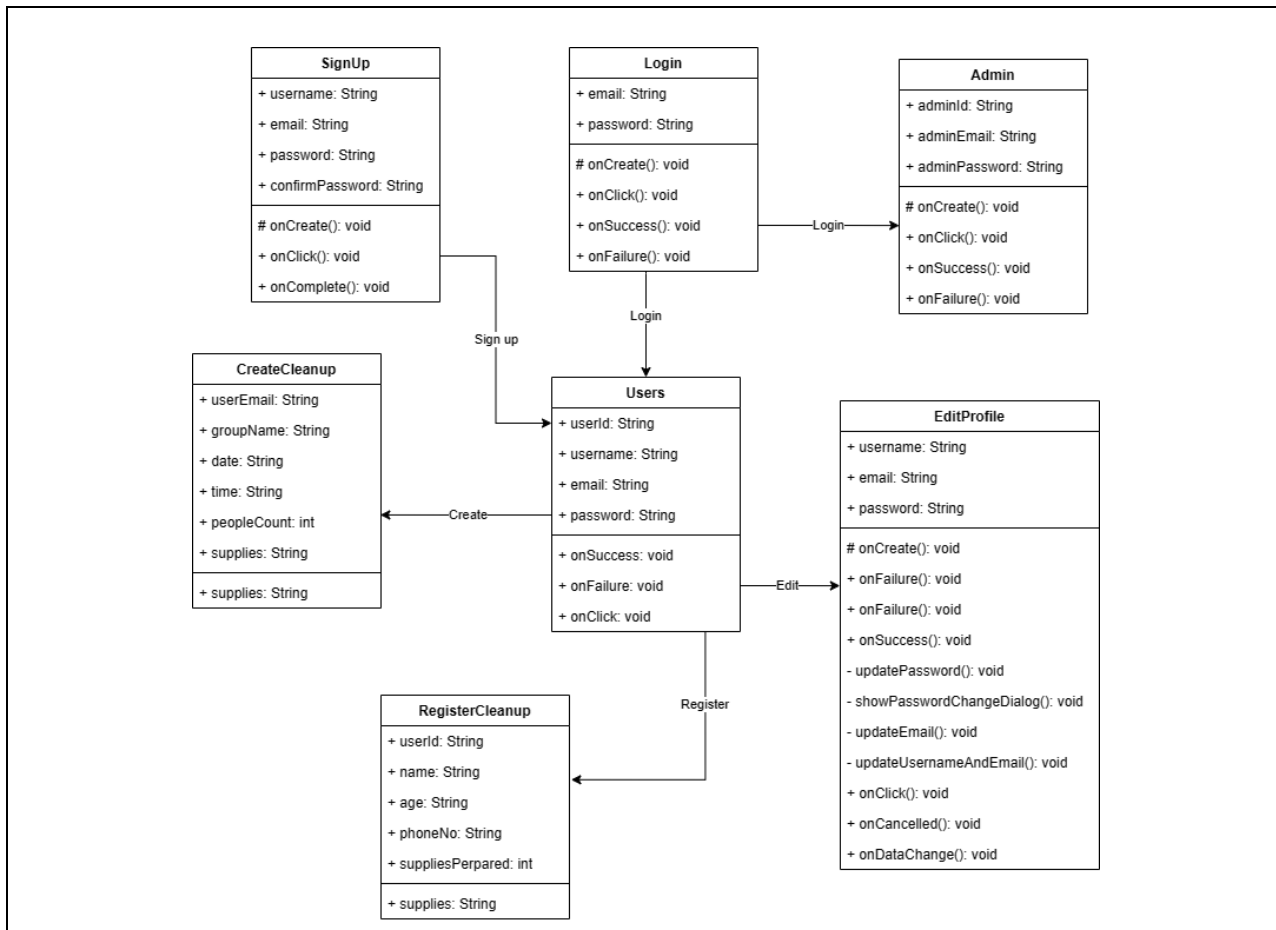
Appendix H: Activity Diagram for Users



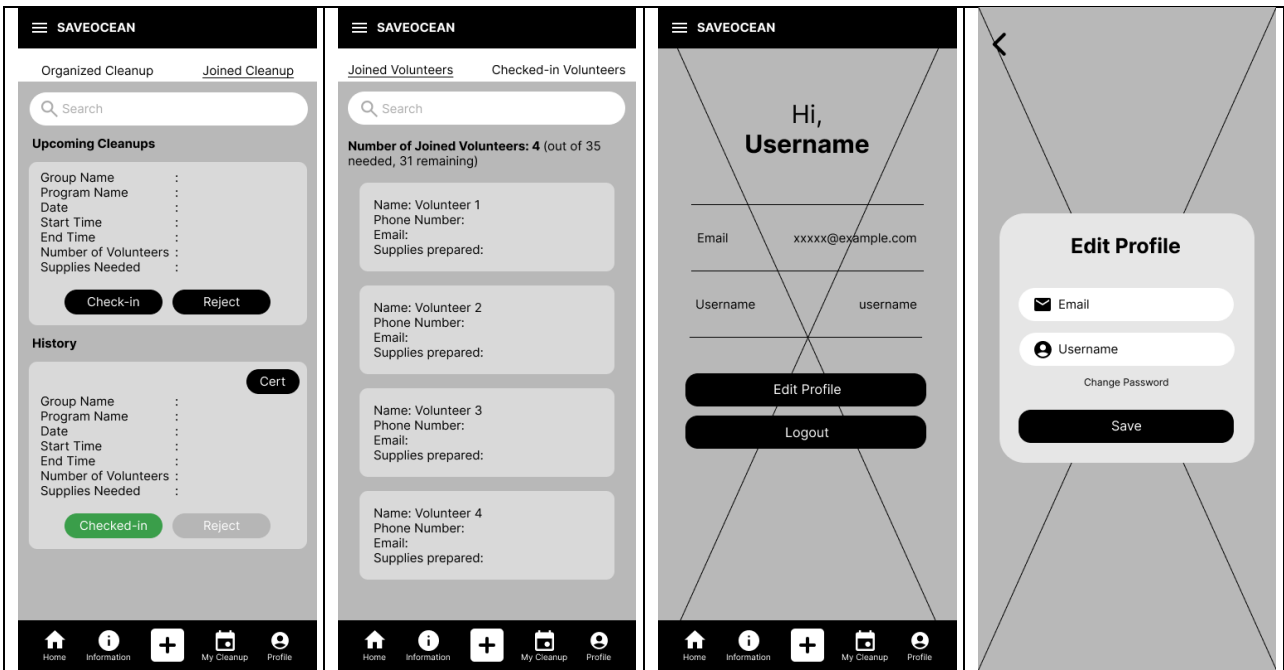
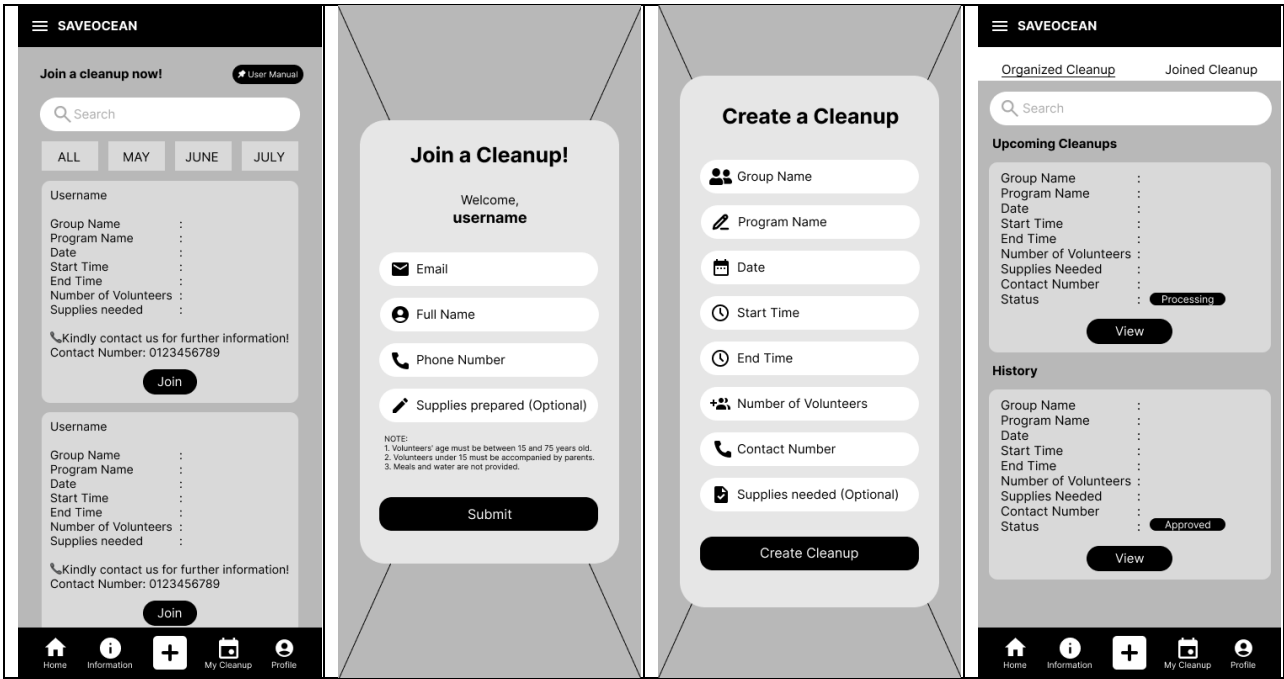
Appendix I: Activity Diagram for Administrators



Appendix J: Class Diagram



Appendix K: Interface Design List for Users



Appendix L: Interface Design List for Administrators

The interface design for administrators is divided into four main sections:

- Dashboard:** Features a sidebar with navigation options (Dashboard, Admin List, User List, Cleanup Requests, Approved Cleanup, Rejected Cleanup, Profile, Logout) and a main content area with summary cards for Total Cleanup Requests, Total Users, Total Approved Cleanups, Total Volunteers, and Total Admins. It also includes several charts: Overall Approved Cleanups Accounting Organizations, Total Approved Cleanups in 2024 by Months, Comparison between Total Number of Joined Volunteers and Checked-in Volunteers, and Comparison between Total number of Organizations and Volunteers.
- Admin List:** Shows a table of administrators with columns for No., Admin Name, Email, and Action (Delete). Includes an 'Add New Admin' button and pagination (1, 2).
- Cleanup Requests:** Displays a calendar view for May 2024 with green dots indicating approved cleanups. A note explains: 'Number of Green Dot in a day = Number of Approved Cleanups in a day'. Below the calendar is a table of cleanup requests with columns for No., User Email, Group Name, Program Name, Phone Number, Date, Start Time, End Time, No. of People, Supplies needed, and Action (Approve, Reject).
- Cleanup Requests Details:** Provides a detailed view of a specific cleanup request, including a table with columns for No., User Email, Group Name, Program Name, Phone Number, Date, Start Time, End Time, No. of People, Supplies needed, and Action (Approve, Reject).