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Application of Web and Mobile-Based Information System for Diabetes Patient Management at Bandar Lor Clinic

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Keywords

Blood Glucose Monitoring; Diabetic Patient Management; Healthcare Technology; Mobile Application; Web Application.

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Abstract

Diabetes mellitus is a chronic disease that requires continuous monitoring and management. Klinik Pratama Bandar Lor Kediri faces challenges in managing information for diabetic patients, including recording medical history, monitoring blood glucose, facilitating patient–doctor communication, and providing continuous education. Limited access to complete and up-to-date patient data hinders service delivery and complicates clinical decision-making, while patients often struggle to record examination results, adhere to treatment schedules, and obtain optimal consultations. To address these challenges, this study developed DiaCare, a web and mobile based information system built using the prototyping method with Flutter and Firebase. The system integrates key features such as health record management, medication reminders, online consultations, activity tracking with calorie estimation, digital delivery of laboratory results, dietary monitoring, and diabetes-friendly menu recommendations. Functional testing using the black-box method achieved a 100% success rate, validating that all features performed as expected. By enabling patients to self-monitor their condition while maintaining real-time communication with doctors, DiaCare improves efficiency, data accuracy, and patient engagement. The findings suggest that DiaCare has the potential to enhance diabetes management and optimize healthcare services for patients requiring regular monitoring at Klinik Pratama Bandar Lor Kediri.

1. Introduction

The advancement of information technology has transformed various sectors, particularly healthcare. The integration of digital tools and communication technologies has improved the efficiency, speed, and accuracy of data management, enabling better access to patient information and supporting more precise clinical decisions [1]. For individuals with chronic illnesses such as diabetes mellitus, which requires consistent monitoring and treatment, digital health tools are particularly beneficial. According to the International Diabetes Federation (IDF), Indonesia ranks seventh worldwide in diabetes prevalence, with over 19 million recorded cases in 2021 [2].

Despite this, many primary healthcare clinics in Indonesia still encounter obstacles in handling patient information. Fragmented or paper-based records often slow down services, limit comprehensive monitoring, and complicate decision-making. The implementation of electronic medical records and other digital health technologies has been shown to improve efficiency, coordination, and data accessibility in Indonesia [3]. Previous studies in the country have also demonstrated how digital expert systems can support medical decision-making and improve healthcare service accuracy [4]. Patients with diabetes, however, continue to struggle to keep track of test results, comply with medication schedules, and receive timely consultations, which can hinder effective long-term disease management [5].

Recent studies have emphasized that mobile health (mHealth) technologies play an important role in supporting self-management among patients with Type 2 diabetes. The use of mHealth applications has been proven to improve patient engagement, monitoring consistency, and communication with healthcare providers [6][7]. Furthermore, research on DIACOACH a mobile application designed for virtual health coaching has demonstrated its effectiveness in empowering diabetic patients through education, glucose tracking, and personalized consultation features [8]. These findings highlight the growing importance of integrated mHealth systems in Indonesia that can bridge communication between patients and clinics while promoting healthier lifestyles through education, tracking, and feedback. These findings highlight the increasing importance of integrated mHealth systems in Indonesia that can bridge communication between patients and clinics while encouraging healthier lifestyles through education, tracking, and feedback.

While existing diabetes applications primarily focus on glucose monitoring, few integrate real-time consultation, activity tracking, and dietary management into a unified system suitable for primary healthcare settings in Indonesia. This gap underscores the need for a more comprehensive and patient-centered solution.

Therefore, the objective of this study is to design and implement an integrated diabetes management application (DiaCare) using Flutter and Firebase that enhances digital health services in primary healthcare clinics by improving data management, communication, and patient engagement.

2. Research Methods

The development model adopted in this study is the prototyping model, which emphasizes iterative development and continuous user feedback [9]. This approach was chosen to ensure that the Diabetes Patient Management Information System (DiaCare) aligns with the real needs of healthcare staff and patients. The stages of research began with permission and data collection, followed by requirement analysis, initial design, prototype development, system testing, and refinement until the system was finalized.

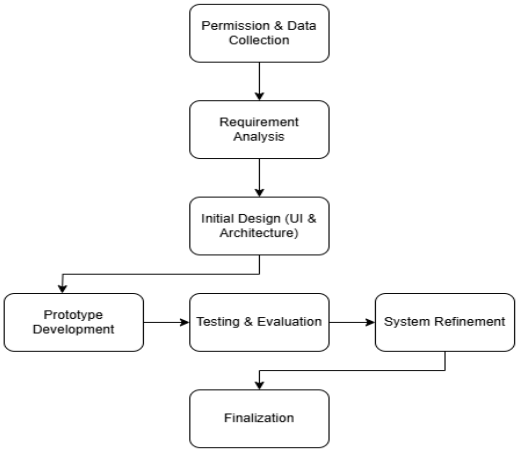

Figure 1. Research Flow with the Prototyping Model

The first stage focused on data collection at Klinik Pratama Bandar Lor Kediri. Information was gathered through direct observation of activities such as patient registration, consultation flow, and medical record handling. To complement these observations, interviews with the clinic's physician were conducted to better understand the challenges in diabetes care and to identify expectations for the proposed digital system.

All patient-related information in this study was managed in accordance with ethical research standards. Prior to data collection, approval and ethical consideration were obtained from the management of Klinik Pratama Bandar Lor Kediri. Patient data were processed in anonymized form to maintain confidentiality, with all identifiable information (names, addresses) removed. Only diabetes-related health data such as laboratory results, examination history, and consultation records were used for analysis and system design. The study complied with the Ministry of Health Regulation No. 24 of 2022 on Electronic Medical Records and adhered to general principles of data protection and research ethics to ensure information security and integrity throughout the study.

The next phase was requirement analysis, where both functional and non-functional needs of the system were identified. Functional requirements consisted of modules for patient registration, electronic health records, medication reminders, activity monitoring, dietary logs, and communication between doctors and patients. Non-functional requirements focused on performance, security, and usability to ensure that the platform operates reliably and remains accessible to its users.

In the design stage, system architecture and the user interface (UI) were developed. The architecture was structured using the client–server model, enabling the integration of both mobile and web platforms. System diagrams were produced with Draw.io, while the user interface mockups were designed in Figma to visualize the application layout and interaction flow.

Prototype development employed Flutter as the primary framework, with Firebase providing the backend services. Firebase Firestore acted as the main database, Firebase Authentication supported user account management, and Firebase Cloud Messaging enabled notifications. Additionally, Firebase Storage handled document and image uploads. Development activities were conducted using Visual Studio Code as the integrated development environment (IDE), and Google Chrome was chosen as the main testing browser.

For system validation, black-box testing was applied. This testing method focuses on verifying system outputs against inputs without evaluating the internal code [10][11]. Core features assessed included patient record entry, reminder notifications, consultation messaging, and activity tracking. The system was deemed valid if it met the specified requirements, and reliable if consistent outcomes were observed across multiple testing sessions.

Finally, system refinement was carried out by improving the prototype according to test results and user feedback. These refinements led to the completion of a finalized version of the application that was more stable and aligned with user needs.

3. Result and Discussions

Initial Condition of the Clinic System

At Klinik Pratama Bandar Lor Kediri, diabetes management was initially carried out in a manual manner. Patients relied on handwritten notes to record their blood glucose levels, HbA1c, water consumption, and daily physical activities. This approach made it difficult for both patients and healthcare providers to consistently track progress. Moreover, the lack of an automated reminder feature often caused patients to neglect recording their health data or forget scheduled medication. Doctor consultations were limited to face-to-face meetings, and laboratory results were still documented in paper form, which complicated data retrieval when required. These shortcomings slowed down timely medical intervention and ultimately reduced the effectiveness of patient care.

To overcome these challenges, this study introduces the DiaCare Application, a web- and mobile-based system specifically designed to assist in diabetes management. The platform integrates a variety of essential features, including digital health record logging, medication reminders, online consultation services, electronic laboratory result management, and a nutrition module that estimates daily calorie needs while offering healthy menu suggestions. All information is stored securely in a centralized database and made available in real time to both patients and healthcare providers. Through the clinic's dashboard, doctors are able to monitor patient conditions using graphical visualizations and deliver timely advice or treatment adjustments whenever signs of deterioration are detected, thereby enhancing the overall quality of care.

Effectiveness of DiaCare Application

The implementation of the DiaCare application has significantly enhanced the management of patient data at Klinik Pratama Bandar Lor Kediri. In the past, diabetic patients relied on manual recording of their health information, which made long-term monitoring less effective and often caused delays or missed medication schedules. With the adoption of DiaCare, patients are now able to log blood glucose, HbA1c, and physical activity digitally, while doctors can directly access this data in real time through an integrated clinical dashboard. The system's medication reminder feature also supports patients in maintaining better adherence to their treatment plans. According to feedback from clinic staff, DiaCare not only accelerates access to laboratory results but also strengthens communication between patients and healthcare providers, ultimately resulting in more efficient and effective diabetes management.

System Design and Architecture

The system architecture of the diabetes patient management application adopts a client–server model that seamlessly integrates both web and mobile platforms. It is organized into three main layers. The first is the user layer, which involves patients, doctors, and administrators as the primary stakeholders. The second is the application layer (frontend), providing user interfaces through mobile applications for patients and web-based dashboards for doctors and administrators. Lastly, the server–database layer (backend) is responsible for processing, storing, and synchronizing data. This layered design supports secure data handling, real-time information exchange, and role-based access control, ensuring that monitoring, consultation, and administrative tasks for diabetes management can be carried out effectively and efficiently.

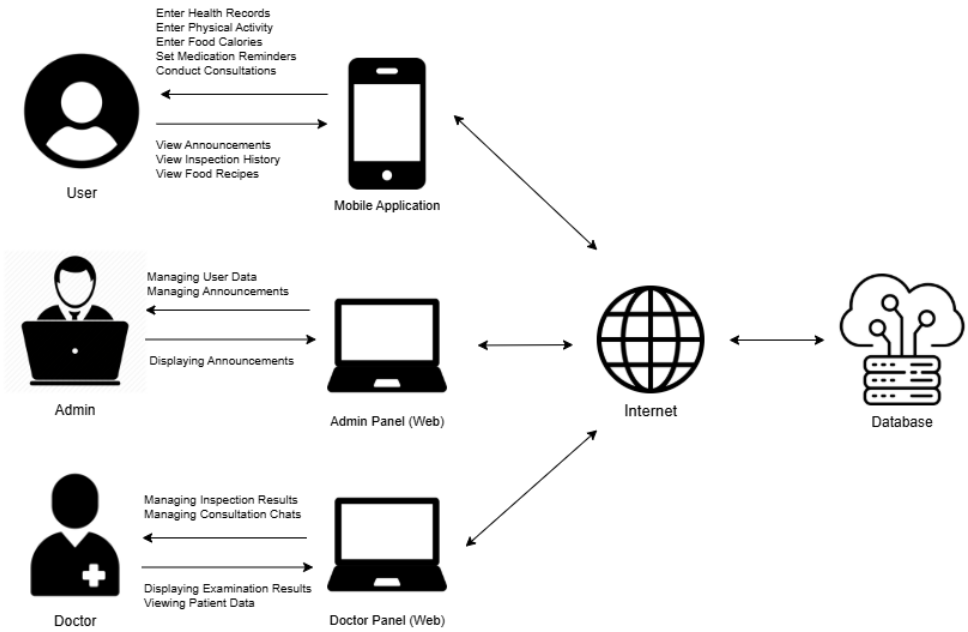

Figure 2. Architectural Models

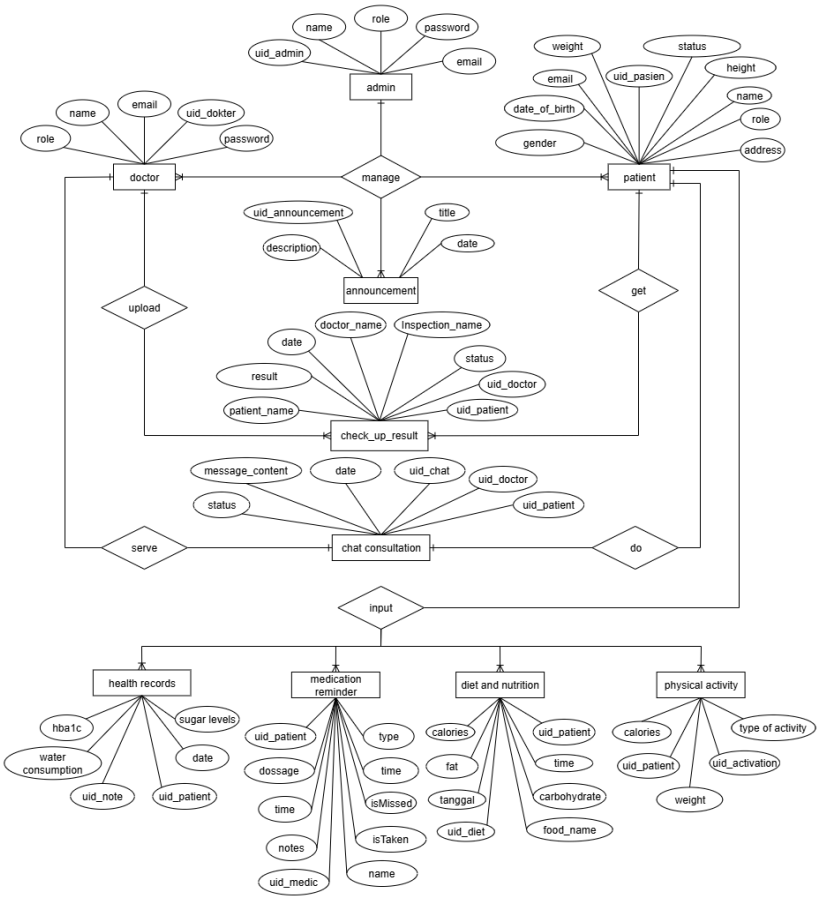

Figure 3. ERD Database system

The Entity Relationship Diagram (ERD) consists of twelve entities, including Admin, Doctor, Patient, Announcement, Examination Result, Consultation, Health Record, Medication Reminder, Diet and Nutrition, and Physical Activity. The Patient entity serves as the central hub, connected to key medical data such as glucose levels, HbA1c, water intake, diet, and activities. Meanwhile, the Doctor manages consultations and examination results, and the Admin oversees announcements and user accounts. This integrated structure enables secure, real-time access to patient information and supports more effective diabetes management.

Table 1. Definition of System Actors

No	User	Detail
1	Admin	Admin is responsible for managing the system. The admin can register new doctors, validate accounts, manage user data, and publish clinic announcements
2	Doctor	Doctor acts as a healthcare provider in the system. The doctor can view patient health records, respond to consultation messages, monitor patient progress, and upload laboratory results.
3	Patient	Patient is the primary user of the mobile application. Patients can register, record daily health data (blood glucose, HbA1c, water intake, physical activity, diet & nutrition), set medication reminders, consult with doctors via chat, and access laboratory results digitally.

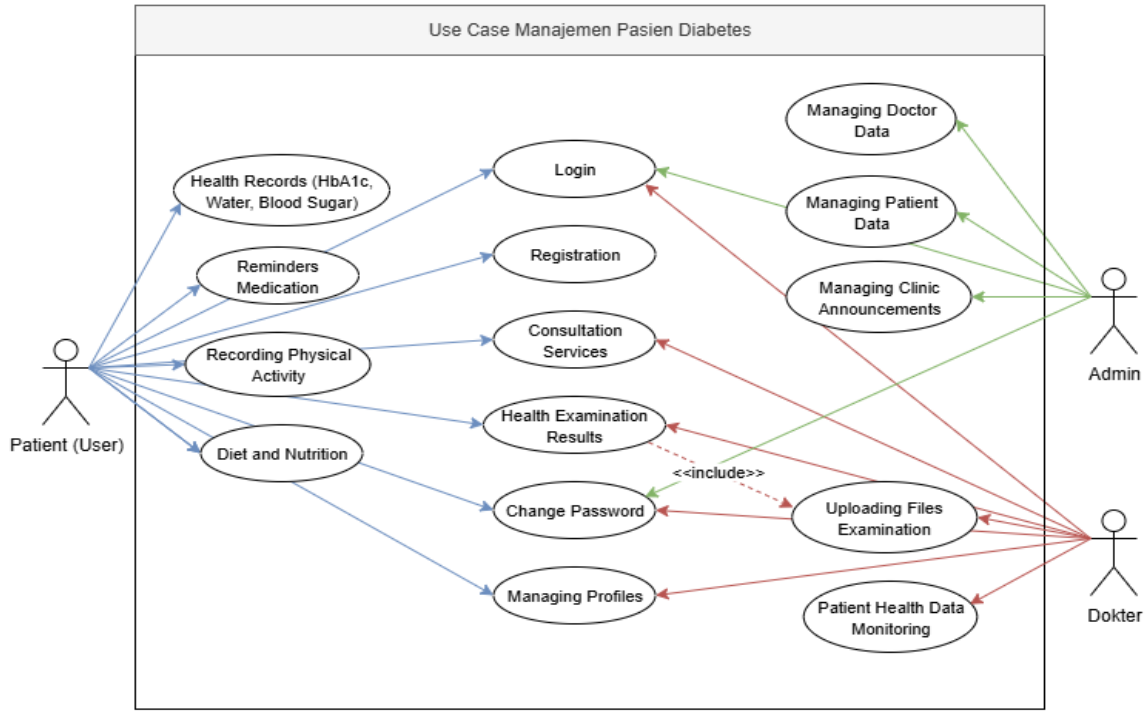

Figure 4. Use Case Diagram

This system includes several core features to support diabetes patient management. The Patient actor can access health records, record physical activity, manage diet and nutrition, receive medication reminders, perform registration and login, manage personal profiles, and access consultation services with doctors. The Admin actor is responsible for managing patient data, doctor data, and clinic announcements to ensure smooth system operation. The Doctor actor provides consultations, uploads examination results, and monitors patient health data to support timely medical interventions.

Application Features and Functionality

The system was developed with a comprehensive set of features to support diabetes management, including secure login, digital health record monitoring, medication reminders, physical activity tracking, dietary and nutrition management, online consultations, and electronic access to laboratory results. These capabilities enable patients to track their health conditions continuously while maintaining direct communication with healthcare providers. As a result, the application enhances accessibility, strengthens treatment adherence, and improves overall diabetes self-management compared to traditional paper-based approaches [12], [13].

Beyond improving access, the integration of clinical data and lifestyle management in a single platform allows for more personalized healthcare. By recording essential parameters such as blood glucose, HbA1c, dietary intake, and physical activity, the system produces a holistic health profile that can be jointly reviewed by patients and medical professionals. This design reflects the growing trend in digital health solutions, where multiple indicators are combined to provide more accurate, individualized, and patient-centered care [14]. In addition, the use of real-time digital records reduces the risk of information loss and ensures continuity of care, since health data remain consistently available for follow-up evaluations and medical decision-making [15].

Patient Features

Figures 5–12 present representative screens from the patient module of the DiaCare application. These interfaces collectively demonstrate how patients can securely access their accounts, record and visualize clinical parameters such as blood glucose, HbA1c, water intake, and physical activity, as well as manage medication reminders and dietary intake. The integrated consultation feature further enables real-time communication with doctors, while digital access to laboratory results ensures that patients can review their medical history anytime and anywhere. By combining clinical monitoring and lifestyle management in one platform, these features aim to improve treatment adherence, patient engagement, and the overall effectiveness of diabetes self-management, consistent with previous studies on mobile health implementations in Indonesia [5], [17].

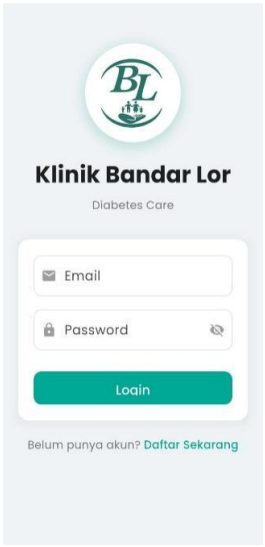

Figure 6. Login

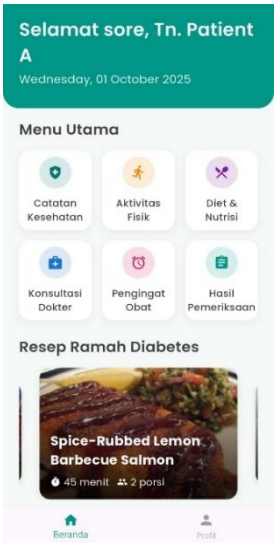

Figure 5. Home

Figure 7. Check Up Result

Figure 8. Reminder Medication

Figure 9. Physical Activity

Figure 10. Diet and Nutrition

Figure 11. Consultation

Figure 12. Health Records

Doctor Features

The Doctor Dashboard serves as a centralized platform that streamlines doctors' daily tasks by integrating all key features into one interface. Through this dashboard, doctors can upload and manage laboratory results via the "Kirim Hasil Pemeriksaan" menu, review previous records in "Riwayat Pemeriksaan", and monitor patients' health indicators such as glucose levels, HbA1c, and water intake in "Monitoring Pasien." The "Chat Konsultasi" feature facilitates real-time communication between doctors and patients, enabling timely consultations and follow-ups, while the "Pengaturan" menu allows account management and system customization.

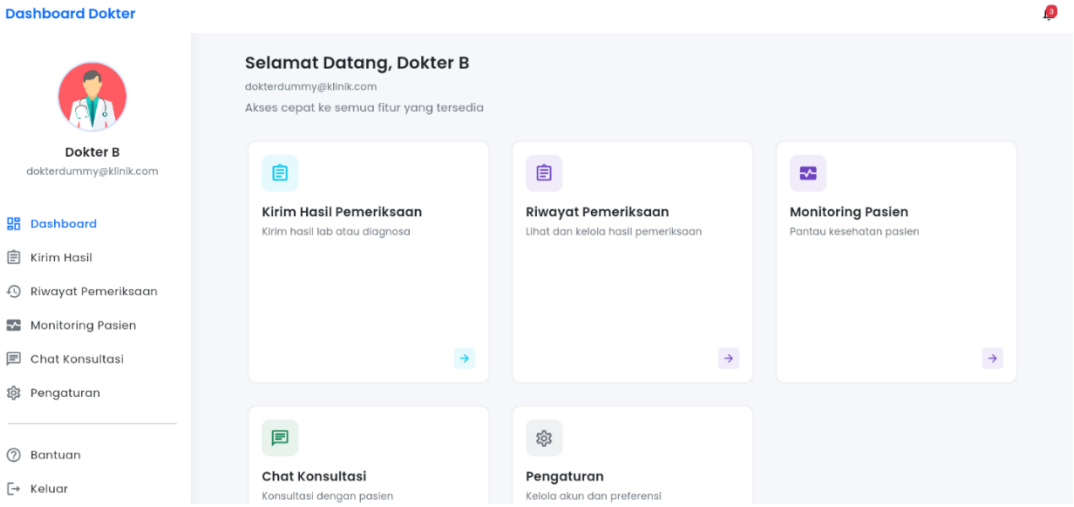

Figure 13. Dashboard Doctor Page

Admin Features

The Admin Dashboard acts as the main control center for managing the DiaCare system. Through this interface, administrators can register new doctors, publish announcements, and manage user data such as patients and doctors. It also provides system settings to control preferences and ensure platform security. With its simple and organized layout, the dashboard helps administrators oversee operations efficiently and maintain smooth coordination across all user roles.

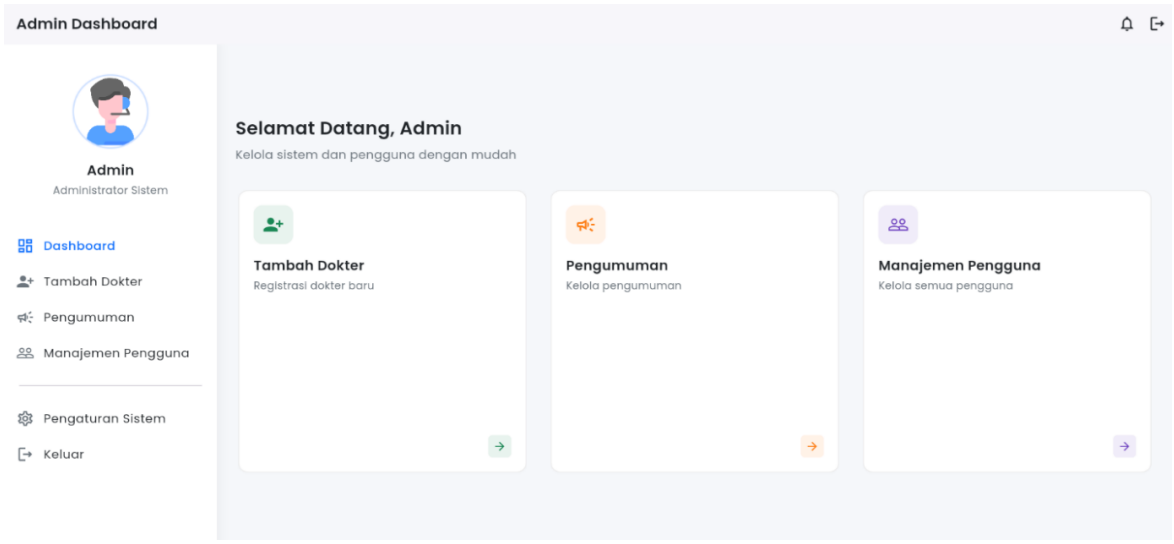

Figure 14. Dashboard Admin Page

System Testing Results

System testing was carried out using the black-box testing method to ensure that the application features function according to their expected behavior. The results of the testing are summarized in Table 2.

Table 2. Black-box Testing Results

No	Tested Feature	Expected Result	Actual Result	Status
1	Login	User can log in with valid credentials; error displayed for invalid input	Feature works as expected	Valid
2	User Registration	New patient account can be created and stored in database.	Feature works as expected	Valid
3	Health Record Input	Patient can input blood glucose, HbA1c, water intake, and activity	Feature works as expected	Valid
4	Medication Reminder	Notification triggered at scheduled time	Feature works as expected	Valid
5	Online Consultation Chat	Real-time exchange of messages between doctor and patient	Feature works as expected	Valid
6	Laboratory Results	Doctor uploads lab results; patient can access results digitally	Feature works as expected	Valid
7	Announcements	Admin can create announcements; patients can view them.	Feature works as expected	Valid
8	Physical Activity	Patient can input daily steps, and the system calculates calories burned automatically.	Feature works as expected	Valid
9	Diet & Nutrition	Patient can add food items or enter custom meals, and the system calculates total daily calorie intake	Feature works as expected	Valid

All test cases were successfully executed with outcomes matching the expected results. The overall success rate of the functional testing is 100%, indicating that the system meets its functional requirements and is ready for use. The black-box testing was conducted across multiple user roles (patient, doctor, and admin) and on various devices to ensure consistent behavior and reliability across platforms.

In comparison to other mHealth systems such as DIACOACH, which primarily focuses on glucose monitoring and virtual health coaching [8], DiaCare integrates a broader range of diabetes management features including electronic health records, medication reminders, nutritional tracking, and doctor consultations within a single ecosystem. This integrated approach provides more holistic and continuous support for both patients and healthcare providers.

From a performance standpoint, internal testing demonstrated that the DiaCare application operated efficiently, with an average page loading time of approximately 2.3 seconds based on multiple trials conducted across desktop and mobile environments. In terms of usability, informal feedback obtained from clinic staff during prototype evaluation indicated positive responses regarding system responsiveness, layout clarity, and ease of navigation. These findings suggest that the system provides a satisfactory level of performance and user experience, aligning with general usability standards for healthcare applications.

However, this study also has limitations. The system was implemented and tested only at a single clinic (Klinik Pratama Bandar Lor Kediri), with a relatively small number of users, and without formal stress or scalability testing on the server. Future research should expand user testing to multiple healthcare centers and include performance benchmarking under high-traffic conditions to further validate system robustness and usability.

4. Conlusions and Future Works

The DiaCare application, which integrates health record management, medication reminders, doctor consultations, activity tracking, dietary monitoring, and digital laboratory result delivery, has effectively addressed the primary challenges of diabetes care at Klinik Pratama Bandar Lor Kediri. Previously, patients relied on fragmented and manual methods, which often caused missed reminders and limited access to medical information. With DiaCare, both efficiency and accessibility have been enhanced: clinicians are able to monitor

patient health trends through dashboards for timely interventions, while patients benefit from structured reminders and centralized records. Results from black-box functional testing demonstrated that all features performed as expected, yielding a 100% validity rate. These outcomes confirm the system's reliability, usability, and practical potential in supporting diabetes management. Compared with earlier mobile health solutions that typically emphasized isolated features, DiaCare provides a more integrated platform by combining consultations, health tracking, and electronic medical records in a single system.

Future improvements of DiaCare may include integration with wearable devices, such as glucometers and fitness trackers, to enable automatic health data collection and reduce manual input [16]. The use of machine learning could also assist in detecting early signs of complications and providing personalized recommendations. Furthermore, broader usability testing with diverse participants and enhanced offline functionality are recommended to improve accessibility, especially in rural areas. Finally, interoperability with Indonesia's national health information systems should be explored to support scalability and alignment with the country's digital health transformation agenda [17].

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