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Android-Based Medication Reminder Application for Type 2 Diabetes Mellitus Patients

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A B S T R A C T

Type 2 Diabetes Mellitus is a chronic disease that requires routine and continuous treatment. One of the problems often experienced by patients is forgetting to take their medication on schedule. To address this issue, this research aims to design and build an Android-based medication reminder application named Diabetes Buddy. This application is developed using the Waterfall method with stages of needs analysis, system design, implementation, and testing, which can help patients manage their medication consumption independently. The Diabetes Buddy application has main features that include medication reminder notifications, medication stock management, recording medication consumption history, and information on medication usage guidelines. This system uses Firebase Realtime Database as a data storage medium, allowing user data and medication schedules to be accessed in real-time and integrated. The test results show that the application runs well on Android devices and it is expected that this application can provide convenience for patients in monitoring and adhering to their treatment regimen. This application can improve patient adherence to treatment and provide convenience for families in supporting the healing process.

INTRODUCTION

Diabetes mellitus is a chronic non-communicable disease that causes high blood sugar levels in the body and is a long-term disease. (Erawantini et al., 2017). Type 2 diabetes mellitus (T2DM) is caused by genetic factors that affect insulin production, so the body cannot produce enough insulin. (Hardianto, 2021). Beside genetic factors, unhealthy eating habits, lack of physical activity, obesity, and stress can also worsen this condition. (Denggos, 2023). This condition impacts the increase in microvascular and macrovascular complications, as well as a decline in the quality of life of patients. (Boy et al., 2023). One of the main challenges faced by patients is adherence to the medication schedule. Most T2DM patients still fall into the moderate to low adherence category for antidiabetic therapy. (Wulan et al., 2026). Therefore, an Android-based smartphone application is needed as a solution that can help type 2 diabetes mellitus patients remain consistent in independently and sustainably undergoing treatment.

The use of smartphone-based health applications can assist patients in monitoring medication consumption, scheduling therapy, receiving health education, and improving communication with healthcare professionals. (Ghozali, 2024). Diabetes blood sugar monitoring applications can improve patient adherence to treatment and self-health monitoring. (Susilowati et al., 2023).

The Ngobat application is a medication adherence app that uses gamification on the Android platform with features such as medication reminders, notifications, and medication reports. (Aldiansyah et al., 2021). Daily reminder features, medication usage pattern analysis, and educational support in mHealth applications can significantly improve medication adherence in patients with chronic diseases, including diabetes mellitus. (Astri et al., 2026). Previous research has not developed applications specifically tailored to the needs of T2DM patients in aspects such as personalized reminders, real-time adherence monitoring, a simple user interface, and the integration of health education that aligns with the characteristics of diabetes patients. An application for scheduling medication reminders, managing medication consumption history, managing medication stock, accessing application usage guides, accessing diabetes medication information, and receiving automatic medication reminder notifications according to schedule. The Diabetes Buddy application was developed to provide features for automatic medication consumption reminders, recording medication usage history, and monitoring support that can help patients consistently follow their therapy. This research is expected to contribute to the development of digital health technology, particularly in the management of chronic type 2 diabetes mellitus.

LITERATURE REVIEW

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disease that requires long-term management thru pharmacological therapy, dietary regulation, physical activity, and continuous blood glucose monitoring. One of the main factors determining the success of T2DM therapy is the patient's adherence to the medication regimen provided by healthcare professionals. Non-adherence to medication can lead to poor glycemic control, increased HbA1c

levels, chronic complications, and higher healthcare costs. (Shrivastava et al., 2023). The adherence level of DMT2 patients to medication is still relatively low in various developing countries. This is caused by the complexity of therapy, forgetfulness in taking medication, lack of health education, low patient motivation, and limited self-monitoring of therapy. Additionally, elderly patients with multimorbidity tend to have difficulty maintaining consistent medication adherence due to memory limitations and the high frequency of daily medication use.

The development of digital technology has led to the emergence of the mobile health (mHealth) concept as an innovative approach to supporting chronic disease management. mHealth is the utilization of mobile devices such as smartphones and tablets to support healthcare services, patient education, health condition monitoring, and real-time therapy reminders. In diabetes patients, the implementation of mHealth is considered effective in improving self-management and the quality of life of patients because it allows for more flexible and personalized access to healthcare services. (Mohammed et al., n.d.) (Company-bezares & Aretio-pousa, 2022). Mobile phone-based interventions provide features such as medication schedule reminders, automatic notifications, recording of medication consumption history, health education, and blood glucose level monitoring that can enhance patient engagement in therapy. (Shrivastava et al., 2023). The use of smartphone applications in DMT2 patients can significantly improve medication adherence. Most respondents stated that the application is easy to use and helps them be more disciplined in following their daily therapy. The study also emphasized that the simple interface features and automatic reminders are important factors in the success of Android-based health applications. (Alamsyah et al., 2023). In addition to functionality aspects, data security and user privacy are also major concerns in the development of Android-based health applications. The challenges of mHealth development include the protection of patient medical data, user authentication security, and system integration with formal health services. (Aljedaani & Babar, 2021). Therefore, the development of modern health applications is not only oriented toward ease of use but also toward system security and the sustainability of application usage.

METHODOLOGY

This research uses the Software Development Life Cycle (SDLC) development method with a Waterfall model approach to design and build an Android-based medication reminder application for Type 2 Diabetes Mellitus patients. The Waterfall method was chosen because it has systematic, structured, and well-documented development stages, making it suitable for developing health applications that require clear system requirements and stable development processes.(Pratrian et al., 2026).

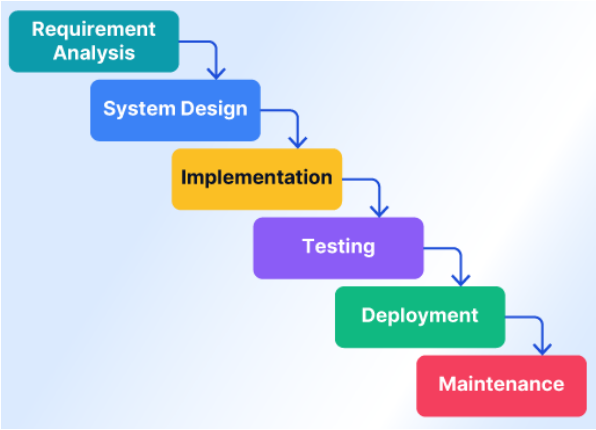

Figure 1. waterfall model

The Waterfall Model is a linear and sequential software development approach, starting from the requirements analysis phase, design, implementation, testing, deployment, to system maintenance. Each phase must be completed before moving on to the next phase, making it easier to control software quality. (Saravanos & Curinga, 2023). In the context of developing Android-based health applications, the waterfall method is effective because it supports comprehensive system documentation, clear user requirement validation, and thorough software testing.

RESEARCH RESULT

a. Use Case Diagram

Use case diagram for the development of the Diabetes Buddy application for reminding patients with Type 2 Diabetes Mellitus to take their medication, based on Android, is shown in Figure 2.

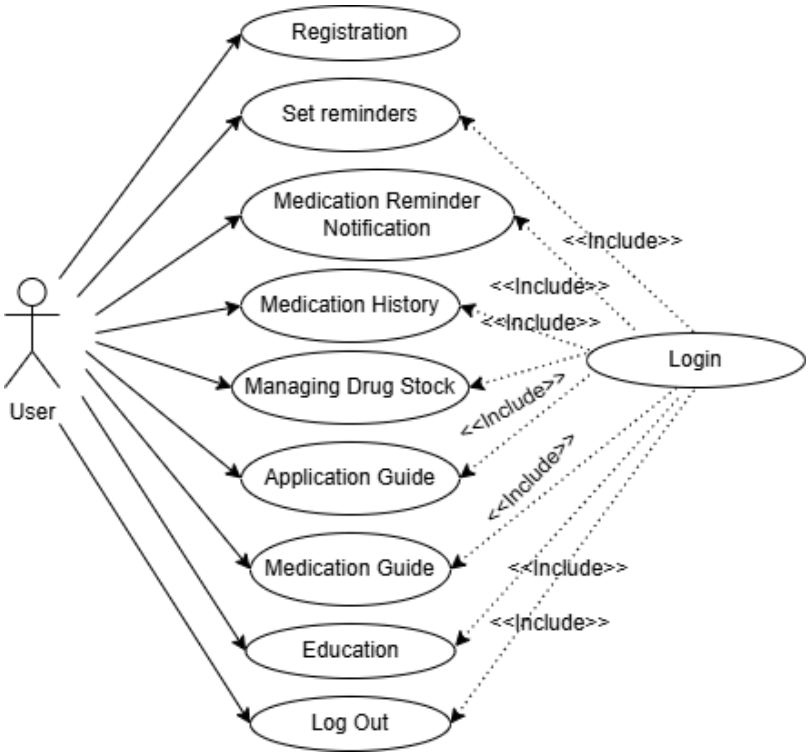

Figure 2. Use Case Diagram

The use case diagram in the image depicts the interaction between users and the medication reminder application system. This diagram shows nine main functions that users can access, namely account registration, login, setting medication reminder schedules, managing medication consumption history, managing medication stock, accessing application usage guidelines, accessing diabetes medication information, receiving automatic medication reminder notifications according to schedule, and logging out of the system. The entire use case is designed to support user compliance in taking medication and facilitate the management of diabetes therapy independently.

b. Activity Diagram

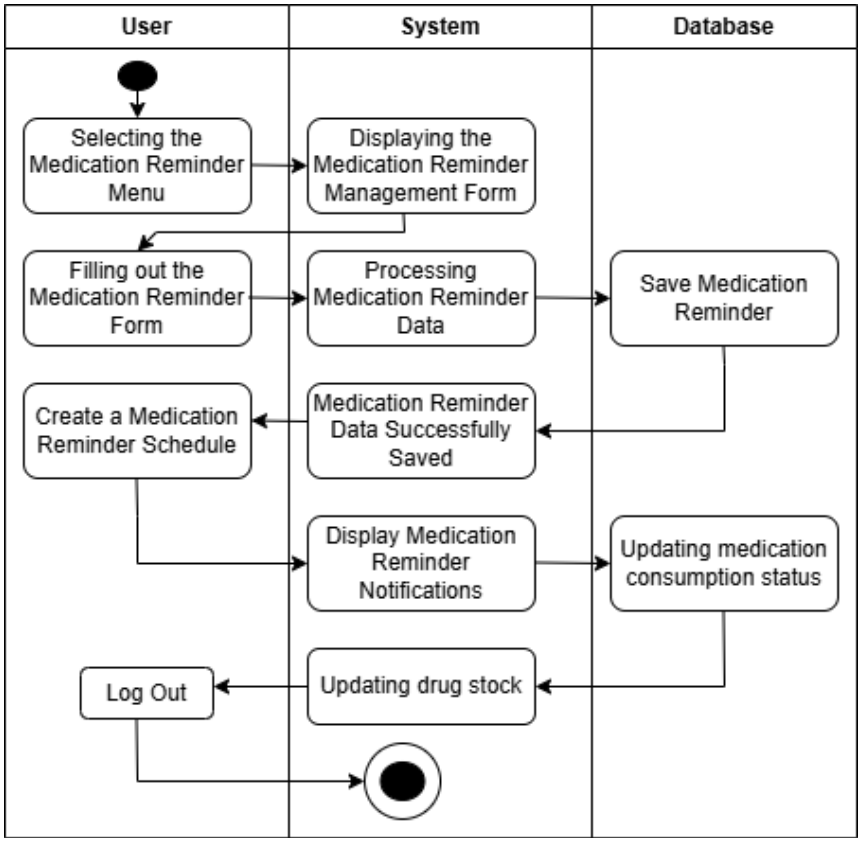

Figure 3. Activity Diagram

Figure 3 presents an activity diagram that illustrates the flow of activities for each feature of the Type 2 Diabetes Mellitus patient medication management application. This diagram shows the interaction between users and the system in carrying out various processes that support medication management and adherence to the medication schedule. Additionally, the activity diagram provides a clear representation of the sequence of user activities and the system's response to each action taken during the use of the application.

c. Class Diagram

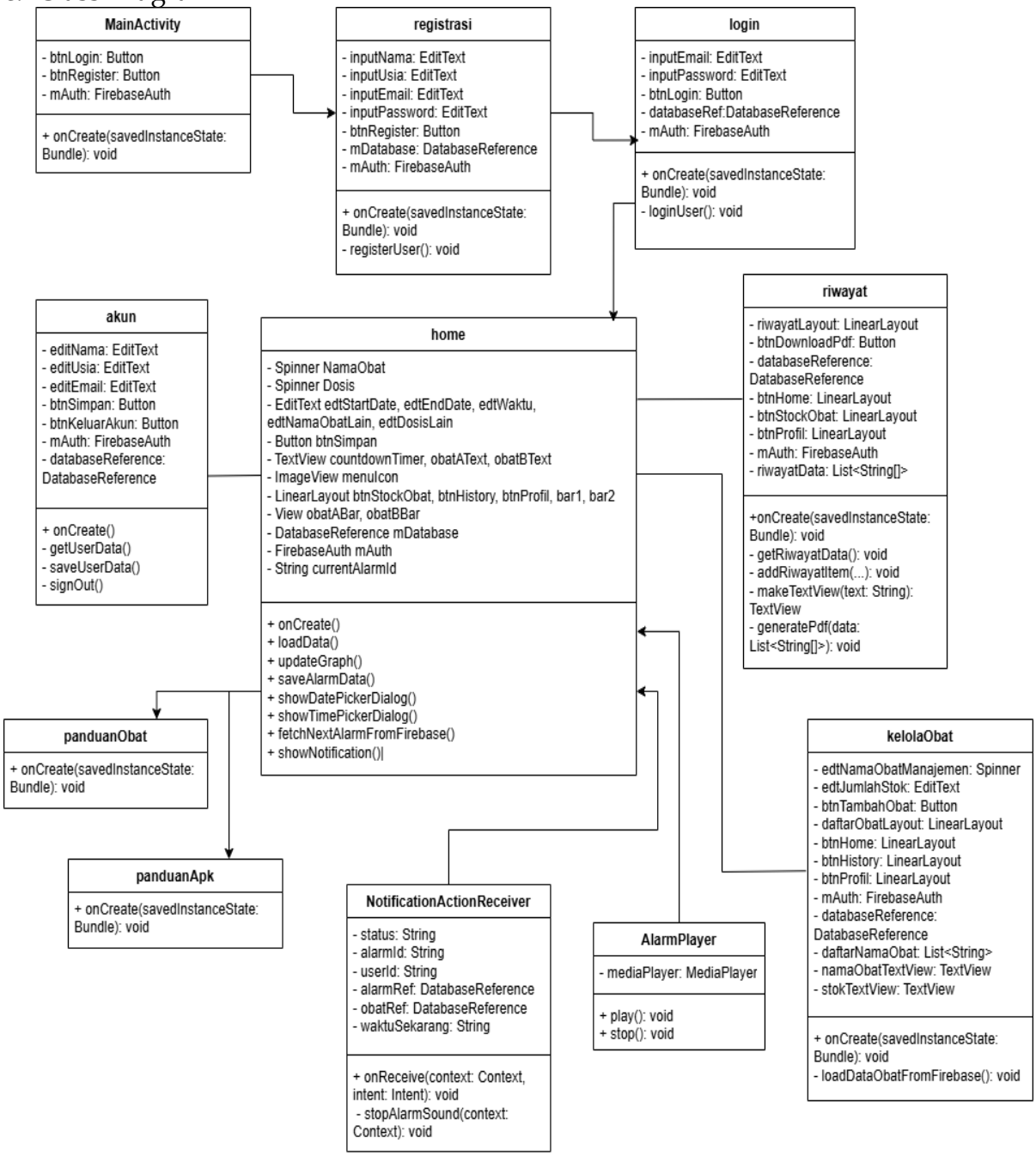

Figure 4. Class Diagram

The Diabetes Buddy application is a medication reminder app built from several integrated classes and supported by Firebase services for authentication and real-time data storage. The MainActivity class serves as the entry point of the application, providing user authentication features thru the registration and login processes. After successfully logging in, users are directed to the main page to set up their medication consumption schedule based on information such as date, time, medication name, and dosage, which is then saved to Firebase to generate reminder notifications. In addition to the reminder feature, the application provides user profile management, medication stock management, and recording of medication consumption history, which can be displayed in list

form and exported to PDF format. Usage history is automatically updated based on user responses to alarm notifications. The application is also equipped with a user guide feature and medication information to enhance user understanding. The notification and alarm mechanisms are managed thru a special class that handles user responses to medication reminders and alarm sound playback. Integration between components and the use of Firebase as a database and authentication system that enables the application to support medication therapy management more effectively, structured, and sustainably.

d. User Interface

The user interface (UI) is used by diabetes patients to interact with the Android-based Diabetes Buddy application. The user interface of the Diabetes Buddy application includes registration and login forms, main menu, application guide, medication guide, education page, medication stock, medication consumption history, profile, and medication reminder notifications.

1. Registration and login form

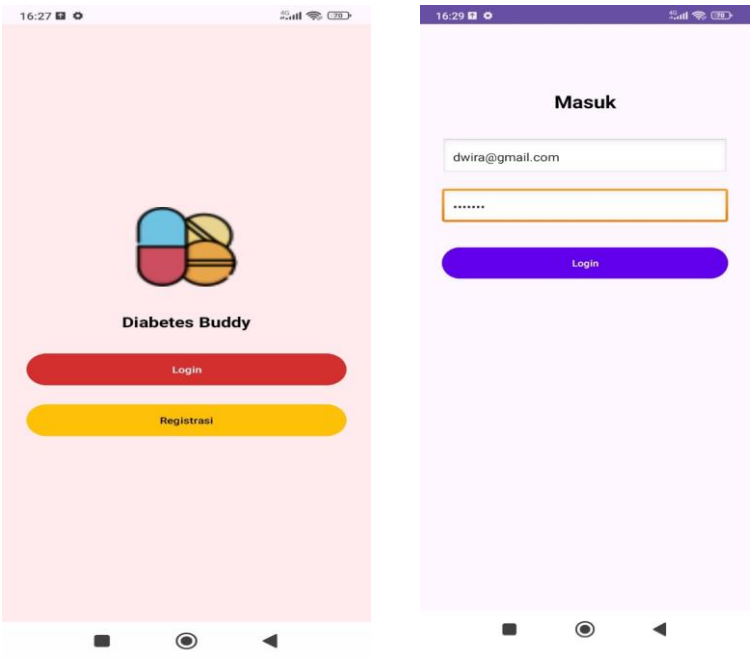

Figure 5. Login and Registration

Registration is the process of creating a new account by users to access the Android-based Diabetes Buddy application. Meanwhile, login is the authentication process performed by users to gain access to the Diabetes Buddy application. In the login process, users must enter a username in the form of an email address and a password that has been previously registered.

2. Main Menu

Figure 6. Main Menu

On the main page of the application, users can see real-time medication reminder information displayed in hours, minutes, and seconds format. Additionally, there is a reminder settings form that allows users to specify the medication name, start date, end date, and time of medication consumption. At the bottom of the application, there are four navigation icons: Home, Stock, History, and Profile, which serve to facilitate users in accessing and switching between the available features.

3. Aplication User Guide

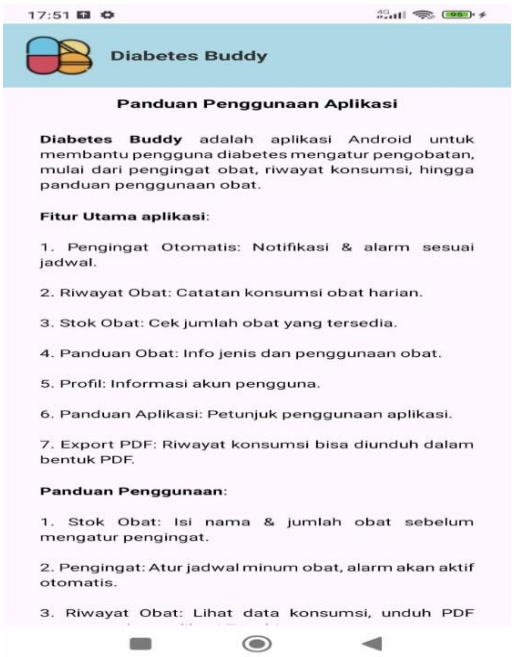

Figure 7. Application User Guide

The user guide page on the Diabetes Buddy app is designed to help users understand all the available features and how to use them effectively. This application provides various main features, including automatic reminders in the form of notifications and alarms according to the medication consumption schedule, daily medication usage history recording, medication stock monitoring, information on types and usage rules of medications, user profile management, and application usage guidelines. In the usage guidelines section, important steps that users need to take are explained, such as filling in the medication stock data first, setting the medication consumption schedule so that the alarm and notification system can run automatically, and accessing and downloading the recorded medication consumption history.

4. Medication usage guide

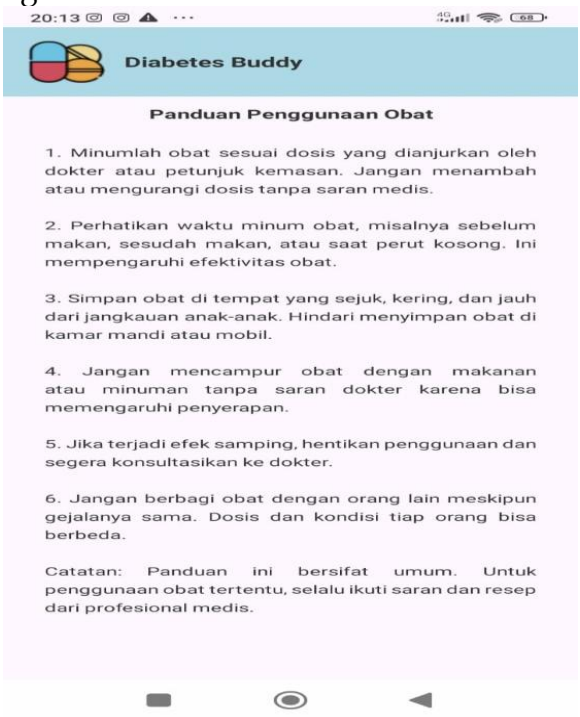

Figure 8. Medication usage guide

The medication usage guide provides general instructions to ensure the medication is consumed correctly and safely. The medication should be used according to the dosage recommended by the doctor or the instructions on the packaging, without altering the dosage independently. The timing of consumption, such as before or after meals, needs to be observed to maintain the effectiveness of the medication. The medicine should also be stored in a cool, dry place, out of reach of children. Avoid mixing medication with food or drink without medical advice as it can affect the absorption of the medication. If side effects occur, stop using it immediately and consult a doctor. In addition, the medication should not be shared with others because the needs and health conditions of each individual are different. This information is general, so the use of certain medications must still follow the instructions and prescriptions of healthcare professionals.

5. Educational Page

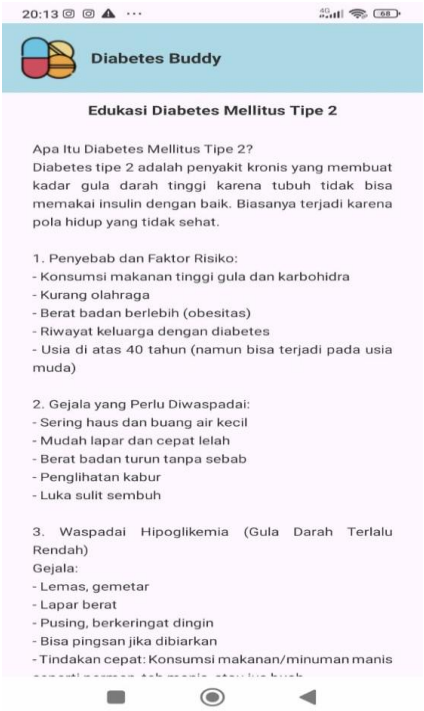

Figure 9. Educational Page

Figure 9 shows the educational page of the Diabetes Buddy application, which contains brief information about Type 2 Diabetes Mellitus. This page presents educational material that includes the definition of the disease, risk factors, common clinical symptoms, as well as an explanation of hypoglycemia and its impact on health. The information is organized systematically and uses simple language, making it easier for users to understand important aspects related to the prevention, early detection, and management of Type 2 Diabetes Mellitus.

6. Medicine Inventory

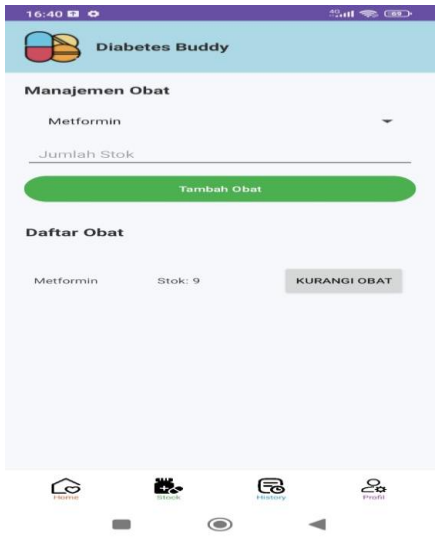

Figure 10. Medicine Inventory

Figure 10 displays the medication management feature in the Diabetes Buddy application. Users can select the type of medication from the dropdown menu, enter the available stock quantity, and then press the Add Medication button to save the data to the system. The list of added medications will be displayed along with their respective stock quantities, such as Glibenclamide, Pioglitazone, and Metformin. The stock of medicine will automatically decrease when the reminder notification sounds and the user presses the Done button to confirm that the medicine has been consumed. Therefore, users need to refill the medication stock first before setting the reminder so that the recording of medication usage can be done accurately. This feature helps users monitor their medication supply effectively and supports adherence to medication consumption for diabetes management.

7. History of medication use

Figure 12. History of Medication Use

Figure 11 displays the interface of the medication consumption history page on the Diabetes Buddy application. This page serves to show the records of medication usage that have been carried out by the user. The information presented includes the name of the medication, dosage, alarm time, start and end dates of use, medication consumption status (on time or not on time), and the confirmation time performed by the user. In addition, there is a Download PDF History button at the top of the page that allows users to download their medication consumption history data in PDF format. At the bottom of the application, there is a navigation menu that provides quick access to various features, such as Home, Medicine Stock, History, and Profile.

8. Medication Reminder Notification

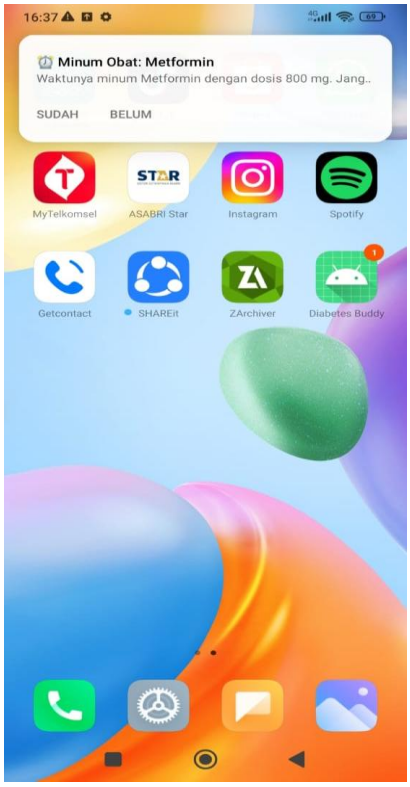

Figure 13. Medication Reminder Notification

Figure 12 shows the medication reminder notification on the Diabetes Buddy app that appears on the main screen and the phone's notification panel. This notification informs that it is time for the user to take their medication and provides two options, namely "YES" and "NO". If the user selects "YES", the application will record that the medication has been taken, automatically reduce the medication stock, and save the data into the consumption history. Conversely, the "NO" option indicates that the reminder has been received but not acted upon, thus considered as a missed schedule. If there is no response, the alarm will continue to sound periodically until the user takes action. This feature is designed to help users take their medication regularly and on time.

The testing of the Diabetes Buddy application uses the Black Box testing method to ensure that each feature of the application can operate according to the specified needs and specifications. This testing method focuses on testing the functional aspects of the system by evaluating the conformity between the given input and the produced output.

Table 1. Results of Black-Box Testing

No	Test Case	Input	Expected Output
1	Registration	nput Name, Age, Email, and Password user	data successfully saved
2	User login	Input the correct Email and Password	The application displays the main menu page

3	User Login	Input incorrect email and password	Error message: Incorrect username and password appears
4	Application usage guide	Select the application usage guide menu	Successfully displayed information about the application usage guide
5	Medication usage guide	Select the medication usage guide menu	Successfully displayed information about the medication usage guide
5	Education Page	Select the education menu	Successfully displayed educational information about type 2 diabetes mellitus
6	Adding medication stock	Select the add medication stock menu	Successfully displayed the list of medication stock that has been inputted
7	Medication consumption history	Select the Medication Consumption	Successfully displayed the medication consumption history
8	Medication reminder notification	-	The medication reminder notification successfully appeared automatically according to the predetermined medication schedule.

DISCUSSION

Because of its high user penetration rate and comparatively inexpensive implementation costs, the Android operating system has emerged as the most popular platform for the creation of health applications. With features like automatic alarms, medicine intake notifications, compliance monitoring, and user health data integration, the Android-based Diabetes Buddy software for medication reminders is made to assist patients in independently managing their therapy schedules. On the Android platform, the Diabetes Buddy app has been effectively created as a digital solution to help patients with Type 2 Diabetes Mellitus stick to their treatment regimens. The application's widespread accessibility to smartphone users is made possible by the Android platform, which makes it easier to use in daily life. The ability to automatically remind patients to take their medications on time through alerts and notifications has been shown to be crucial in lowering the possibility of delays or carelessness that could compromise the effectiveness of the treatment. From needs analysis to design, implementation, testing, and maintenance, the Waterfall method of application development offers a methodical and disciplined procedure. This method creates documentation that aids in future system development and helps guarantee that user demands may be precisely defined from the start. From a

technical standpoint, Firebase Authentication offers a security mechanism that supports the protection of user data, while the integration of Firebase Realtime Database allows the administration and synchronization of user data and prescription schedules in real-time. The application has capabilities for tracking pharmaceutical stock and medication consumption history in addition to reminder functions, which enable users to regularly assess therapy adherence levels and keep an eye on medication availability. The Black Box testing's findings demonstrate that all of the application's primary features function in accordance with system requirements and that no serious functional flaws were discovered. These results demonstrate the application's high degree of dependability as a therapeutic tool. Furthermore, family participation in medication supervision is made possible by the adherence monitoring feature, which may improve patient motivation and consistency in adhering to treatment. All things considered, Diabetes Buddy can combine cloud services, mobile technologies, and an automated notification system into a single platform that facilitates the administration of treatment for Type 2 Diabetes Mellitus. This application has the potential to improve medication adherence, help family members monitor therapy, and lower the risk of complications from treatment non-compliance, making it a viable digital solution alternative for long-term diabetes management.

CONCLUSIONS AND RECOMMENDATIONS

The creation of the Android-based Diabetes Buddy app may be a creative and useful technology way to help people with type 2 diabetes mellitus with their medication adherence issues. The waterfall development paradigm, which guarantees that every stage of development—from needs analysis, design, implementation, testing, deployment, and system maintenance—can proceed methodically and structurally, was used to create the Diabetes Buddy application. For real-time data storage, user authentication, and more efficient, organized, and long-lasting drug therapy management, this application is constructed from a number of interconnected classes and is backed by a Firebase database. With features including automatic alarms, medicine intake notifications, compliance monitoring, and integration of user health data, the Diabetes Buddy app has been operating smoothly and assisting patients in independently managing their therapy schedules.

ADVANCED RESEARCH

An Artificial Intelligence (AI)-based application that can offer diabetic patients individualized advice and adaptive health monitoring is being developed as a result of recent research. This strategy has a lot of promise for enhancing DMT2 patients' future self-management.

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