

## Medicine Reminder Application: MedCare

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**Abstract:** Medication adherence is important to help patients' health condition always in a better situation. However, the existing reminder application has its own weakness in the functionalities offered. Thus, a medicine reminder application, MedCare, has developed to give an alternative way of reminding the medicine to be taken. It also helps the users to manage their reminder and medicine inventory. A waterfall model is used to schedule a plan for the system development process. The application is developed on Android Operating System by using Android Studio and Firebase. The medicine reminder application has been developed to provide the users with convenience of taking medicine. It can also indirectly increase the users' health awareness by maintaining their health condition.

**Keywords:** Medicine, Reminder, Mobile Application

### 1. Introduction

According to a report from WHO, it has found that the medication adherence level of chronic disease patients reached 50%. This makes it worse when the adherence level in developing countries is even low [1]. This study shows that half of the population neglect administering their medication. This situation can affect the follow-up treatment by the doctor. To overcome the problem, a mobile application is designed and developed to inspect the medication process and improve the medication adherence level in the self-monitor patient. In addition, the application allows the users to take advance of managing their medicine inventory. This application also allows users to send a notification email to their family or friends to supervise the users' medication.

This project aims:

- i. To design a medicine reminder application based on the object-oriented approach.
- ii. To develop the medicine reminder application.
- iii. To test the usability and functionality of the medicine reminder application to the target users.

The application is built and developed on an Android-based mobile application by using Dart programming language. The users may register, log in and log out from the application. They can also update their personal information in the user profile. Besides that, the users can manage the reminder

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and the medicine inventory. Furthermore, the users can be supervised by the guardian by sending a notification email. The users can also retrieve the history of the medication process.

This paper is organized as follows: Section 2 discusses the literature review of the related work and developed application. Next, Section 3 describes the methodology used to develop the application including the analysis and design. Lastly, the last section concludes the final work with its advantages and disadvantages and discusses the future work of the project.

## **2. Related Work**

### **2.1 Medicine Reminder System**

The medicine reminder system is a system that targets patient adherence to health care and medication. The system is designed to remind the patient to take their medicine on time. It also supported medication adherence for patients during their home care or caregivers that guide and supervise their families. One of the important parts of the medicine reminder system is the scheduling feature which helps users to plan and outline the timetable of medication as prescribed. The users will get notified once the reminder is set on the schedule. The users can also schedule their timetable with a customizable reminder in which the users can adjust from three aspects, duration, time and intake frequency.

### **2.2 Comparison between the Existing Application with the Medicine Reminder Application**

A comparison is discussed between the existing applications based on the features stated in Table 1. The selected existing applications were DailyDose: Pill Reminder [2], MyTherapy Pill Reminder [3], TOM – Pill & Tablet Reminder [4].

DailyDose: Pill Reminder is a classic medicine reminder mobile application. This application was developed to combine the functionality of a medication alarm reminder together with a medicine tracker logbook [2]. DailyDose provides several main functions such as a medication tracker and body measurement tracker. This application can also record and track doctor's appointment by setting reminders for the appointment and saving the contact information of the doctor.

MyTherapy Pill Reminder is a medicine reminder that combines a pill tracker, mood tracker and a health journal in one application. The users can manage their medicine and track their measurements and symptoms all in one place. MyTherapy also provides the users with medicine inventory to track the remaining medicine in the users' stock. The users can set an amount for their current inventory and a refill reminder to remind them when the inventory is at its threshold.

TOM – Pill & Tablet Reminder is a daily reminder that makes it easy for the users to manage their medication and allow the users to enter measurements, record activities and create reminders with alarm. This application provides a dialogue-based design on setting up medicine reminders for the users to add the medication, measurements, mood and activities quickly and easily. This means the application will ask and the users will reply to the questions without filling in forms or having to tediously search through menus. TOM also prepares a huge database of existing medicine in case to make it easier for users to search for their medicine. TOM also provides Quick Response (QR) scanning to the treatment that users have created on their websites.

**Table 1: Comparison between the existing application and the developed application**

Features/Applications	DailyDose: Pill Reminder [2]	MyTherapy Pill Reminder [3]	TOM – Pill & Tablet Reminder [4]	Developed Application
Easy to learn	✓	✓	✓	✓
Information displayed is simple and clear	✓	✓	✓	✓
Clear navigation	✓	✓	✓	✓
Aesthetic design	✓	✗	✓	✓
Customizable theme	✗	✓	✓	✗
Enter data manually	✓	✓	✓	✓
Enter data by scanning QR code	✗	✗	✓	✗
Register/Login	✗	✓	✓	✓
Manage reminder	✓	✓	✓	✓
Update profile	✗	✗	✗	✓
Send notification email to guardian	✗	✗	✗	✓
Manage medicine inventory	✗	✓	✓	✓
Tracking health indicators	✓	✓	✓	✗
Retrieve history information	✓	✓	✓	✓
Record and track doctor's appointment	✓	✗	✗	✗

### 3. Methodology/Framework

#### 3.1 Waterfall Model

A waterfall model is selected to create a software solution and it is the most established and widely used Software Development Life Cycle (SDLC) model [5]. This model is suitable for those projects with well-defined requirements as the requirements are stated at the start of the project and cannot be changed throughout the process. In this model, the phases go downward through requirements analysis, design, implementation and testing or maintenance [5]. However, a planning phase can be inserted before the requirement analysis to plan smoother software development.

The planning phase starts with defining the project and its goals, as well as determining the solution to achieve those goals. A Gantt chart is planned and constructed to arrange the activities and tasks in an organized way and make the project run more smoothly and efficiently. The Gantt chart of the project is referred to as the figure in Appendix A. The other deliverables such as background research were also conducted in this phase.

In the analysis phase, a survey is prepared to collect information about the users' requirements for the medicine reminder application. The users are required to answer questions which are separated

into different sections: demographic, medical history and medication adherence. After that, the analysis on the data collected proceeded to obtain the users' demands on the developed application. The hardware and software requirements are also analysed in this phase.

In the design phase, user interface design and database design were created to define how the solution will be implemented. A prototype is designed in this phase to inspect the structure and layout of the developed application. Other than that, a database design is designed by using Unified Modelling Language (UML) so that the data is organized in an effective way.

In the implementation phase, MedCare is developed using Android Studio and Visual Studio Code as the code editor. An object-oriented programming language called Dart is used to define the class for the functions and modules inside the application. Besides, Firebase is also used as a database and hosting the backend services.

In the testing phase, a series of tests is conducted to confirm the functional and non-functional requirements of the project. User acceptance testing was also carried out for the evaluation from the users to ensure it meets their needs. An overview of the software development process is shown in Table 2.

**Table 2: Software development workflow and its deliverables**

Phases	Activity	Deliverables
Planning	<ol style="list-style-type: none"> <li>i. Identify problem statements, objectives and project scopes.</li> <li>ii. Set up a work plan or Gantt chart.</li> <li>iii. Study journals and articles about the project's background.</li> <li>iv. Study the functionalities of the existing system.</li> </ol>	<ol style="list-style-type: none"> <li>i. Project proposal.</li> <li>ii. Gantt chart.</li> <li>iii. Literature review.</li> <li>iv. Comparison between the existing application and the developed application.</li> </ol>
Analysis	<ol style="list-style-type: none"> <li>i. Construct and distribute questionnaires on social media.</li> <li>ii. Analyze hardware and software requirements.</li> <li>iii. Identify functional and non-functional requirements.</li> <li>iv. Construct and illustrate UML diagram.</li> </ol>	<ol style="list-style-type: none"> <li>i. User requirements.</li> <li>ii. Hardware and software requirements.</li> <li>iii. Functional and non-functional requirements.</li> <li>iv. UML diagram.</li> </ol>
Design	<ol style="list-style-type: none"> <li>i. Design the database.</li> <li>ii. Design the wireframe.</li> <li>iii. Design the prototype.</li> </ol>	<ol style="list-style-type: none"> <li>i. Wireframe.</li> <li>ii. Prototype.</li> </ol>
Implementation	<ol style="list-style-type: none"> <li>i. Develop the system module.</li> <li>ii. Connect with database.</li> </ol>	<ol style="list-style-type: none"> <li>i. Developed application.</li> </ol>
Testing	<ol style="list-style-type: none"> <li>i. Conduct system testing.</li> <li>ii. Fix bug and improve the system.</li> </ol>	<ol style="list-style-type: none"> <li>i. Test plan.</li> <li>ii. User Acceptance Testing.</li> <li>iii. Bugs fixing.</li> <li>iv. New version system.</li> </ol>

### 3.2 System Analysis and Design

The functional requirement and non-functional requirements were determined and discussed further based on the questionnaires collected from the targeted users. Besides that, UML is used to represent

the developed application in a visual way. The UML used consists of use case diagram, sequence diagram, activity diagram and class diagram.

The functional requirement defines the behaviors of the system and describes its tasks or activities [6]. Table 3 shows the functional requirements of the medicine reminder application.

**Table 3: Functional requirements of the medicine reminder application**

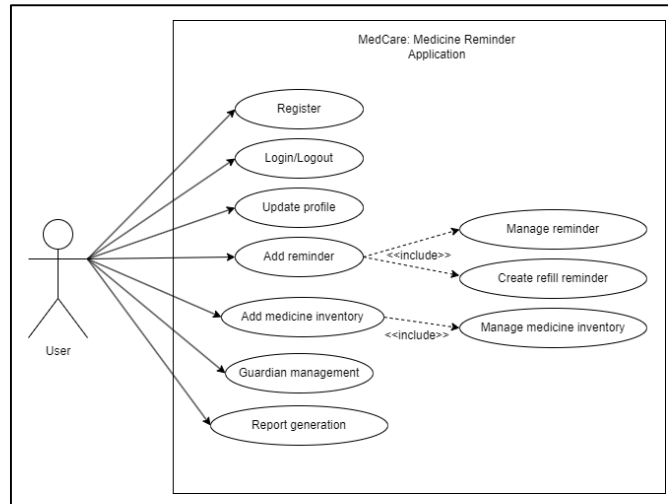
Function	Functionalities
Register	This function allows the new user to register with their personal information such as name, phone number and date of birth.
Login/logout	This function allows the users to login or logout from their account.
Update profile	This function allows the users to update their personal information on the account.
Reminder management	This function allows the users to add, view and delete the reminder for medicine and activity.
Medicine inventory management	This function allows the users to manage their medicine's available stock by adding, viewing, updating and deleting the stock.
Guardian management	This function allows the users to manage their dependents by adding, viewing and deleting the dependents. The users can also set the medicine reminder for the dependents.
Report summary	This function allows the users to summarize and create a report of medication history.

In addition, the non-functional requirement defines the quality or the characteristics of the system. It is used to explain how effectively the systems must function on their users [6]. Table 4 shows the non-functional requirements of the medicine reminder application.

**Table 4: Non-functional requirements of the medicine reminder application**

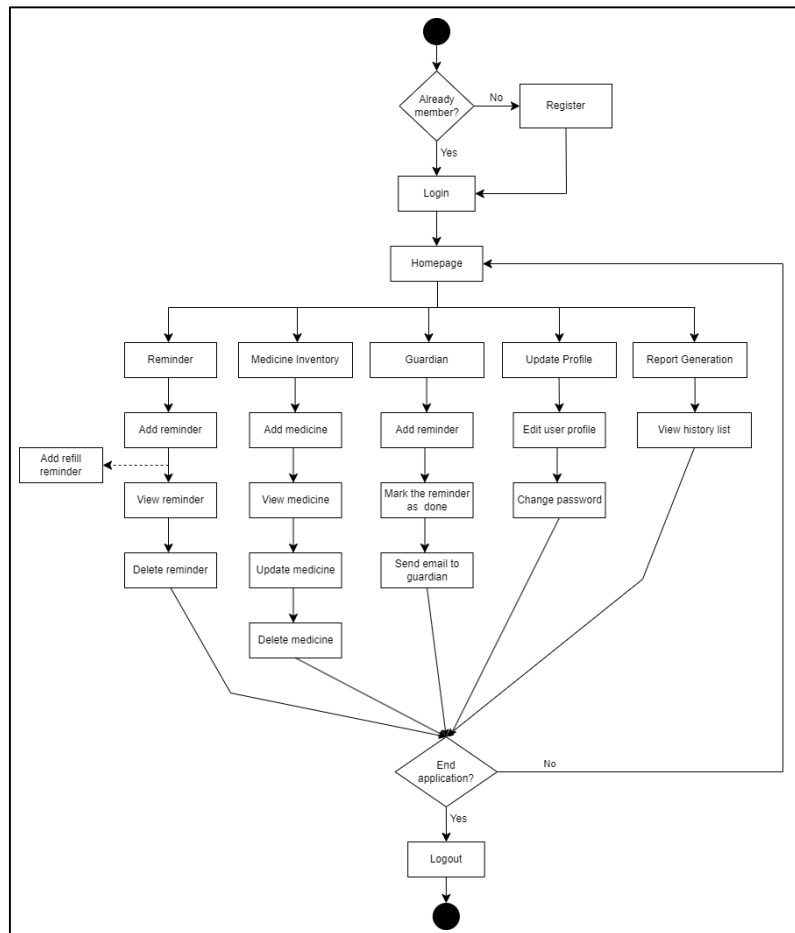
Requirements	Description
Operational	The application has always-on network connection that permit for real-time database updates.
Performance	The application provides page loading within 5 seconds or lesser response time.
Security	The application requires a valid email address for the users to reset their password.
Cultural/Political	The personal information of the users cannot transfer from Malaysia to any country.

The use case diagram is one of the types of UML diagram that is used to represent the interaction between the users and the system. The roles of users for this application are illustrated by using a use case diagram. The use case diagram is shown in Figure 1.



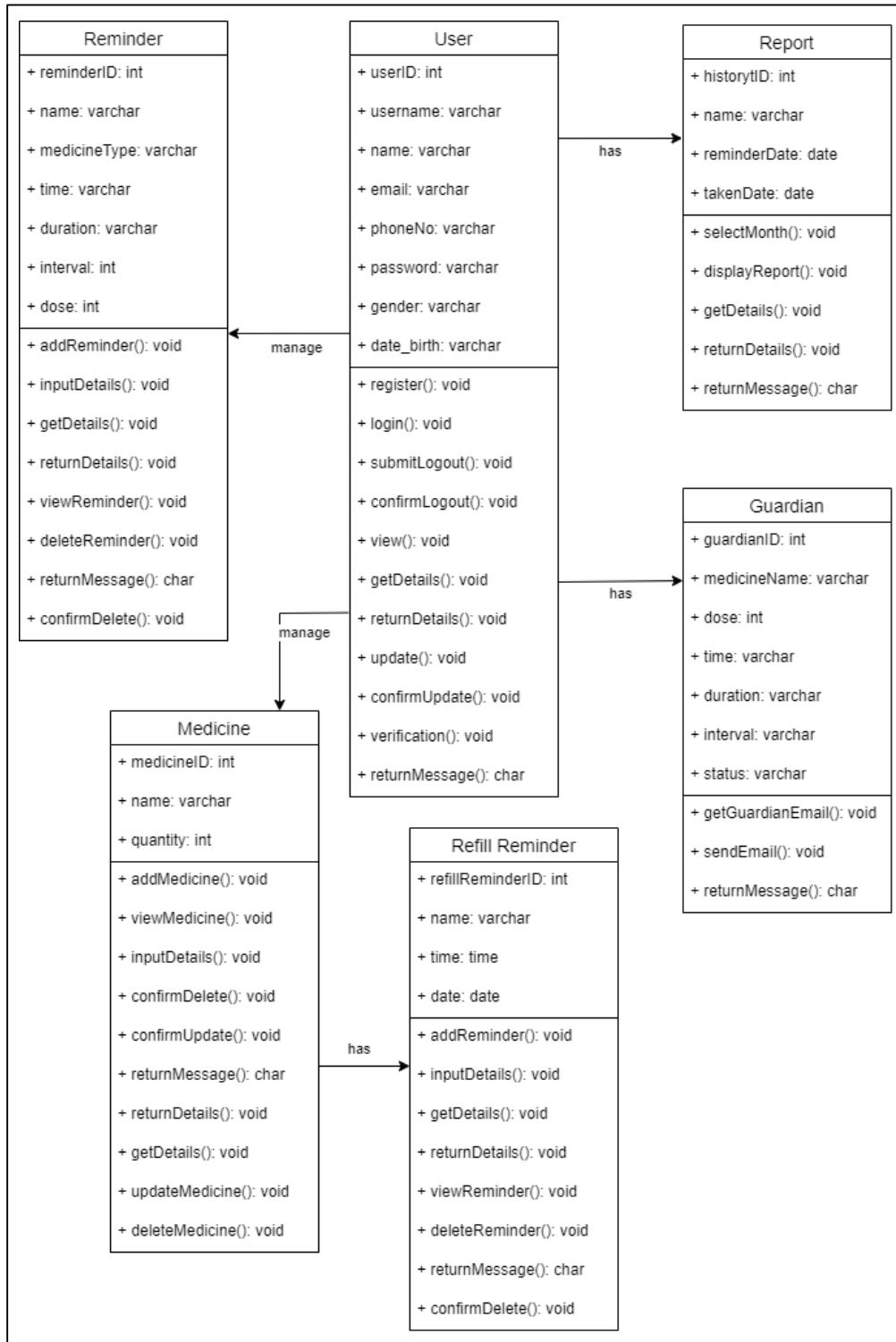
**Figure 1: Use case diagram of the medicine reminder application**

The activity diagram is a representation that is used to display the activities flow of the users within the system. The activity diagram for the user is shown in Figure 2. At the beginning of the process, the users can login to their account or register if they have no existing account in this application. The users can manage the reminder and medicine inventory in this application. The users also send notification email to their guardian’s email. Besides that, the users can update their personal information such as name and phone number in their user profile. Lastly, the users can also retrieve their medication history to ensure their medication process is going well.



**Figure 2: Activity diagram for user**

The class diagram is a structure that outlines the components of the system by displaying the system’s classes, attributes and the relationship between the classes. The class diagram of the developed application is shown in Figure 3. There are total of six classes in this application which include class Reminder, class Medicine, class Refill Reminder, class User, class Guardian and class Report.



**Figure 3: Class diagram of the medicine reminder application**

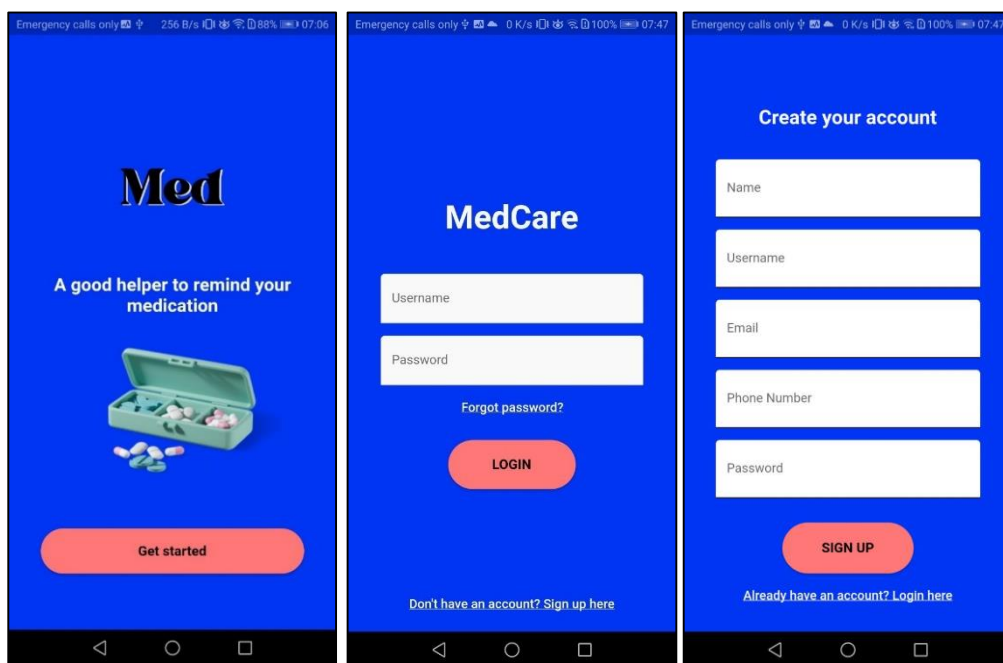
Lastly, a user interface design is a graphical element of a software system or application. It is designed by creating different models of system function [7]. In this project, a prototype of the developed application is designed and illustrated to display the details of each module.

#### 4. Results and Discussion

The medicine reminder application, MedCare is developed by using Dart programming language and Flutter as the framework for creating an application that runs on Android devices. Meanwhile, the back end of the application is developed by using Firebase SDKs (Software Development Kit) to connect to the Firestore Database provided.

##### 4.1 System Implementation

The registration module allows the users to register as a new user to the application. The users are required to enter the input value of name, username, email, phone number and password. The back end will check whether every input field is filled. If the input field is not filled, an alert message will appear to users so that they continue to enter all the required fields. The interface of the register page is shown in Figure 4.



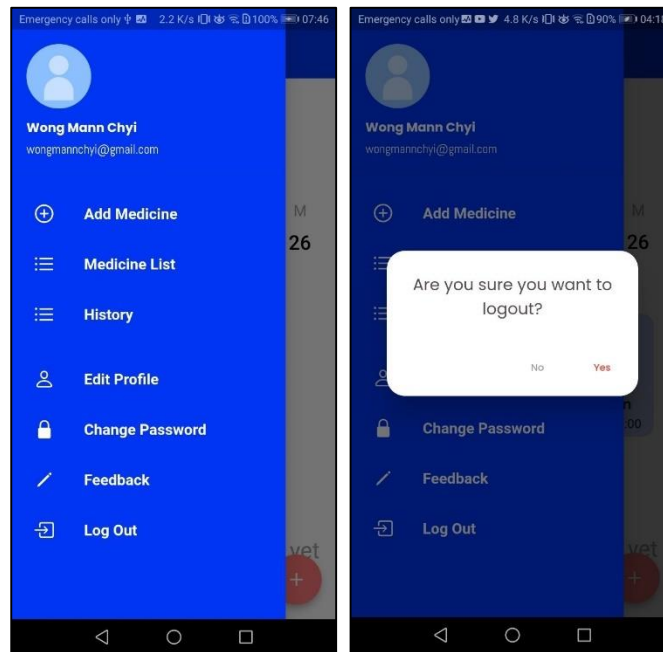
**Figure 4: Interface of register page**

For the login module, the users are allowed to login to the application with the username and password that have been registered in the registration module. The users are required to enter the correct username and password or it will display the users with an alert message that the username or password is invalid. Figure 5 shows the interface of login page.



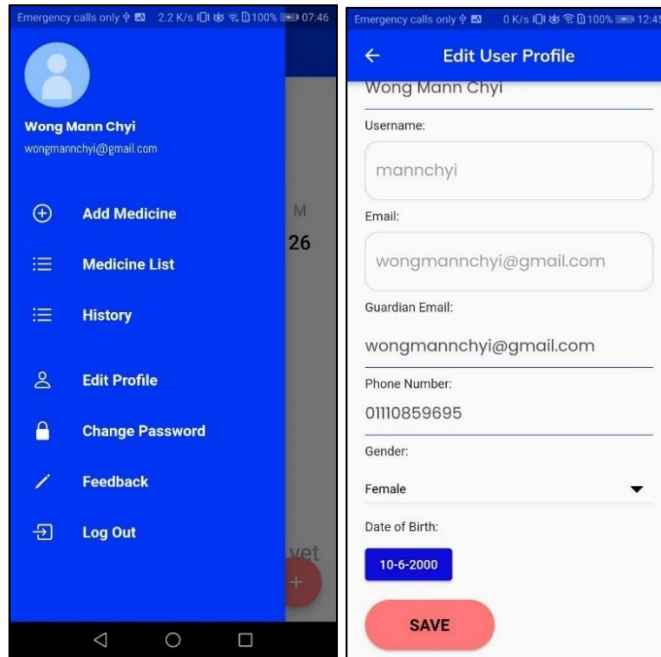
**Figure 5: Interface of login page**

The logout module allows the users to logout the session from the application. An alert message will be displayed to the users to confirm that the users want to proceed with logout from the application. Figure 6 shows the interface of logout page.



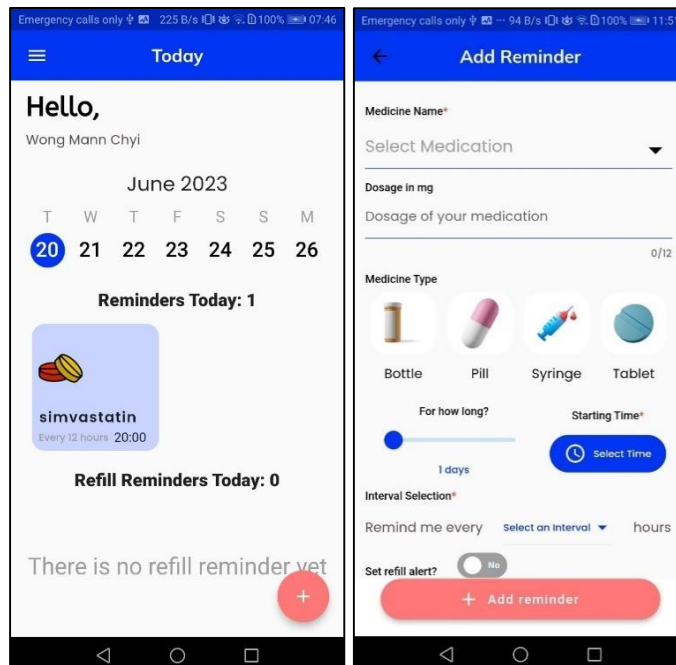
**Figure 6: Interface of logout page**

In the user profile management module, the users can edit their personal information such as name, phone number, gender and date of birth to save it in the database. Figure 7 shows the interface of the user edit page.

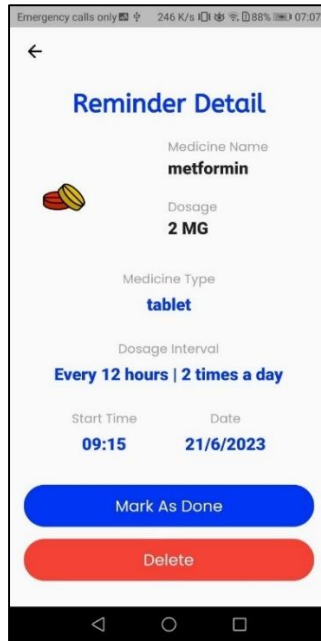


**Figure 7: Interface of user edit page**

In the medicine reminder management module, the users can add the reminder for their medication process. Before adding a reminder for the medication process, the users have to add the medicine first to determine what medicine will be taken in the reminder. While setting up the reminder, an alert notification can also be added to remind the users to refill their medicine. Furthermore, the users can view the reminder added to the home page. Figure 8 shows the interface of add medicine reminder page while Figure 9 shows the interface of view reminder page.

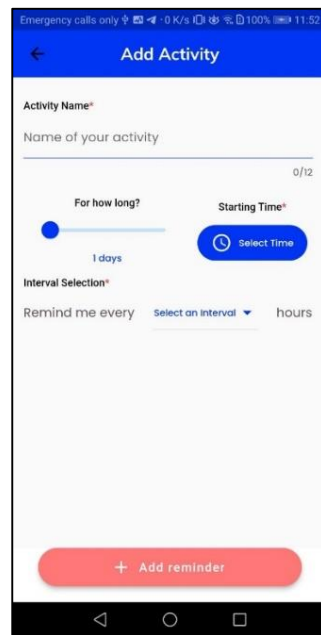


**Figure 8: Interface of add medicine reminder page**



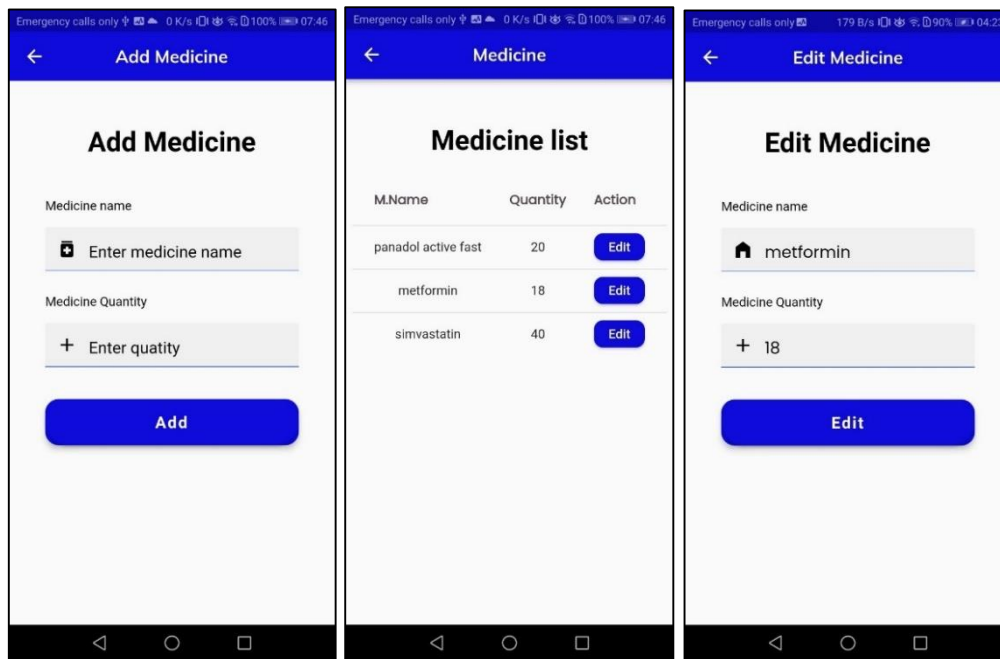
**Figure 9: Interface of view reminder page**

In the activity reminder management module, it is the same way to add reminder in medicine reminder management module. However, the activity reminder only requires filling in the activity name, duration, starting time and interval (hours). The interface of the adding activity reminder page is shown in Figure 10.



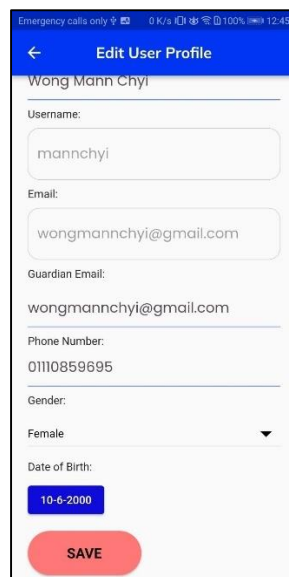
**Figure 10: Interface of add activity reminder page**

In the medicine inventory management module, the users can add medicine to the database for setting up the medicine reminder. Besides that, the medicine can be viewed in a list and the users can update the changes of remaining quantity in the medicine added. Figure 11 shows the interface of the medicine inventory page.



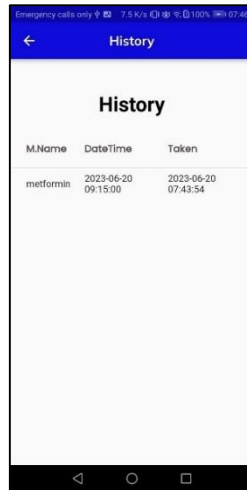
**Figure 11: Interface of medicine inventory page**

In the guardian management module, the users can add the guardian’s email on their user profile page. When the users mark a reminder as done, the application will send a notification email to the guardian’s email so that the guardian can supervise the users on their medication process. Figure 12 shows the interface of add guardian’s email page.



**Figure 12: Interface of add guardian’s email page**

In the report generation module, the users can review their medication history. The date and time of the reminder is displayed to the users with the comparison of the actual time of taking the medicine. Figure 13 shows the interface of the history page.



**Figure 13: Interface of history page**

## 4.2 System Testing

The testing phase aims to find out and fix the bugs that occur in the application. In this project, functional testing and user acceptance testing is conducted to ensure a good quality of the developed application and meets the business requirements in real life.

### 4.2.1 Test plan

The purpose of the test plan is to make sure the medicine reminder application is running as well as what has been stated in the system implementation. Table 5 shows the results of the test plan that was conducted on the medicine reminder application.

**Table 5: Results of test plan**

No.	Modules	Description	Test case	Expected output	Actual output
1.	Register	-	Incomplete data input	An alert message will display if the text field is empty.	Pass
			Unique username	An alert message will display if the username is repeated in database.	Pass
			Complete registration form	The users register successfully to the application.	Pass
2.	Login/Logout	Login	Incomplete data input	An alert message will display if the text field is empty.	Pass
			Invalid username or password	An alert message will display if the username or password is not match with the data stored in database.	Pass
			Complete form	The user is login successfully and redirected to the home page.	Pass
		Logout	Logout from application	A confirm message will display and ask whether proceed to log out.	Pass
3.	User profile management	User profile	Display user profile	The user profile will display full name and email of the user.	Pass
			Update user profile	The user can update their name, phone number, gender and date of birth.	Pass

**Table 5: (cont)**

No.	Modules	Description	Test case	Expected output	Actual output
3.	User profile management	Forget password	One time password	The reset password link will send to the user's email if the email of the user registered exists in the database.	Pass
4.	Reminder management	Reminder list	Add reminder	The users can add a reminder with the details such as duration, interval and time taken.	Pass
			Read reminder	The reminder will display on the home page.	Pass
			Delete reminder	A confirm message will display and ask whether proceed to delete the reminder.	Pass
5.	Medicine inventory management	Medicine inventory list	Add medicine inventory	The users can add a medicine inventory with details such as medicine name and total quantity.	Pass
			Read medicine inventory	The reminder will display on the medicine inventory page.	Pass
			Update medicine inventory	The users can update the medicine's name and the total quantity.	Pass
			Delete medicine inventory	A confirm message will display and ask whether proceed to delete the medicine inventory.	Pass
			Refill reminder of medicine inventory	A notification will display if the medicine inventory is out of stock.	Pass
6.	Guardian management	-	Send notification email	The email sends successfully to the one who supervised the user when the user marks the reminder as done.	Pass
7.	Report generation	Track the medication history	Read the medication progress	The users can view their medication progress within a week.	Pass
			Read the history of the medication.	The user can view their medication history for the whole time.	Pass

#### 4.2.2 User Acceptance Test

User Acceptance Testing (UAT) is a type of test that faces the end-user to ensure the application can meet the performance requirements and solve real-world problems. There are two parts which are user interface testing and functionalities testing. In addition, there are a total of 10 users that are involved in this UAT. The ranking number 1 is highly unsatisfied whereas ranking number 5 is highly satisfied.

**Table 6: Results of user interface testing**

No.	Features	Ranking				
		1	2	3	4	5
1.	The application is easy to learn.			2	2	6
2.	The application has clear navigation.			2	6	2

**Table 6: (cont)**

No.	Features	Ranking				
		1	2	3	4	5
3.	The information displayed is simple and clear.				5	5
4.	The color used is suitable to the theme of the application.			3	3	4
5.	The font size is suitable to read.				4	6

**Table 7: Results of functionalities testing**

No.	Features	Ranking				
		1	2	3	4	5
1.	Register function				2	8
2.	Login/logout function				4	6
3.	User profile management function			1	3	6
4.	Medicine reminder management function			2		8
5.	Activity reminder management function			1	6	3
6.	Medicine inventory management function			1	2	7
7.	Guardian management function			1	4	5
8.	Report summary			1	2	7

Based on the results of user interface testing in Table 6, most of the users were satisfied with the user interface of the medicine reminder application. A total of 60% of the users were highly satisfied that the application is easy to learn and the font size is suitable to read. For the results of functionalities testing in Table 7, most of the users are highly satisfied with the modules of the application. A total of 80% of the users were highly satisfied with the register function and the medicine reminder management function.

## 5. Conclusion

The medicine reminder application has been developed to make it easier for users to take their medications. The application also increases the health awareness level of the users indirectly by maintaining their health condition.

Even though the medicine reminder application has developed successfully and achieved the project goal, improvement still has to be done. The first limitation is that the process for the application to capture the data is too complicated. The application only provides the users with enter manually. This may cause that the users could find it tedious to enter all the information needed to create a reminder. The second limitation is the function of reset password only occur in email. The elderly people may find it difficult to log in email in case to reset or change their password. The third limitation is most of the elderly people may not be familiar with English language. They may face difficult to use the application with English language only.

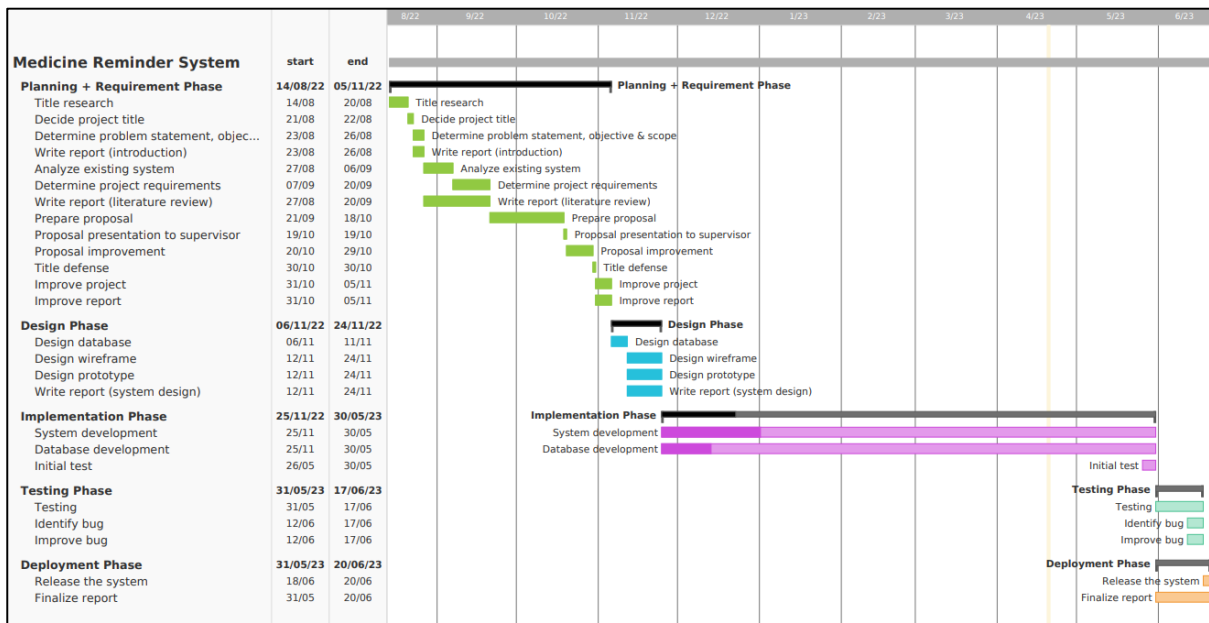
Since the limitations outlined have a great deal of opportunity to be improved upon in future works, the improvement can be made by analyzing the advantages and disadvantages of the application. The first recommendation is improving the process of data capturing by using barcode or QR code. The application can scan the barcode or the QR code of the prescriptions so that the medicine information can be entered automatically. This can simplify the process of adding a reminder. The second recommendation is the application that allows the users to use Short Message Service (SMS) to receive the One Time Password (OTP) for resetting or changing their password.

This brings convenience to the elderly people from logging in into their email account. The third recommendation is the application can equip with multiple language especially for the local language in Malaysia such as Malays, Mandarin and Tamil language. This helps the elderly people to adapt easily with the application.

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### Appendix A



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