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Emergency Notification and Healthcare Mobile Application for Elderly

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Abstract: In Malaysia, 15 percent of Malaysians are expected to become aged 65 years old and older in the year 2030 and about seven percent of Malaysia's population 60 years and older are living alone. However, it will be serious if the elderly living alone suffers emergence health problems or an emergency happens. Therefore, emergency notification and healthcare mobile application is developed to help the elderly to notify their guardians in a faster and easier way when they meet emergencies as well as to provide healthcare service to the elderly. The objective of this project is to design an emergency notification and healthcare mobile application for the elderly based on Android programming. The methodology used in this project is iterative and incremental development model. This application is developed using Android Studio and Firebase as database. The key result of this project is to provide emergency and healthcare supports that give advantages to the elderly and their guardians. Overall, the development of this application is able to serve the seniors and their guardians with constant help with the recommendation of making it compatible with all smartphone operating systems.

Keywords: Emergency Notification, Healthcare, Mobile Application

1. Introduction

Emergency notification is a system that offers an easy way which use to send notifications to any scale of people on a device through the communication channel [1]. For healthcare, a health system includes all individuals and activities whose main purpose is to encourage, enhance, or preserve health [2]. The senior citizens within the modern society have brought incredible weight and numerous elderlies have been living alone without anybody went with them since their offspring are occupied with work and ought to battle with severe competition. There is an expanding chance of falls and strokes which may debilitate their lives [3]. Hence, when somebody is in an emergency in a common situation, he or she can contact only one person at once and also need help from others to call their family or doctor. Other than that, the seniors with nobody went with the need for ongoing observing to decrease their uneasiness and the chance of accidents. However, the cost of hiring a nurse or maid at home will be a tremendous challenge for them. Furthermore, the elderly is no aware of their health problems and may forget the times to take medicine.

Normally, the healthcare management system and emergency notification system are on a separate system. Nonetheless, the healthcare management system such as reminder and emergency notification systems is important for the senior citizens living alone as well as the patients who suffer from chronic diseases. It is not user-friendly anyway for the users and is better to combine healthcare and emergency notification functions in one system. Hence, the objective of this project is to design an emergency notification and healthcare mobile application for the elderly based on Android programming. This mobile application provides five main modules which are user management, emergency notification management, reminder management, health diary, and tips. There will be different interfaces for different types of users and the user and the guardian will interact with each other.

2. Related Work

In this section, the domain background and technology used in this project are illustrated. The comparison of existing applications with the proposed application is analysed according to the features of each application.

2.1 Emergency Notification System

A significant mechanism for individual protection and safety is the emergency notification system. There have two types of basic emergency notification systems. The first type is intended to encourage the user to wear a programmed button at home with a connection to the application server. The second type is purposely built a mobile application with an emergency button in the application. If anything happens suddenly, users only have to press the button to secure. The devices will send a notification to particular organizations or individuals who have set up beforehand. The research found that by evaluating user and non-user of the emergency notification system, the user of the emergency notification system obtained more favorable results about feeling guarded and more reliable at home [4].

2.2 Healthcare Mobile Application

Healthcare apps are mobile apps that assist with health-related functions. Healthcare application development is the mechanism by which an application is developed for mobile devices to supporting the user manage their health problems, lifestyle goals, hospital visits, or insurance claims effectively. There are various categories in healthcare applications which include control of medicine taking, the interaction of doctors and clinic, control of diet taking, appointment scheduling, and so on [5].

2.3 Comparison of Existing Application with Proposed Application

The table below shows the comparative analysis of the three existing applications with the proposed application. There are some differences and similarities with the proposed application. Based on the comparison table, the proposed emergency notification and healthcare mobile application for the elderly provides the most functions among the three existing applications.

Table 1: Comparison of existing application with proposed application

Applications Functions	Emergency SOS Safety Alert – Personal Alarm App	Emergency App HandHelp	Emergency Alert	Proposed Application
Integrate with Healthcare (Reminder, Health Diary)	No	No	No	Yes
Free for all	Yes	Yes	No	Yes
Two User Interfaces	No	No	No	Yes
Status Notification	Yes	No	Yes	Yes
Location Tracking	Yes	Yes	No	Yes
Video Recording and Photo Capturing	No	Yes	No	No

Table 1 (continued): Comparison of existing application with proposed application

Functions / Applications	Emergency SOS Safety Alert – Personal Alarm App	Emergency App HandHelp	Emergency Alert	Proposed Application
Login and Register	Yes	Yes	Yes	Yes
Tips on handling emergency	No	No	No	Yes

3.   Methodology/Framework

The methodology used in the emergency notification and healthcare mobile application for the elderly is iterative and incremental development model. The fundamental of this model is to enhance the system via the repetitive process (iterative) and in smaller sections at a period (incremental), enabling the developer to make use of the experiences learned through the previous system [6]. The reason for choosing this methodology is because it allows the developer to add any new functionality at any time. Also, this methodology enables the developer to implement and test the application in an incremental way as some of the modules will be modified or changed at every iterative step. There are four phases in this methodology which are analysis, design, implementation, and testing. The life cycle will be replicated continuously by each iteration and incremental state until a complete application is established and fully developed.

3.1   Analysis Phase

In the analysis phase, all the information on the related field is gathered. Feasibility analysis is performed to analyze user requirements and the method used to collect the user requirement is by interview the elderly and guardian. Also, the developer is expected to review all the information gathered to collect the specifications of the application for further clarification in the design and implementation phases.

3.2   Design Phase

In the design phase, a review of the data obtained in the analysis phase is classified to establish a feasible architecture. The object-oriented approach is used and the architecture of the application is supported by the use case diagram, activity diagram, sequence diagram, and class diagram. The basic user interface of the application will be designed and performed using the wireframe.

3.3   Implementation Phase

In the implementation phase, the application is built according to the prototype design in the design phase. This phase converted prototype design into operation. Every preparation, design, and concept documentation will be written into codes. The software used to develop the application is Android Studio and Firebase is used as a database. The actual functionality of the application is crucial in this phase. Also, the application will go into various improvements, modifications, and updates here.

3.4   Testing Phase

In the testing phase, the deployment of the application is executed by the users once the implementation of the application is finished. Throughout this phase, usability testing or acceptance testing would be performed. To validate each feature and ascertain the flaws found in the application, it will test with the test plan. Any bugs in the application are to be found and corrected at this phase.

3.5   Project Planning

The planning for this project is with a clear and detailed work plan to allow us to prioritize systematically and make the project done more in less time. The Gantt chart of the project is attached in appendix Figure 1.
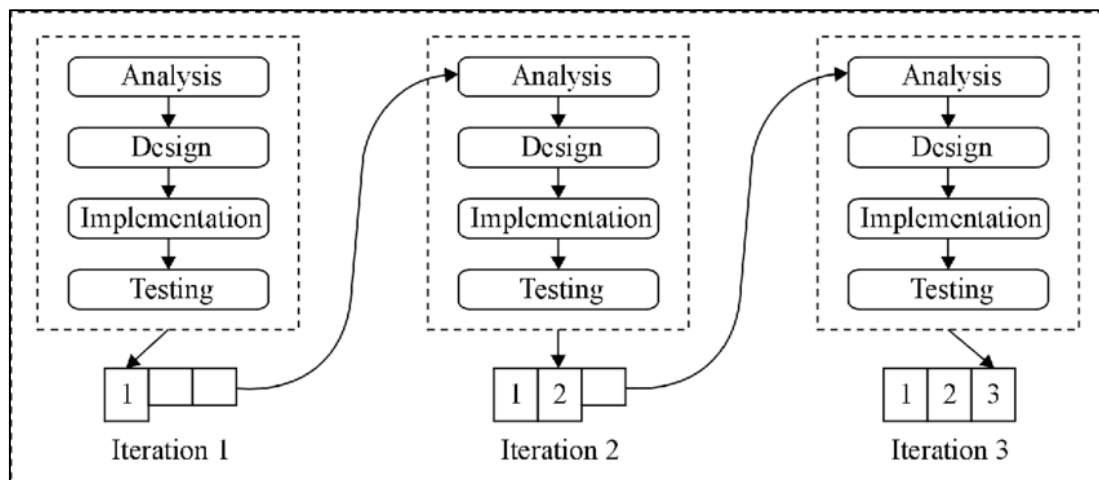
Figure 1: Iterative and incremental model [7]

4. Results and Discussion

The functional and non-functional requirements are analyzed in this section. Also, the use case diagram, activity diagram, sequence diagram, class diagram, interface and test plan of the application are designed.

4.1 Functional and Non-functional Requirements Analysis

Functional requirements define the functionality of the system while non-functional requirements identifies a set of criteria require to determine the particular function of the application. The purpose of requirement analysis is to collect all the details required to design a system that satisfies the information needs. The tables of functional and non-functional requirements analysis are attached in appendix Table 1 and Table 2.

4.2 Use Case Diagram

The use case diagram describes the interaction of the user with the system. For modeling, defining and reporting the actions of an element, case diagram is significant. The use case diagram shows how the user and guardian interact with the application. It illustrates what functions can be performed by the user and guardian respectively. The use case diagram is attached at appendix Figure 2.

4.3 Activity Diagram

The activity diagram is another vital diagram in UML to illustrate workflow in the system. Both of the users and guardians need to register if they are a new member then only they can login with their personal information. The application will verify their account before displaying the user or guardian homepage. After that, the user and guardian can choose what functions they want to perform. The workflow of each user type is illustrated respectively in appendix Figure 3 and Figure 4.

4.4 Sequence Diagram

The sequence diagram tends to explain the operation flow in sequential order and hence presents the interactive component of the system. It will help describe the entities involved and the data exchanged among them and the overall sequence of the application's events. Due to the limitation of this paper, only main sequence diagrams are shown in appendix Figure 5 and Figure 6.

4.5 Class Diagram

In the object-oriented approach, the class diagram is the key building block and is a kind of static model diagram which explains the class of the system. They are required to describe the various entities in a system, their attributes, their functions, and their relationships. There are seven main classes which

are Users, Guardian, Elder, Contact, Alert, Reminder, and Diary. The class diagram is attached at appendix Figure 7.

4.6 Implementation of Module

Emergency notification and healthcare mobile application consist of five modules which are user management module, emergency notification module, reminder management module, health diary module, and emergency handling tips module. The implementation of five modules has two user types which are elderly and guardian. Each of the module implementations will be discussed in detail accordingly.

4.6.1 Implementation of User Management Module

Figure 2 shows the interface of login, register and profile pages. All of the users require to input their username, email, phone number, password and user type to create an account. On the other hand, all of the users require to input the email and the password being registered to log in. On the profile page, the users can update their personal information.

(a)   **(b)**   **(c)**
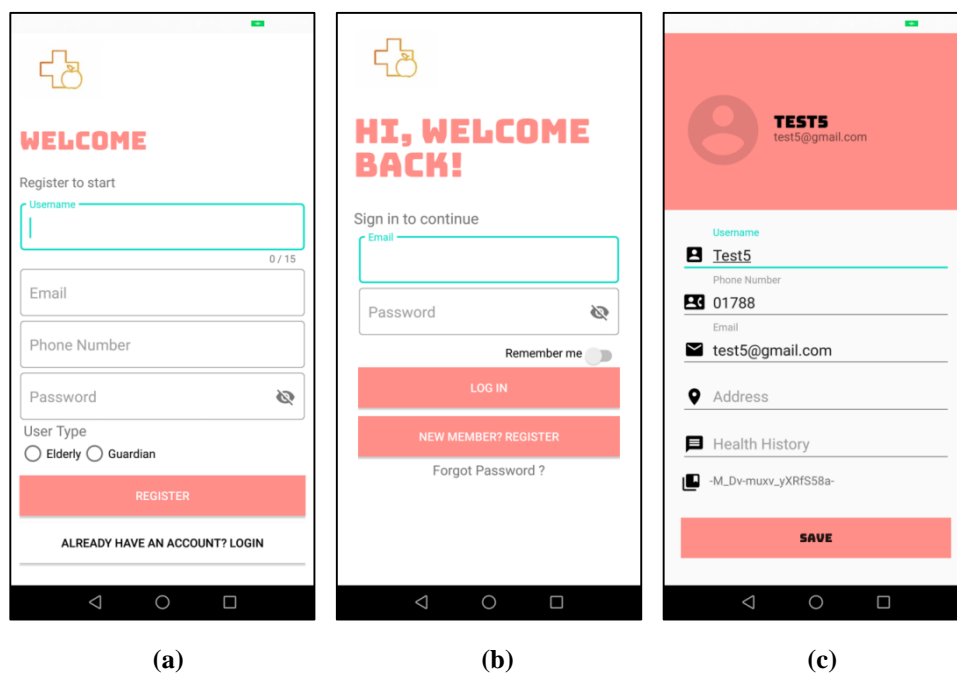
Figure 2: (a) Interface of login, (b) register and (c) profile page

4.6.2 Implementation of Emergency Notification Module

Figure 3 shows the interface of emergency contact and send emergency notification pages. The user side can add emergency contact by clicking on add icon and input the phone number and username of the registered guardian. The user side can send emergency notification by clicking on the button and confirm the permission of an alert message. Then the guardian side will receive the emergency notification by push notification.
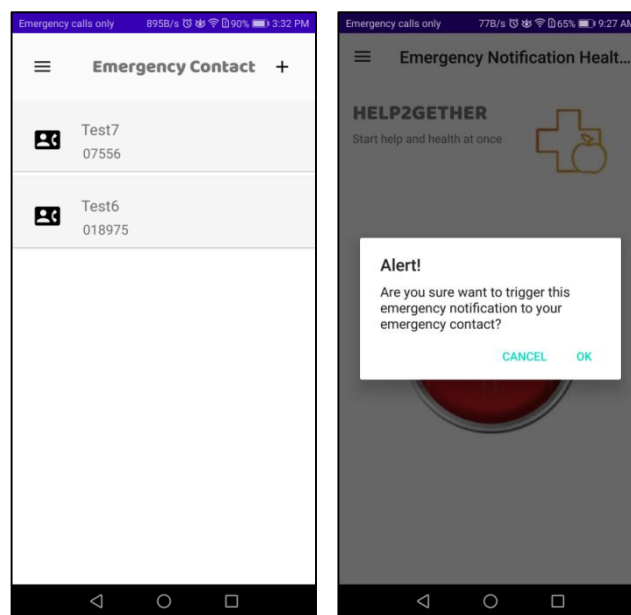
(a)   (b)

Figure 3: (a) Interface of emergency contact and (b) send emergency notification pages

4.6.3   Implementation of Reminder Management Module

Figure 4 shows the interface of reminder, add reminder of user side and add reminder of guardian side. The user and guardian can add the reminder by clicking on the add icon. Both sides are required to input event, date and time and the guardian side can choose to turn on or turn off the toggle of elder notification. When the toggle of elder notification is turned on, the guardian side can set a reminder for the user side by selecting the recipient. The guardian side needs to add elder as recipient by inputting the secret code of the elder. All of the users have a secret code and it can be copied from the profile page.
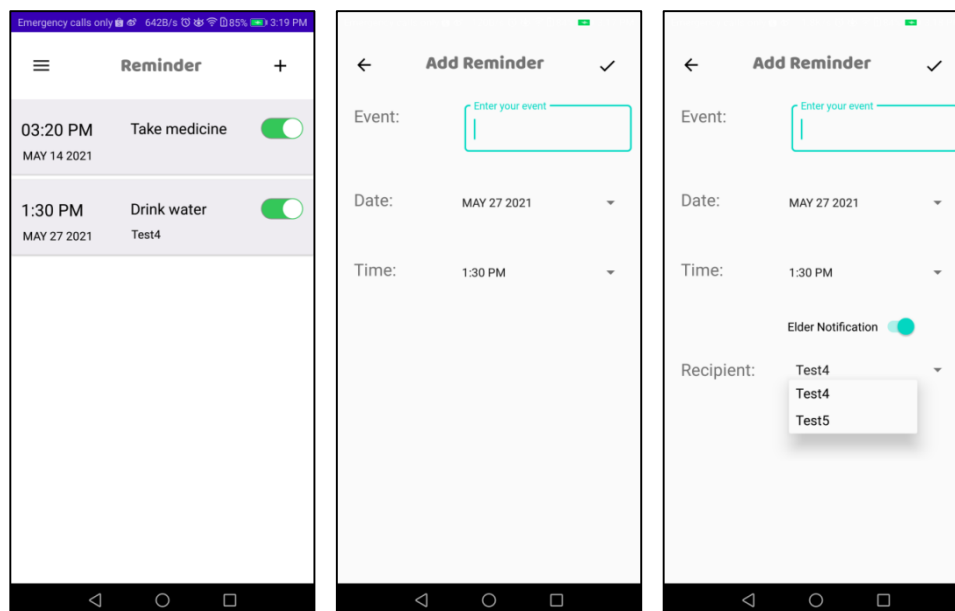
(a)   (b)   (c)

Figure 4: (a) Interface of reminder, (b) add reminder of user side and (c) add reminder of guardian side

### 4.6.4   Implementation of Health Diary Module

Figure 5 shows the interface of health diary, add health diary and view health diary of guardian side pages. The user side can add the health diary by clicking on the add icon. The users are required to input date, feeling, symptom, note and recipient. The user side needs to add guardian as recipient by inputting the secret code of the guardian. All of the users have a secret code and it can be copied from the profile page. The guardian side can only view the health diary of the user side.

(a)   **(b)**   **(c)**
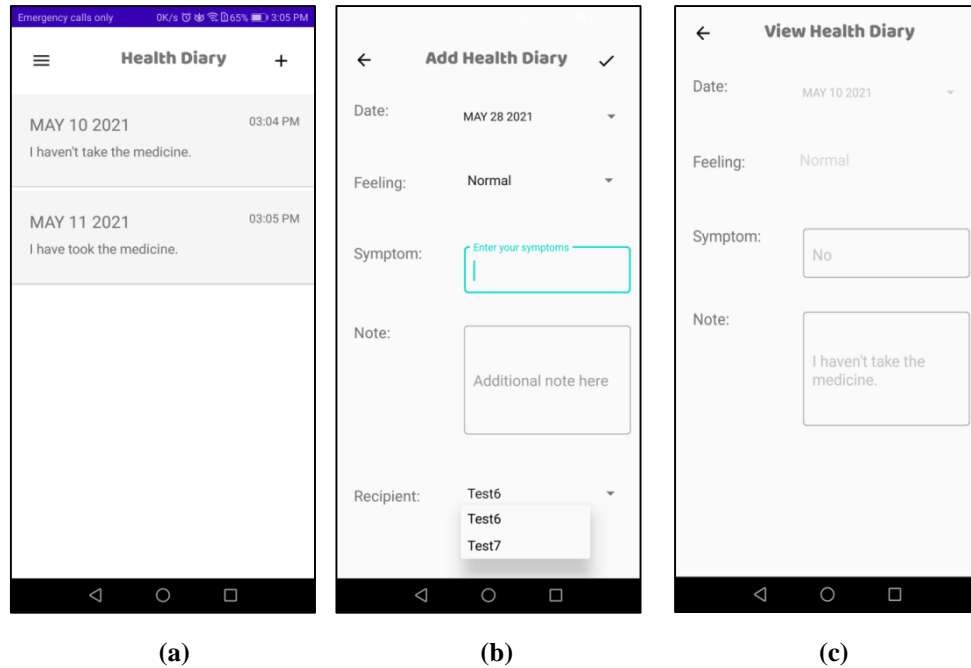
Figure 5: (a) Interface of health diary, (b) add health diary and (c) view health diary of guardian side pages

4.6.5   Implementation of Emergency Handling Tips Module

Figure 6 shows the interface of emergency handling tips pages. This tip is only visible at guardian side. There is an image on ways to handle emergency situation and the phone number of various emergency departments.
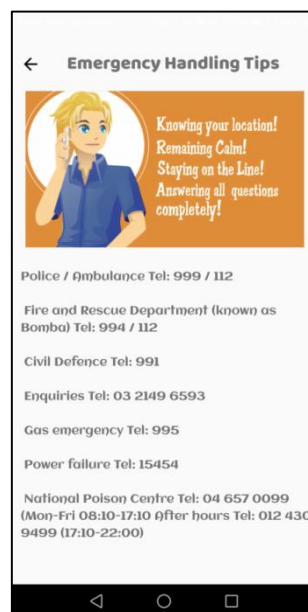
Figure 6: Interface of emergency handling tips

4.7   Testing

Testing is a crucial part of the development process. It was performed to ensure that the application worked properly and met the requirements. Two types of testing will be carried out and each of the testing is explained in detail.

4.7.1   Test Plan Result

Emergency notification and healthcare mobile application is installed on the mobile phone to test the results based on five modules which is user management module, emergency notification module, reminder management module, health diary module, and emergency handling tips module. The expected output and the actual result are recorded in the table. The test plan result is attached at appendix Table 3.

4.7.2   User Acceptance Form Result

In user acceptance testing, 15 respondents are chosen to test each module of the proposed application. From the figure below, it can be seen that most of the respondents are strongly satisfied with the application and a few of the respondents ranked moderate. The respondents are selected randomly from three different age ranges. There are six respondents aged between 18 to 35, four respondents aged between 36 to 55, and five respondents aged 56 or above.
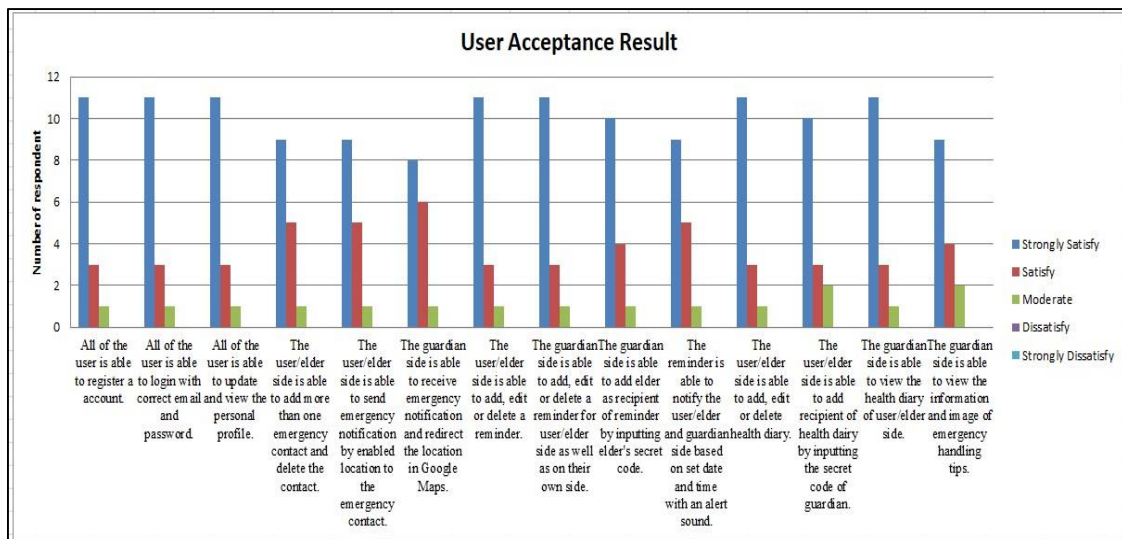

Figure 7: User acceptance form result

5.   Conclusion

In conclusion, the proposed emergency notification and healthcare mobile application is expected to help the elderly when they encounter any incidents in a fast and easier way. This mobile application will be acting like an invisible assistant that can aid the elderly as well as the elderly's guardian. There are some future works work is needed for the improvement of this mobile application. One of the future works is to make it compatible with all smartphone operating systems. Besides, emergency notification and healthcare mobile application can apply a home screen widget or specific gesture to trigger the emergency notification function. This application is designed to aid the elderly staying alone at home and their guardians who are occupied with works to decrease the uneasiness of them. In short, the development of emergency notification integrated with healthcare based on Android programming in one mobile application is able to serve the seniors and their guardians with constant, long haul, and non-intrusive help.

Acknowledgement

Appendix A

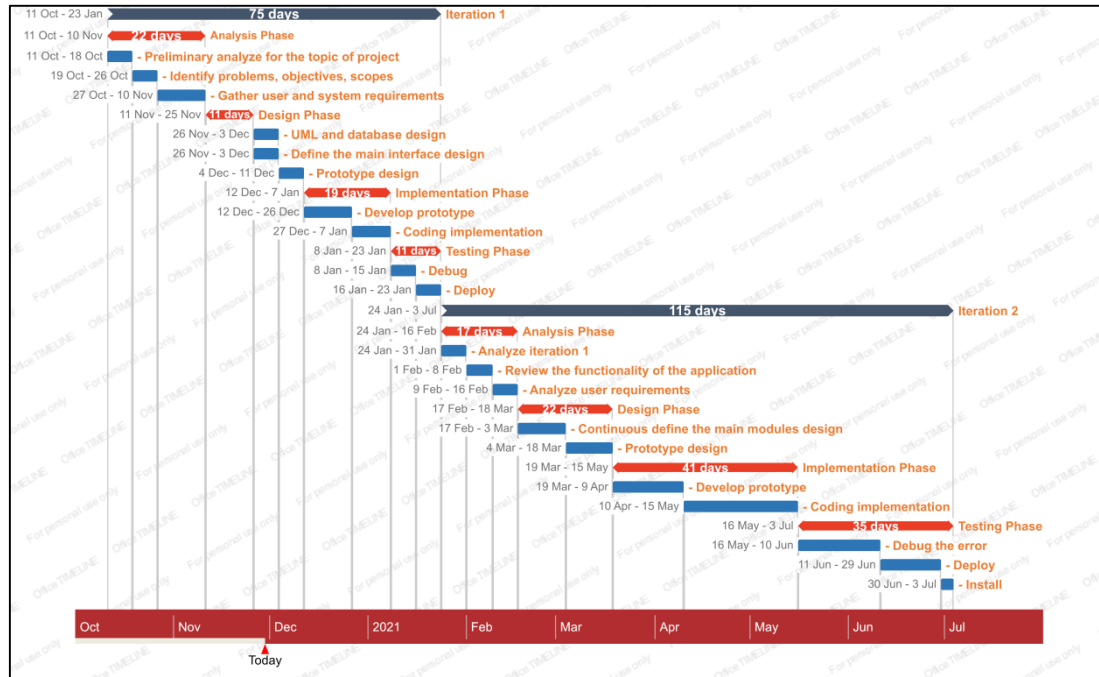**Figure 1: Gantt chart of the project**

Table 1: Functional requirement analysis of the application

| Modules	Functionalities
Register - User - Guardian	- Both user types can register as new user in the application - Display error message for any invalid input of data
Login - User - Guardian	- Both user types can login with valid username and password - Display error message for any invalid input of data
Update account - User - Guardian	- Both user types can edit and save their personal information
Emergency contact - User	- User can add, delete and edit multiple emergency contact
Emergency notification - User - Guardian	- User can send emergency notification with current location to guardian - Guardian able to receive alert of emergency notification from the user
Reminder - User - Guardian	- User can set, edit or delete reminder - Guardian able to set, edit or delete reminder for the user - Guardian able to set, edit or delete reminder - Both user types can receive reminder on set date and time

Table 1 (continued): Functional requirement analysis of the application

Modules	Functionalities
Health diary - User - Guardian	- User can add, edit or delete health feeling and health problem - Guardian able to view the updated health diary from the user
Emergency handling tips - Guardian	- Guardian can view the emergency handling tips

Table 2: Non-functional requirement analysis of the application

Requirements	Description
Performance	- Application can direct user and guardian to the correct session according to the service request - Application can be accessed at any time
Security	- Application can access with correct username and password - Password has a combination of alphabet, special symbol and number to meet the strong password management
Interface	- Application able run properly on any Android smartphone
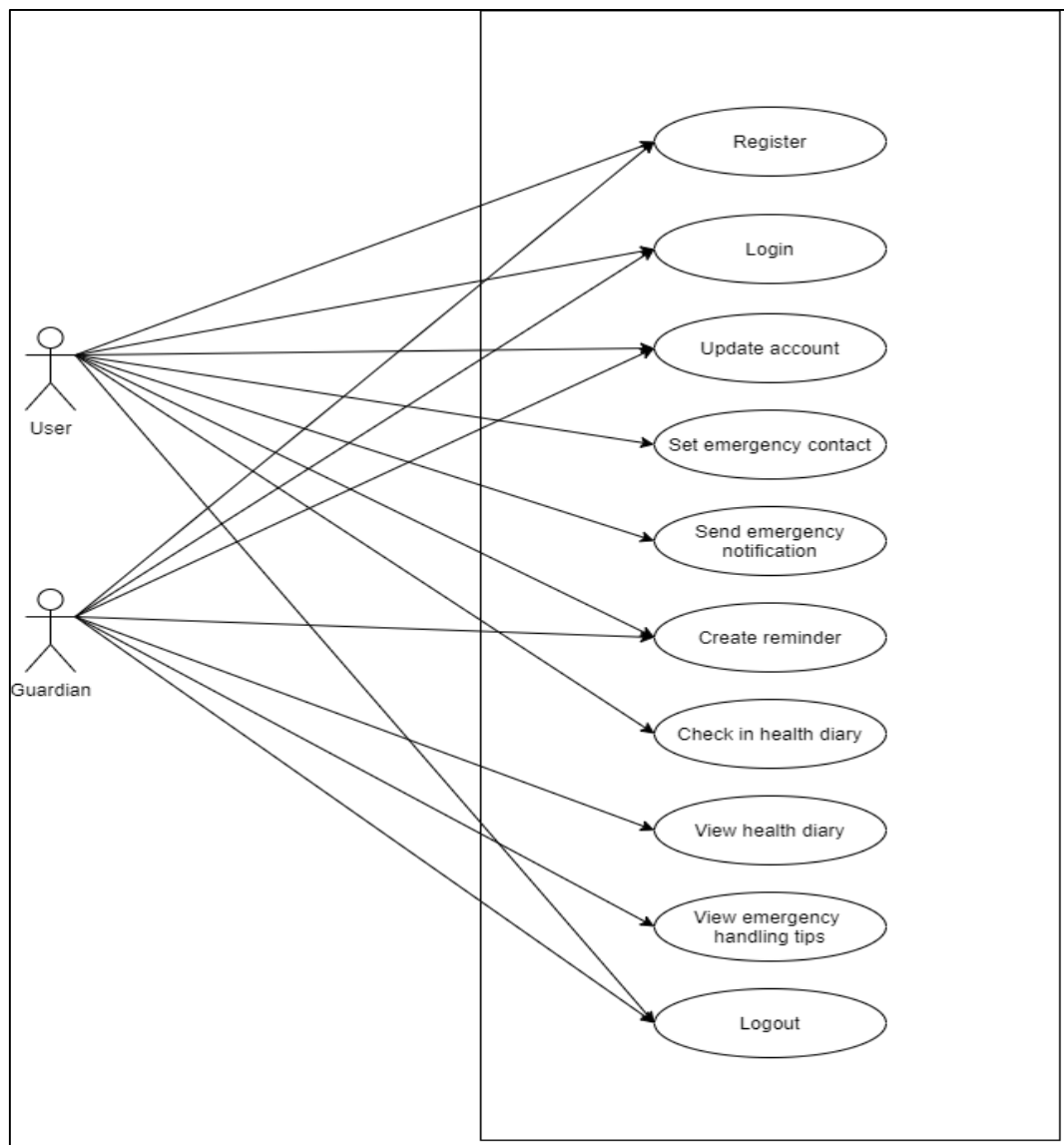
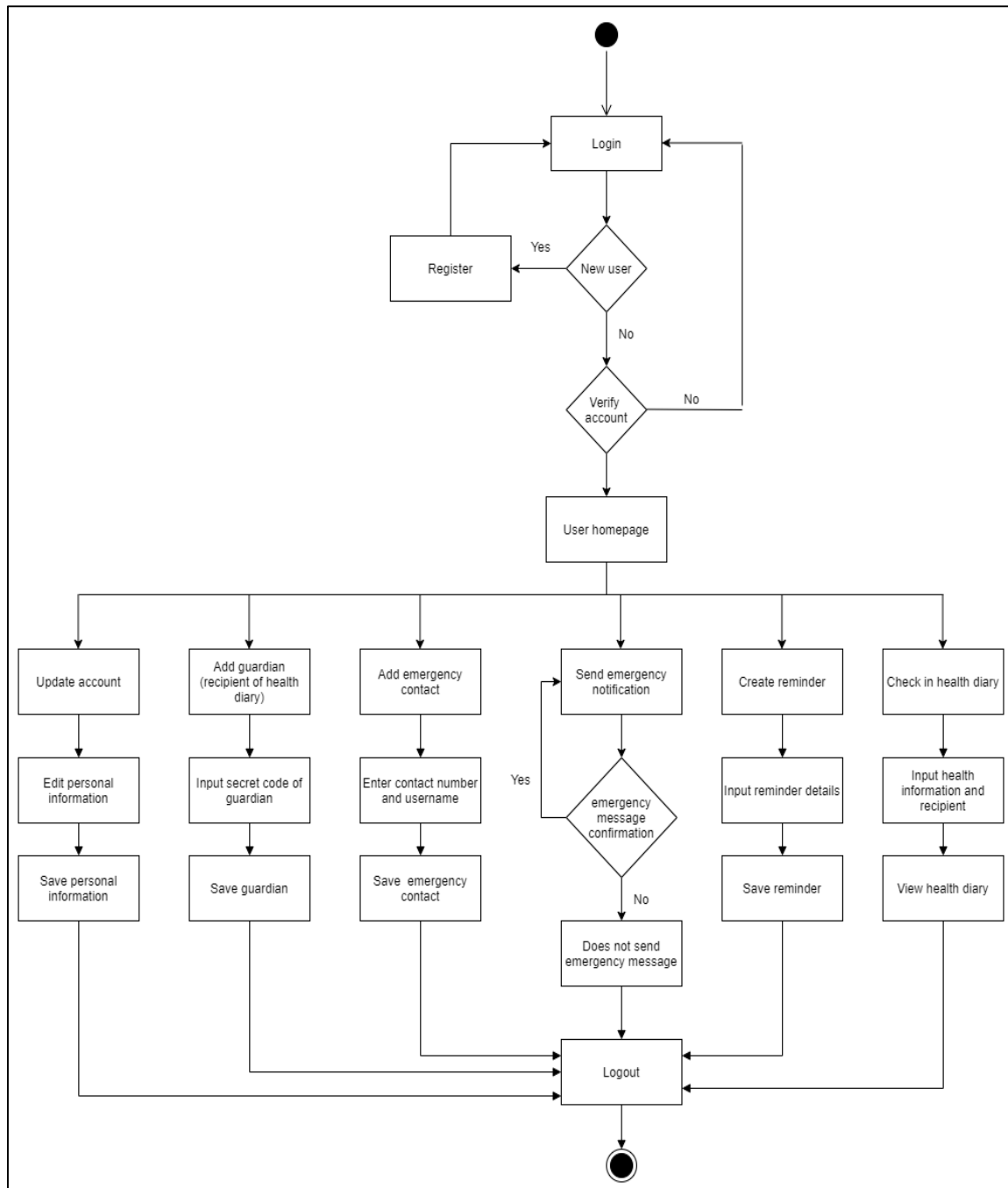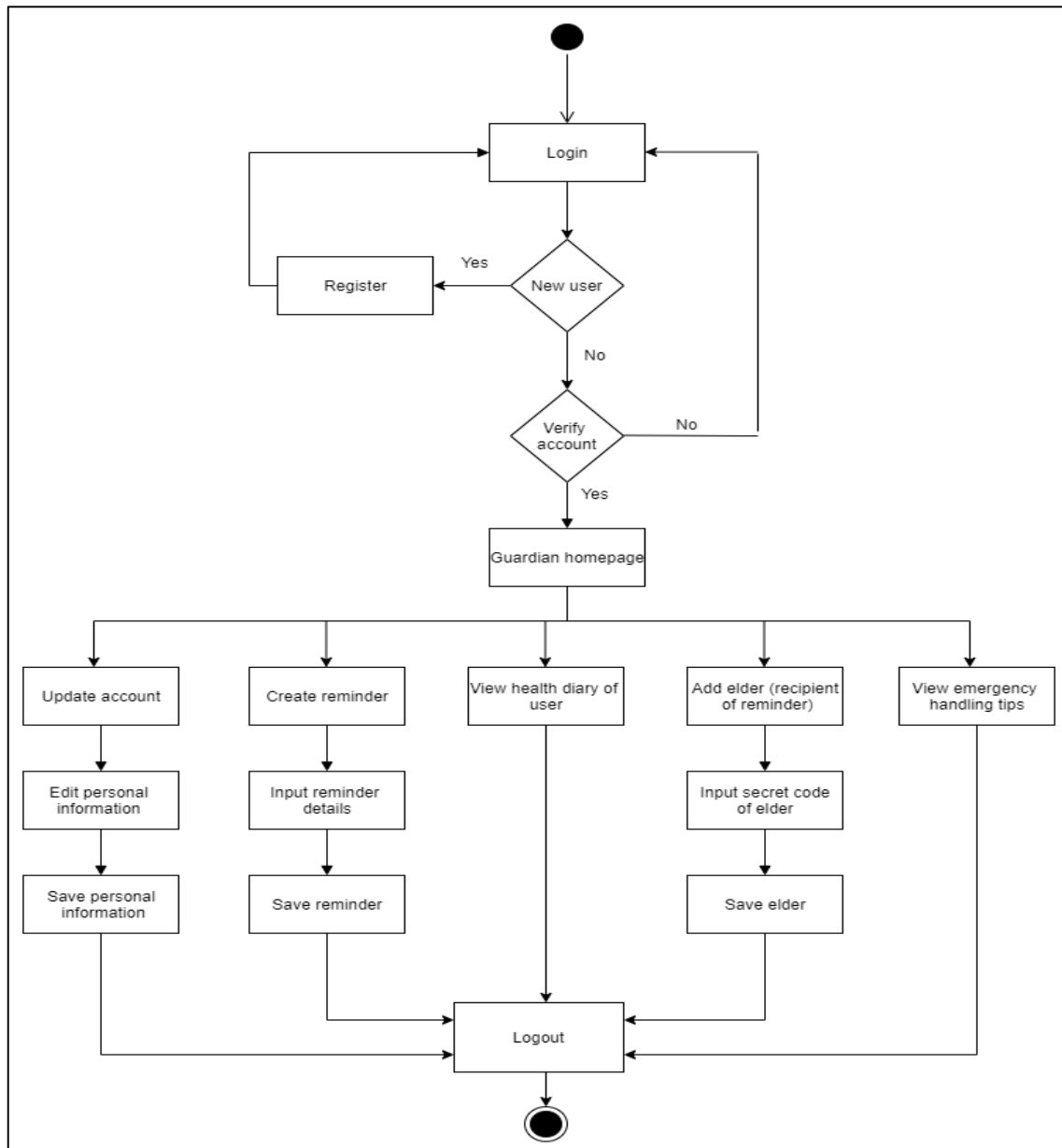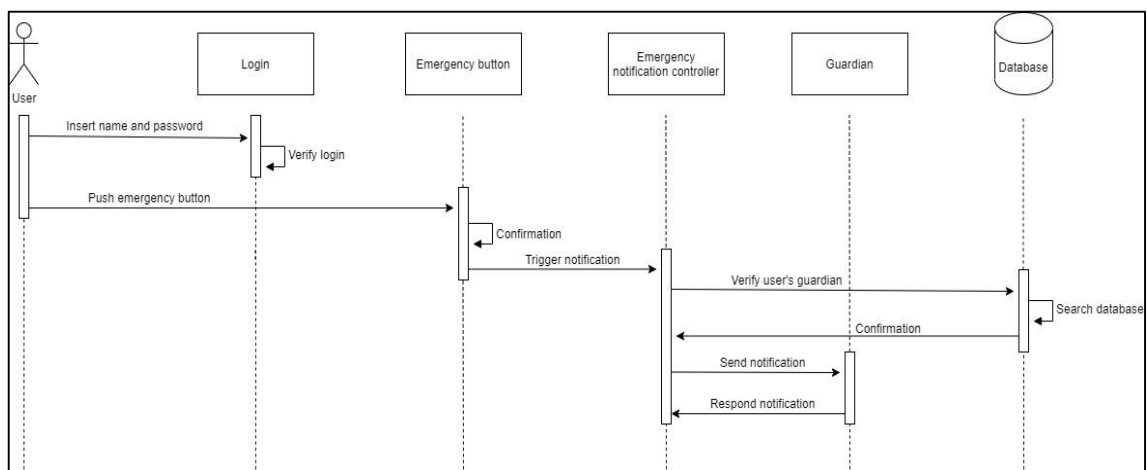**Figure 2: Use case diagram**

Figure 3: Activity diagram of the user side

Figure 4: Activity diagram of the guardian side

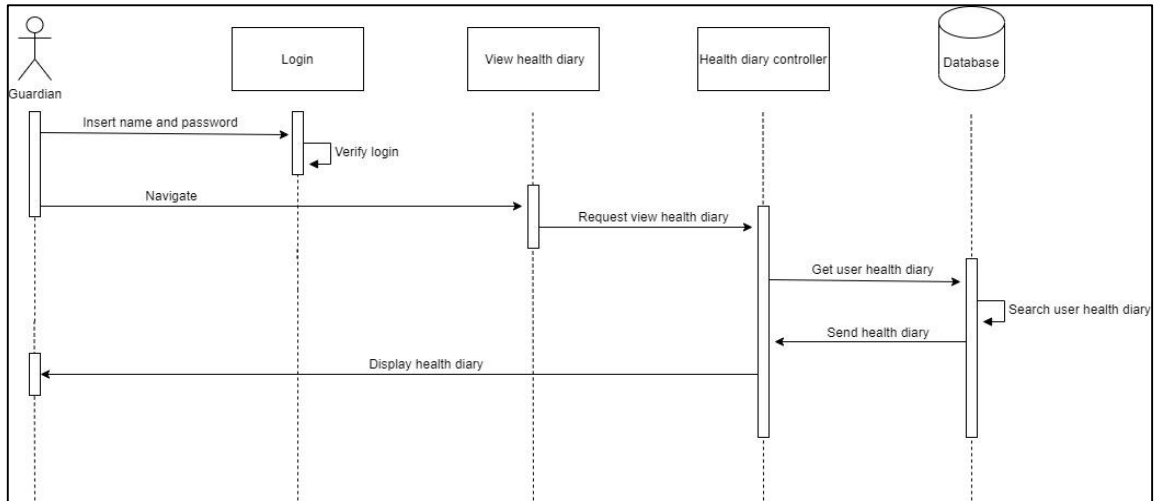**Figure 5: Sequence diagram of the send emergency notification**

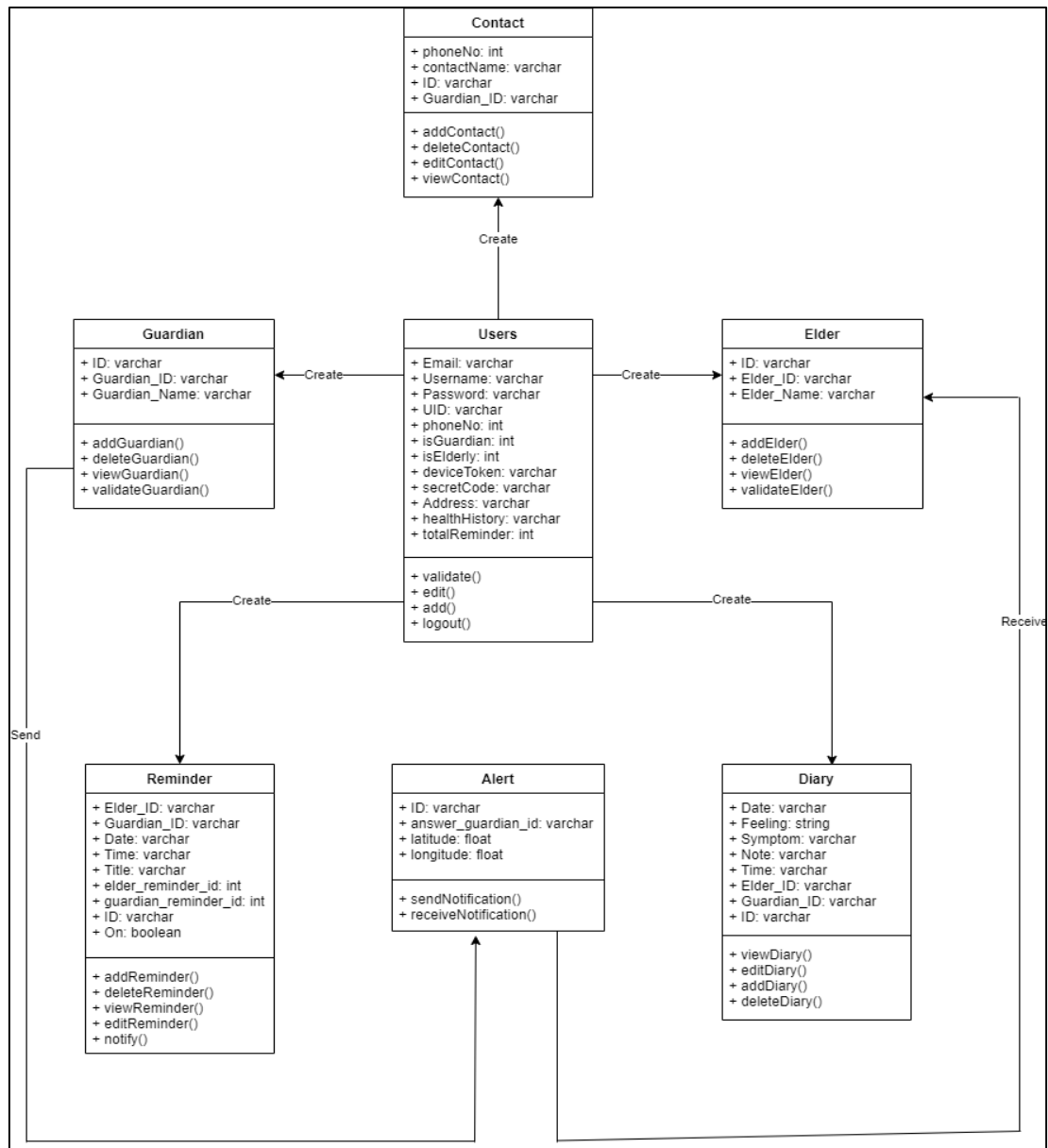**Figure 6: Sequence diagram of the view health diary**

Figure 7: Class diagram

Table 3: Test plan result

Module 1: User management		
Input	Expected Output	Actual Result
- User inputs username, email, phone number, password, and user type to register. - User inputs email and password to login. - User inputs username, email, phone number, address, health history and date of birth at profile.	- The account is created successfully. - Validation on each field, if the user inputs invalid data or leave a blank, it will shows error message. - User is able to login based on the correct email and password. - Information of the user is updated successfully.	Pass
Module 2: Emergency Notification		
Input	Expected Output	Actual Result
- User inputs username and phone number to create an emergency contact. - User clicks on emergency button. - Guardian clicks "OK" on emergency notification.	- The phone number and username is checked from the database. If the username and phone number exist, emergency contact is added successfully. - User can add or delete the contact. - A confirmation message is prompt out when the button is clicked. - GPS function is enabled and the emergency notification is sent successfully according to the added emergency contact. - Guardian is able to receive the emergency notification. If the first guardian does not respond to this notification in 30 seconds, another notification will send to the next contact. - Emergency notification is able to redirect to Google Maps when "OK" is clicked.	Pass
Module 3: Reminder management		
Input	Expected Output	Actual Result
- User inputs event, date and time. - Guardian inputs event, date, time and recipient. - Guardian inputs the secret code of the user to add the elder as recipient.	- The reminder is added successfully. - User and guardian can add, edit and delete the reminder. - The push notification with an alert sound will come out based on the set date and time. - The elder is added successfully with the valid secret code.	Pass
Module 4: Health diary		
Input	Expected Output	Actual Result
- User inputs date, feeling, symptom, note and recipient. - User inputs secret code of the guardian.	- The health diary is added successfully. - User is able to add, edit and delete the health diary. - Guardian is able to view the health diary only. - The guardian is added successfully with the valid secret code.	Pass

Table 3 (continued): Test plan result

Module 5: Emergency Handling Tips		
Input	Expected Output	Actual Result
- Guardian clicks on emergency handling tips page.	- Guardian is able to view the emergency handling tips.	Pass

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