# MOBILE HEALTH TECHNOLOGY FOR MONITORING AND MANAGING THE HEALTH OF PEOPLE WITH LUPUS (ODAPUS)

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**SUPERVISOR ENDORSEMENT PAGE**

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## THESIS

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Yogyakarta, December 24th, 2025

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# MOBILE HEALTH TECHNOLOGY FOR MONITORING AND MANAGING THE HEALTH OF PEOPLE WITH LUPUS (ODAPUS)

## THESIS

Has been defended in front of the examiners as one of the requirements to obtain a Bachelor of Informatics degree from the Undergraduate Program in Informatics at the Faculty of Industrial Technology, Universitas Islam Indonesia

Yogyakarta, January 9th, 2026

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Thus this statement letter is made, hopefully it can be used properly.

Yogyakarta, December 24th, 2025

( Diva Ivani Arista Pangastuti )

# DEDICATION

I extend my deepest gratitude and praise to Allah SWT, whose grace, mercy, and guidance have enabled me to complete this undergraduate thesis successfully. This work is wholeheartedly dedicated to my parents, whose unwavering support has been invaluable throughout this journey. Their endless prayers, encouragement, and unconditional love have been the foundation of my strength. I also honor myself for not giving up in the face of challenges, for continuing to believe in my ability, and for showing resilience until the very end. May this achievement be the beginning of a lifelong effort to make them proud and bring them happiness.

# MOTTO

"Sufficient for us is Allah, and He is the best Disposer of affairs."

(QS. Ali Imran: 173)

"The best Protector and the best Helper."

(QS. Al-Anfal: 40)

"Technology is best when it brings people together and improves lives." — Matt Mullenweg

# FOREWORD

*Bismillahirrahmanirrahim, Assalamu'alaikum Warahmatullahi Wabarakatuh.*

*Alhamdulillahirabbil'alamin*. All praise be to Allah SWT for His abundant mercy, guidance, and enlightenment, through which the writing of this undergraduate thesis, entitled "Mobile Health Technology for Monitoring and Managing the Health of People with Lupus (ODAPUS)", has been made possible. This thesis is submitted as one of the requirements for graduation from the Informatics Department, Faculty of Industrial Technology, Universitas Islam Indonesia. The journey of completing this thesis was not without its challenges. However, with the support of many individuals, along with hard work and dedication, the author was able to complete it successfully. On this occasion, the author would like to express sincere gratitude to the following parties:

1. Allah SWT, the Almighty God, for His endless grace and guidance throughout this journey.
2. My beloved parents, for their constant prayers, moral support, and unwavering encouragement in every step I take during the process of writing this thesis.
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5. All members of my family: Mbak Puri, Nandya, Mas To'o, Mas Inu, Sabrina, Jennah, and Shanum, as well as all other extended family members who cannot be mentioned individually, who have provided prayers and support throughout my thesis work and my entire academic journey.
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12. Yayasan Sahabat Cempluk and all ODAPUS respondents who have been willing to participate in this research, for their time, cooperation, and valuable contributions that made this study possible.

The author realizes that this thesis is still far from perfect and contains several shortcomings. Constructive feedback and suggestions for improvement are genuinely welcomed. Hopefully, this undergraduate thesis can contribute meaningfully to the development and implementation of mobile health technology for lupus management.

Yogyakarta, December 24th, 2025

( Diva Ivani Arista Pangastuti)

# ABSTRACT

Systemic Lupus Erythematosus (SLE) is a chronic autoimmune disease requiring continuous monitoring for effective management. In Indonesia, approximately 1.7% of the adult population suffers from SLE, facing challenges such as limited access to specialists, high healthcare costs, and geographical barriers. Existing mobile health (mHealth) applications for SLE remain limited in quality, with average scores of only 2.3-2.7 out of 5 on the Mobile App Rating Scale (MARS). Currently, there is no comprehensively developed and empirically tested mHealth application specifically designed for Indonesian ODAPUS (People with Lupus) that considers the local context.

This research employed a prototyping approach involving ODAPUS from the early development stages. Data collection was conducted through two Focus Group Discussions (FGDs) with 10 ODAPUS from Sahabat Cempluk Foundation and a user needs questionnaire involving 22 respondents. The LUFY (Lupus Fighter Diary) application was developed for Android using Kotlin and Firebase Realtime Database, featuring daily health recording, medication reminders, rule-based flare screening, routine check-up reminders, and SLE educational content. Usability evaluation was conducted using the System Usability Scale (SUS) with 10 respondents.

Research results demonstrate successful development of the LUFY application with five main features aligned with ODAPUS needs. The rule-based flare screening algorithm analyzes symptom combinations through five hierarchical priority levels. Usability evaluation yielded an average SUS score of 88.75 out of 100 ("Excellent" category), significantly exceeding the digital health application benchmark of 68 (SD 12.5). High scores were obtained in ease of use (96% agreed, scale 4-5), low complexity (87% disagreed with complexity, scale 1-2), good feature integration (96% agreed), and high consistency (86% disagreed with inconsistency). These results indicate that the participatory approach successfully produced a user-friendly application meeting Indonesian ODAPUS needs.

Keywords: Systemic Lupus Erythematosus, mobile health, self-management, flare screening, usability, System Usability Scale

# GLOSSARY

| | |
|---|---|
| Flare | A period of exacerbation or increased lupus disease activity characterized by the emergence of acute symptoms or worsening of existing symptoms. |
| mHealth | Mobile Health, medical and public health practices supported by mobile devices such as smartphones and tablets. |
| ODAPUS | Orang Dengan Lupus (People with Lupus), an Indonesian term used to refer to lupus patients or individuals living with lupus. |
| Prototyping | A software development method that produces an initial representation of a system before full-scale development, involving iteration and user feedback. |
| Remission | A period with minimal lupus disease activity or absence of active symptoms. |
| Self-management | An individual's ability to manage disease symptoms, treatment, physical and psychological impacts, and lifestyle adjustments associated with chronic conditions. |
| SLE | Systemic Lupus Erythematosus, a chronic systemic autoimmune disease characterized by autoantibody production and multi-organ inflammation. |
| SUS | System Usability Scale, a usability evaluation instrument consisting of 10 statements to measure the usability level of a system based on user perceptions. |

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# CHAPTER I
# INTRODUCTION

## 1.1 Background

Systemic Lupus Erythematosus (SLE) is a chronic systemic autoimmune disease characterized by the production of autoantibodies, deposition of immune complexes, and multi-organ inflammation that can lead to tissue and organ damage (Hoi et al., 2024). The term "systemic" indicates that this disease can affect multiple organ systems simultaneously or sequentially (Muhammad et al., 2021). Research by Tian et al., (2022), indicate that the disease predominantly affects Fanouriakis women of reproductive age, resulting in significant physical, psychological, and social burdens that can negatively impact patients' quality of life and daily functioning.

Globally, SLE is recognized as a major public health concern. Recent studies estimate that approximately 3.41 million people worldwide live with SLE, with a global prevalence of around 43.7 per 100,000 individuals. The prevalence among adult females is substantially higher, reaching approximately 78.73 per 100,000, while among males it remains significantly lower at 9.26 per 100,000. Indonesia has one of the largest female SLE populations in Asia, with approximately 131,214 women affected by the disease (Tian et al., 2022).

In Indonesia, comprehensive national epidemiological data on SLE remain limited. A large-scale retrospective cohort study from the Hasan Sadikin Lupus Registry in Bandung, encompassing 1,263 SLE patients from 2001 to 2020, reported a mortality rate of 9.9%, with infection accounting for 40.8% of all deaths. The 1-, 5-, and 10-year survival rates among Indonesian SLE patients were 95.6%, 89.7%, and 82.1%, respectively. The Indonesian Ministry of Health estimates that approximately 1.7% of the adult population may be affected by lupus, translating to tens of thousands of patients nationwide (Prisie, 2024). Additionally, 10.2% of Indonesian SLE patients develop tuberculosis, highlighting the infectious disease burden in this immunosuppressed population (Hamijoyo et al., 2022).

Effective management of SLE requires continuous symptom monitoring, strict medication adherence, early detection of flare-ups, and adequate patient education, as emphasized by international clinical guidelines (Fanouriakis et al., 2023). However, many people with lupus (ODAPUS) face significant difficulties in managing their condition daily due to limited access to rheumatologists, frequent hospital visits, high healthcare costs, and geographical barriers

(Moulaei et al., 2022). These challenges are particularly pronounced in developing countries like Indonesia, where healthcare infrastructure may be unevenly distributed. As a result, patients may experience delayed treatment adjustments and increased risk of serious complications.

The rapid advancement of digital health technologies has introduced mobile health (mHealth) applications as a promising approach to support self-management in chronic diseases (Debon et al., 2019). Several studies have shown that well-designed mHealth interventions can improve medication adherence, enhance symptom awareness, and increase patient engagement in self-care (Kim et al., 2025).

Despite their potential benefits, existing mobile health applications for SLE patients remain limited in quality and functionality. A 2020 systematic review found that lupus-focused apps scored a mean of only 2.3 out of 5 on the Mobile App Rating Scale (MARS), indicating poor overall quality (Dantas et al., 2020). A subsequent 2022 critical appraisal showed modest improvement but still reported average scores of only 2.7 out of 5, below acceptable standards for clinical health applications (Ramasamy et al., 2022). Common issues identified include complex navigation, poor visual design, lack of personalization, and inadequate cultural adaptation. Usability assessments of mHealth apps in developing countries have revealed similar problems such as complex navigation, poor aesthetics, and lack of culturally relevant content (Islam et al., 2020).

In the Indonesian context, there is currently no fully developed and empirically tested mobile health application specifically designed for ODAPUS. Existing digital health solutions are generally limited to generic medication reminders or basic health diaries that do not comprehensively support systematic symptom tracking, early flare-up detection, or disease-specific education. Furthermore, international lupus apps are not available in Indonesian language or do not consider the local healthcare context, including the high tuberculosis co-infection rate, limiting their relevance for Indonesian patients.

Therefore, this research aims to develop a mobile health application specifically designed for Indonesian ODAPUS to support daily symptom monitoring, medication management with reminders, educational resources, and flare-up screening tools. The developed application will be evaluated using the System Usability Scale (SUS), a standardized usability assessment instrument with an established benchmark score of 68 (SD 12.5) for digital health applications (Hyzy et al., 2022). Through this development and evaluation process, this research seeks to

provide Indonesian lupus patients with an effective digital tool to enhance their self-management capabilities and improve health outcomes.

## 1.2 Problem Statement

The problem statements of this research are as follows:

a. How can a mobile health (mHealth) application be designed and developed to support self-management of Systemic Lupus Erythematosus (SLE) for people with lupus (ODAPUS) in Indonesia?
b. Does the developed mHealth application demonstrate good usability based on evaluation using the System Usability Scale (SUS)?

## 1.3 Research Scopes

The scopes of this research are as follows:

a. The mobile health (mHealth) application developed in this research is intended specifically to support self-management of Systemic Lupus Erythematosus (SLE) for people with lupus (ODAPUS) in Indonesia.
b. The mHealth application focuses on core self-management features, including daily symptom monitoring, medication management with reminders, educational content related to SLE, and flare-up screening.
c. The mHealth application is developed for use by patients (ODAPUS) only and does not include features for healthcare providers or clinical decision-making.
d. The evaluation of the developed mHealth application is limited to usability testing using the System Usability Scale (SUS).
e. The application functions as a self-management support tool and is not intended to replace professional medical consultation or clinical diagnosis.

## 1.4 Research Objectives

The objectives of this research are:

a. To design and develop a mobile health (mHealth) application that can effectively assist ODAPUS in monitoring daily symptoms, managing medication, performing self-administered flare screening, and accessing educational information related to SLE.
b. To evaluate the usability of the developed mHealth application using the System Usability Scale (SUS).

## 1.5 Benefits of Research

The benefits of this research are:

a. Providing a mobile health (mHealth) application that facilitates people with lupus (ODAPUS) in monitoring their health condition and managing Systemic Lupus Erythematosus (SLE) more effectively.
b. Supporting ODAPUS in improving self-management practices by providing accessible symptom tracking, medication management, and educational information related to SLE.

## 1.6 Writing Systematics

The structure of this thesis consists of six chapters, organized as follows:

a. CHAPTER I: INTRODUCTION

   This chapter presents the background of the research, problem formulation, research scope, research objectives, research benefits, and the writing systematics.
b. CHAPTER II: LITERATURE REVIEW

   This chapter discusses the theoretical foundations related to Systemic Lupus Erythematosus (SLE), mobile health (mHealth) applications, self-management in chronic diseases, prototyping method, usability concepts, technology stack, and related previous studies.
c. CHAPTER III: RESEARCH METHODOLOGY

   This chapter explains the research methods in detail, including research subjects and location, data collection techniques through Focus Group Discussions and questionnaires, the prototyping approach, usability testing procedures, and research stages.
d. CHAPTER IV: RESULTS AND DISCUSSION

   This chapter presents the development results of the LUFY application through two iterations, including communication with users, system design, database and UML modeling, application implementation with technical details, usability testing results using the System Usability Scale (SUS), and comprehensive discussion covering research objective achievement, design evolution, research strengths and limitations.
e. CHAPTER V: CONCLUSION AND RECOMMENDATIONS

This chapter contains conclusions drawn from the research results and recommendations for future research and system development.

# CHAPTER II
# LITERATURE REVIEW

## 2.1 Literature review

### 2.1.1 Comparison of Previous Studies Related to mHealth Applications for SLE

Previous research serves as the foundation for this study by providing data support and identifying areas for improvement. In this literature review, 6 peer-reviewed journal articles were obtained focusing on mobile health (mHealth) application development for self-management of Systemic Lupus Erythematosus (SLE) and chronic diseases.

The literature review process used PubMed as the primary database with the keyword " mobile health applications development for self management". The review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework with the following inclusion criteria applied: (1) published between 2020-2025, (2) full-text journal articles in English, (3) topics related to mHealth applications development for self-management of SLE, and (4) studies discussing usability evaluation or patient-centered design approaches.

Data collection was conducted according to the PRISMA diagram consisting of identification, screening, eligibility, and included stages. The PRISMA diagram can be seen in Figure 2.1.

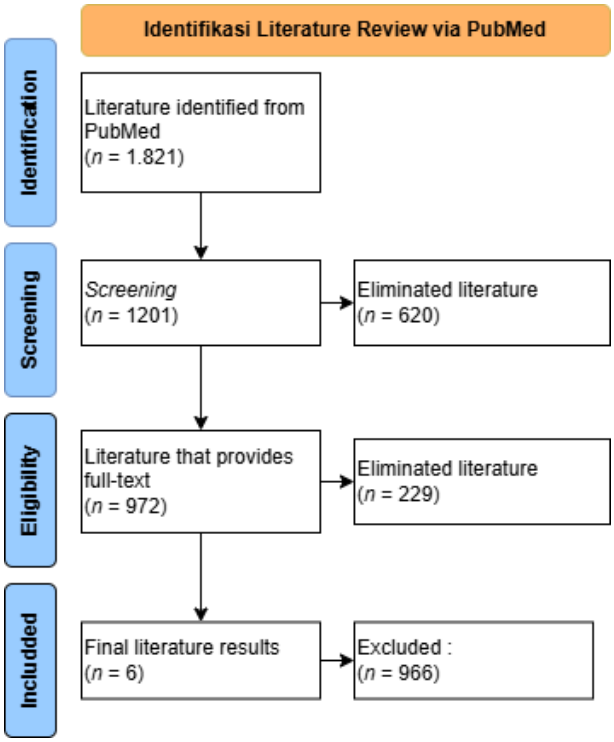



Figure 2. 1 PRISMA diagram

1. Identification

   At this stage, literature was identified using PubMed with the keyword "mobile health applications development for self management". This stage yielded 1.821 articles.

2. Screening

   At this stage, literature was eliminated based on the requirement that journal titles contain the keyword "mobile health applications development for self management" within the 2020–2025 publication range. This stage resulted in 1.201 articles.

3. Eligibility

   This stage selected data eligibility by choosing full-text literature. A total of 972 articles were obtained.

4. Included

   The final stage resulted in 6 articles considered the most relevant, valid, and appropriate for analysis in this literature review.

The six articles that passed the final selection in the PRISMA diagram were then analyzed and compared in Table Literature Review below. This table presents important information from each study, including publication year, methodology, problem domain, application features, and testing methods to identify trends and research gaps related to mobile application development for ODAPUS.

Table 2.1 Comparison with Related Research on Self-Management Application Development

| No. | Researcher | Methodology | Problem Domain | Fiture | Testing |
|---|---|---|---|---|---|
| 1. | Dantas et al. (2020) | Not detailed | Evaluation of the Use of mHealth Technology in SLE Management | Review of Available Applications:<br>a. Symptom monitoring<br>b. Medication reminders<br>c. Facilitating communication with healthcare providers | Identification of Usability and Long-Term Engagement Challenges |
| 2. | Ramasamy et al. (2022) | Not detailed | Critical Assessment of mHealth Applications for SLE and Lupus Nephritis | Review of Available Applications:<br>a. Medical record storage<br>b. Medication reminders<br>c. Self-management tips<br>d. Education information | Evaluation of Features |
| 3. | Bell et al. (2021) | Not Detailed | Collecting and Validating Patient-Reported Outcomes (PROs) Using Mobile Applications for SLE Patients | a. Symptom and outcome tracking<br>b. Reminders<br>c. Patient input features<br>d. Integration with medcal systems | a. Patient compliance assessment in reporting<br>b. Demonstration of improved adherence |

| | | | | | |
|---|---|---|---|---|---|
| 4. | Leung et al. (2021) | Stakeholder meetings + clickable prototype development | Development of digital toolkit to improve quality of life for SLE patients | a. Educational modules<br>b. Self-assessment tools<br>c. Wellness tracking<br>d. Goal setting features-Resources and support | a. Alpha usability testing (n=6)<br>b. Beta usability testing (n=9 with SLE patients/providers/advocates)<br>c. Semi-structured interviews |
| 5. | Guardino et al. (2024) | Participatory design with multi-stakeholder engagement meetings | Patient and caregiver recommendations for mobile health app for pediatric SLE | a. Symptom tracking<br>b. Medication management<br>c. Appointment reminders | a. Focus group discussions<br>b. Multi-stakeholder engagement (patients, caregivers, clinicians) |

| | | | | | |
|---|---|---|---|---|---|
| 6. | Deck et al. (2025) | Human-Centered Design (HCD) with behavior change theory integration | Theory-based mHealth app for fatigue management in SLE | a. Symptom Tracking<br>b. Reminder<br>c. Educational Content<br>d. Social Network | a. Two rounds of focus groups (n=12 SLE patients)<br>b. Likert scale ratings for feature importance |

Based on Table 2.1, it can be identified that most previous studies:

1. Did not develop a fully functional mHealth application.
2. Focused on specific aspects of disease management, such as health education, patient condition reporting, or fatigue management.

In addition, the majority of these studies were conducted in Western countries; therefore, cultural context and healthcare systems in developing countries have not been extensively discussed.

### 2.1.2 Comparison of Available Mobile Health Applications for SLE

In addition to academic research, several mHealth applications for SLE have been made available, either commercially or as research prototypes. Table 2.2 presents a comparison of the main features of these applications.

Table 2.2 Comparison of Mobile Health Applications for SLE

| Feature | My Lupus Log | Lupus journey | Lupusku |
|---|---|---|---|
| Language | English | English | Indonesian |
| Daily Diary | Yes | no | Yes |

| | | | |
|---|---|---|---|
| Medication Reminder | Yes | no | Yes |
| Routine Control Reminders | No | no | No |
| Flare Screening | No | Yes | No |
| Educational Content | Yes | No | Yes |
| Photo Documentation | No | Yes | Yes |
| Target User | ODAPUS | ODAPUS | Children with Lupus |

Based on Table 2.2, the available applications generally provide basic features such as symptom tracking and medication reminders. However, several limitations remain, including:

a. Daily symptom monitoring is not yet comprehensive.
b. Application interfaces that predominantly use the English language.

### 2.1.3 Research Gaps

Based on the review of existing studies and applications, several research gaps can be identified as follows:

a. Limited research that documents the development process of mHealth applications to comprehensively support self-management for SLE patients.
b. A lack of studies adapting SLE mHealth applications to local cultural and language contexts, particularly in developing countries.
c. Insufficient integration of comprehensive self-management features within a single application platform.

These gaps indicate that there are still opportunities for further research in developing mHealth applications that can more optimally support SLE patient self-management and better align with user needs.

## 2.2 Lupus

### 2.2.1 Definition of Lupus

Lupus is a chronic inflammatory autoimmune disease characterized by a loss of immune self-tolerance, leading to the production of autoantibodies and immune complex formation that can damage healthy tissues. The heterogeneity of clinical presentations and the relapsing–

remitting nature of the disease require long-term management and continuous monitoring to prevent organ damage and improve patient outcomes (Maidhof & Hilas, 2012).

### 2.2.2 Types of Lupus

Lupus erythematosus is divided into several types based on clinical manifestations and the organs involved. Systemic lupus erythematosus (SLE) is a multisystem chronic autoimmune disease with a relapsing and remitting course, with prevalence higher in women of childbearing age, with a female predominance of 9:1 (Ameer et al., 2022). Cutaneous lupus erythematosus (CLE) presents as an exclusive cutaneous disease or comprises one of the multiple manifestations of systemic LE, subdivided into three main subtypes - acute CLE (ACLE), subacute CLE (SCLE) and chronic CLE (CCLE) (Siviero Do Vale & Garcia, 2023). Drug-induced lupus erythematosus (DILE) is a lupus-like syndrome temporally related to continuous drug exposure which resolves upon drug discontinuation ((Vedove et al., 2012), while Neonatal lupus erythematosus (NLE) is a rare acquired autoimmune disease linked to organ damage from maternal autoantibodies crossing the placenta to the foetus (Sun et al., 2025). This study focuses on SLE because it has the most complex clinical manifestations with multisystem involvement and requires continuous monitoring.

### 2.2.3 Systemic Lupus Erythematosus (SLE)

Systemic Lupus Erythematosus (SLE) is a chronic systemic autoimmune disease characterized by the production of autoantibodies, deposition of immune complexes, and multi-organ inflammation that can lead to tissue and organ damage (Hoi et al., 2024). The term "systemic" indicates that this disease can affect multiple organ systems simultaneously or sequentially (Muhammad et al., 2021).

The clinical manifestations of Systemic Lupus Erythematosus (SLE) are highly variable and may change over time, with common symptoms including fatigue, fever of unknown origin, joint pain and inflammation, as well as skin abnormalities such as malar rash and photosensitivity (Vaillant et al., 2023). SLE may also involve vital organs such as the kidneys (lupus nephritis), the cardiopulmonary system, the nervous system, and cause hematological abnormalities (Li et al., 2025). The variability of symptoms and differing levels of severity among patients indicate the need for an individualized and continuous monitoring approach in SLE management (Sjöwall & Parodis, 2022).

SLE is characterized by a disease course marked by flares and remission. A flare is an increase in disease activity that requires therapeutic adjustment, whereas remission is a period

with minimal or no disease activity. Flares can range from mild to severe and may potentially cause organ damage if not detected early (Adamichou & Bertsias, 2017).

### 2.2.4 Disease Activity Assessment in SLE

Systemic Lupus Erythematosus Disease Activity Index 2000 (SLEDAI-2K) is one of the most widely used and validated instruments for assessing disease activity in patients with systemic lupus erythematosus (SLE). The SLEDAI-2K focuses on objective clinical and laboratory manifestations across multiple organ systems, including mucocutaneous involvement (e.g., rash), musculoskeletal manifestations (arthritis/joint pain), renal abnormalities (e.g., hematuria or urinary abnormalities), serositis, fever, and selected neurological symptoms (Gladman et al., 2002). Therefore, core symptoms used in the flare screening rules of this study are conceptually aligned with the clinical domains assessed in the SLEDAI-2K.

Not all clinically relevant symptoms experienced by patients with SLE are included as direct items in the SLEDAI-2K. Symptoms such as fatigue, although not part of the SLEDAI-2K scoring system, are widely recognized in the literature as key patient-reported outcomes (PROs) that reflect disease burden and impact quality of life. Previous studies have consistently shown that fatigue is highly prevalent among SLE patients and is significantly associated with disease activity and healthcare utilization (Touma et al., 2024). The use of fatigue in this study's flare screening rules is therefore theoretically grounded in the PRO framework, which emphasizes the importance of patient-reported symptoms for self-management and early risk awareness, rather than as a substitute for physician-based clinical assessment.

In clinical practice, manifestations of systemic lupus erythematosus are commonly stratified based on their potential to indicate vital organ involvement and the urgency of medical intervention. Symptoms related to renal and cardiopulmonary involvement are generally associated with more severe disease activity and higher risk of complications, thus requiring prompt medical evaluation (Gladman et al., 2002). In contrast, non-organ-threatening symptoms may reflect mild to moderate disease activity, particularly when occurring in combination, and are often managed through closer monitoring and outpatient consultation. This stratified approach aligns with self-care management principles, where patients are encouraged to recognize symptom patterns and seek appropriate levels of care (Lorig & Holman, 2003). Based on this framework, symptom severity and symptom combination provide a theoretical basis for developing simplified flare screening rules to support patient self-management.

## 2.3 Mobile Health (m-Health)

Mobile Health (m-Health) is defined by the World Health Organization (WHO) as medical and public health practices supported by mobile devices such as smartphones, tablets, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices (Najm et al., 2019). m-Health is a part of digital health that specifically utilizes mobile and wireless communication technologies to enhance healthcare accessibility and quality (Leong et al., 2022). The concept of m-Health was first introduced in 2003 and defined as emerging mobile computing technology, medical sensors, and communication technology for healthcare, with three fundamental technological pillars: computing (such as AI, cloud, big data), communication systems (such as 5G, IoT), and sensors (such as body area networks, tactile) (Alanzi et al., 2024).

## 2.4 Self-Management Support in Chronic Diseases

Self-management in the context of chronic diseases is defined as an individual's ability to manage disease symptoms, treatment, physical and psychological impacts, as well as lifestyle adjustments related to chronic conditions (Allegrante et al., 2019). Self-management encompasses not only medication adherence but also active patient involvement in monitoring health conditions and making appropriate decisions regarding disease management (Chan, 2021). According to Allegrante et al. (2019), self-management involves three separate yet interrelated sets of tasks: medical or behavioral management (symptom management and medication adherence), role management (adjustment of roles in daily life), and emotional management (coping with the psychological impacts of chronic disease). In chronic diseases with unstable characteristics, self-management becomes increasingly critical as patients need to continuously adjust their health management strategies according to changes in disease conditions (Fracso et al., 2022). Self-management support represents systematic efforts to help patients develop the knowledge, skills, and confidence necessary for effective disease management (Chan, 2021). Several key components form comprehensive self-management support. Patient education plays a fundamental role in enhancing understanding of the disease, symptoms, treatment options, and potential complications, thus enabling patients to recognize their body's condition and make appropriate health-related decisions (Fracso et al., 2022).

## 2.5 Prototyping Method

The prototyping method is a software development method used to produce an initial representation of a system before full-scale development. This method allows developers and users to interact directly through a prototype, enabling system requirements to be understood more clearly from the early stages of development.

According to Pressman (2010), the prototyping method is used when users are only able to define general system objectives but cannot yet specify system requirements in detail. Through prototypes, users can provide feedback on the designed system, allowing developers to make improvements and adjustments according to user needs. The prototyping method has several main stages, namely:

a. Communication

   This stage involves communication between developers and users to identify problems, determine system objectives, and explore initial requirements for the system to be developed.

b. Quick Plan and Modeling / Quick Design

   At this stage, initial system planning and design are carried out based on the results of prior communication. The design focuses on the user interface and system flow that can be easily understood by users.

c. Construction of Prototype

   This stage involves building the prototype based on the initial design. The prototype represents the system to be developed and is used as an evaluation medium by users.

d. Deployment, Delivery, and Feedback

   The completed prototype is delivered to users for testing and evaluation. Feedback obtained from users is used as a basis for system improvement and further development.

The prototyping method is iterative, allowing these stages to be repeated until the developed system meets user needs. This method is chosen because it can minimize design errors and improve system alignment with user requirements.

## 2.6 Usability Evaluation of mHealth Applications

### 2.6.1 Usability Concept

Usability is defined as the extent to which a product can be used by specified users to achieve specified goals effectively, efficiently, and with satisfaction in a specified context of use (Johnson et al., 2020). In mobile health (mHealth) applications, good usability is essential

because applications with low usability can cause user confusion and reduced adherence to self-management, while high usability enhances user engagement and supports successful health monitoring (Hach et al., 2024). Therefore, usability evaluation is critical to ensure that developed applications match the needs and capabilities of target users, particularly in health applications where ease of use directly impacts patient adherence to self-management activities.

### 2.6.2 System Usability Scale (SUS)

The System Usability Scale (SUS) is a widely adopted usability evaluation instrument developed by John Brooke in 1986 to measure system usability based on user perceptions (Brooke, 1996). SUS is extensively used across various domains, including mobile health applications, due to its simplicity, rapid administration, reliability, and ability to provide valid results with relatively small sample sizes (Bangor et al., 2009; Peres et al., 2013). SUS consists of 10 statements representing user perceptions of the system, with each statement answered using a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The statements alternate between positive and negative formulations to reduce respondent bias and improve measurement accuracy (Lewis & Sauro, 2021). The ten statements in the System Usability Scale are as follows:

1. I think that I would like to use this system frequently
2. I found the system unnecessarily complex
3. I thought the system was easy to use
4. I think that I would need the support of a technical person to be able to use this system
5. I found the various functions in this system were well integrated
6. I thought there was too much inconsistency in this system
7. I would imagine that most people would learn to use this system very quickly
8. I found the system very cumbersome to use
9. I felt very confident using the system
10. I needed to learn a lot of things before I could get going with this system

These statements are structured to capture multiple dimensions of usability, including learnability, efficiency, memorability, errors, and satisfaction (Brooke, 1996). The calculation of the SUS score follows a standardized procedure (Brooke, 1996; Lewis & Sauro, 2018):

1. For odd-numbered statements (1, 3, 5, 7, 9), calculate the contribution score by subtracting 1 from the respondent's answer value:

Score = Response value - 1

2. For even-numbered statements (2, 4, 6, 8, 10), calculate the contribution score by subtracting the respondent's answer value from 5:
   Score = 5 - Response value
3. Sum all ten contribution scores to obtain a total score ranging from 0 to 40.
4. Multiply the total by 2.5 to convert it to a scale of 0 to 100, yielding the final SUS score:
   Final SUS Score = Total Score × 2.5

The SUS score represents a composite measure of overall usability perception rather than a percentage. Score interpretation follows established benchmarks: a SUS score of 68 is commonly used as the threshold for acceptable usability, with scores above 68 indicating above-average usability and scores below 68 suggesting that the system requires improvements (Bangor et al., 2009; Hyzy et al., 2022). More granular interpretations have been established by recent research: scores above 80.3 are considered excellent (Grade A), scores between 73-80.3 are considered good (Grade B), scores between 68-73 are considered acceptable (Grade C), scores between 51-68 are considered marginal (Grade D), and scores below 51 are considered poor (Grade F) (Sauro & Lewis, 2018; Hyzy et al. 2022). Additionally, SUS scores can be categorized using adjective ratings: scores above 85 are "Excellent," 73-85 are "Good," 52-73 are "OK," 38-52 are "Poor," and below 38 are "Awful" (Bangor et al., 2009).

## 2.7 Technology Stack for Android Application Development

### 2.7.1 Android Application Development with Kotlin

Kotlin is a modern, statically typed programming language that has become the preferred language for Android application development, officially supported by Google since 2017 (Putranto, 2020). Kotlin is designed to enhance developer productivity, reduce common coding errors, and provide a more concise and expressive syntax compared to Java (Ardito et al., 2020). According to a recent empirical study, professional Android developers now use Kotlin as their primary programming language, with 67% reporting increased productivity after adopting Kotlin (Android Developers, 2024).

The use of Kotlin in mobile health application development offers several significant advantages. Kotlin's concise syntax enables simpler and more maintainable code, thereby accelerating the development process and reducing the likelihood of bugs (Putranto, 2020). Empirical evidence demonstrates that Kotlin produces significantly fewer lines of code

compared to Java for equivalent functionality, which constitutes evidence of better code conciseness and reduces the potential for errors (Ardito et al., 2020). This code conciseness is particularly beneficial for healthcare applications where maintaining clean, readable code is essential for long-term sustainability and compliance with regulatory standards.

Kotlin's null safety feature helps minimize runtime errors related to null pointer exceptions, which is critical for health applications that require high stability and reliability during routine use by patients (Ardito et al., 2020). Research findings indicate that Android apps containing Kotlin code are 20% less likely to crash compared to Java-based applications, primarily due to Kotlin's built-in null safety mechanisms (Android Developers, 2024). The frequency of NullPointerExceptions reported during development was significantly lower when developing in Kotlin compared to Java, demonstrating tangible improvements in application stability (Ardito et al., 2020).

Kotlin provides full interoperability with Java, allowing developers to leverage existing Android libraries and frameworks seamlessly. This interoperability enables gradual migration from Java to Kotlin without requiring complete codebase rewrites, making it practical for both new and existing projects. Additionally, Kotlin's support for asynchronous programming through coroutines facilitates efficient management of background processes such as network requests and database operations without blocking the user interface, ensuring a responsive user experience (Bekmuratov, 2025). The language's modern features, including extension functions, lambda expressions, and data classes, contribute to more efficient and readable code structure, which is particularly beneficial for developing complex healthcare applications (Putranto, 2020).

### 2.7.2 Firebase Realtime Database

Firebase Realtime Database is a cloud-based database developed by Google, designed to store and synchronize data in real time. Firebase provides a Backend as a Service (BaaS) solution that facilitates application development by minimizing complexity on the backend side, and enables applications to be accessed anywhere and anytime online (Setiaji et al., 2020). Data is stored in JSON format and continuously synchronized for each client, allowing automatic data updates whenever changes occur in the database without the need for repeated requests (Hasibuan & Triase, 2022).

One of the main advantages of Firebase is its real-time synchronization capability, where every data change that occurs in the database is immediately synchronized to all connected devices (Setiaji et al., 2020). Firebase Realtime Database can automatically update data that

has already been read when changes occur in the database, which is made possible by Firebase's extensive libraries for mobile and web platforms (Hasibuan & Triase, 2022). This feature is very important for mobile health applications that require patient data and health information to always be up-to-date and accessible in real time by users.

# CHAPTER III
# RESEARCH METHODOLOGY

## 3.1 Research Subjects and Location

This research involved ODAPUS (People with Lupus) from two sources:

1. An initial exploratory interview was conducted with one ODAPUS (recruited independently through personal network) in June 2025 to gather preliminary insights for prototype design.
2. The main research activities were conducted with ODAPUS from Yayasan Sahabat Cempluk (Sahabat Cempluk Foundation) located at Jl. Melati Permai, Jongke Kidul, Sendangadi, Mlati, Sleman, Special Region of Yogyakarta, Indonesia, from August to December 2025.

## 3.2 Data Collection Methods

This research uses primary data collected through three methods:

a. Initial Exploratory Interview with ODAPUS

An initial exploratory interview was conducted with one ODAPUS to obtain early insights regarding real conditions and challenges faced in daily SLE health management. The interview results serve as the initial user requirements for designing the first user interface prototype.

b. Focus Group Discussion (FGD)

FGD was conducted twice involving People Living with Lupus (ODAPUS) from Yayasan Sahabat Cempluk. The first FGD aimed to validate the initial prototype design and explore user needs for a mobile health application, while the second FGD aimed to conduct usability evaluation of the developed application.

c. Questionnaire

Two types of questionnaires were used in this research:

1. User Needs Questionnaire (First FGD)

   The questionnaire was distributed to 22 ODAPUS respondents to identify application feature needs and user preferences. The questionnaire consists of 22 statements covering aspects of:

Table 3. 1 User Needs Questionnaire

| No. | Questionnaire Statement |
|---|---|
| 1. | I usually record my daily health condition. |
| 2. | I usually record my condition on paper or in a notebook. |
| 3. | I usually record my condition on my phone, for example in a notes app. |
| 4. | I have felt forgetful or had difficulty remembering symptoms I experienced. |
| 5. | I feel that daily health recording helps me recognize lupus symptoms more quickly. |
| 6. | I often have difficulty remembering medication schedules or doctor appointments. |
| 7. | I am comfortable using alarms or notifications from my phone to remind me of health activities. |
| 8. | I feel disturbed by alarms that frequently appear. |
| 9. | I can distinguish between mild symptoms and flare-up symptoms. |
| 10. | When I feel I'm experiencing a flare, I know what I should do. |
| 11. | When experiencing a flare, I am still able to fill out a short form. |
| 12. | I prefer to enter health data by selecting from provided options. |
| 13. | I feel that storing photos of physical symptoms (rash, swelling, etc.) can help the doctor during evaluation. |
| 14. | I need information or education about lupus in the app. |
| 15. | I have felt difficulty or discomfort when using health apps before. |
| 16. | I have used health apps before. |
| 17. | I feel helped by the health apps I have used. |
| 18. | I feel confused or have difficulty when using health apps. |
| 19. | I want to use an app that can help me record my lupus condition. |
| 20. | I prefer apps with a simple display that is not too cluttered. |
| 21. | I am more comfortable if the app uses language that is easy to understand. |
| 22. | I feel comfortable using apps whose menus are clear and easily accessible. |

2. User Satisfaction Questionnaire - System Usability Scale (SUS) (Second FGD)

The SUS questionnaire was distributed to 10 ODAPUS respondents to measure the application's usability level. The questionnaire consists of 10 statements covering aspects of:

Table 3. 2 System Usability Scale (SUS) Questionnaire

| No. | Questionnaire Statement |
|---|---|
| 1 | I feel that I would like to use this application regularly to help manage my Lupus condition. |
| 2 | I feel that this application is too complicated or confusing. |
| 3 | This application is easy to use for recording and monitoring my condition. |
| 4 | I feel that I need assistance from someone with technical expertise (such as IT personnel or healthcare professionals) to be able to use this application. |
| 5 | The features in this application are well integrated and function properly. |
| 6 | This application feels inconsistent (for example, the interface or features change frequently and are confusing). |
| 7 | I am confident that most ODAPUS users will quickly understand how to use this application. |
| 8 | This application feels cumbersome or difficult to use in daily activities. |
| 9 | I feel confident when using this application. |
| 10 | I need to learn many things before I can use this application smoothly. |

### 3.3 Software Development Method

This research uses the prototyping method in developing the LUFY mobile health application. The prototyping method was chosen because it allows rapid iteration and involves users from the early stages of development to ensure the application meets the actual needs of ODAPUS. The prototyping method stages include:

1. Communication

   Initial stage to explore user needs through two sequential methods:

   a. Initial exploratory interview with one ODAPUS to obtain early insights about real challenges in daily SLE health management. These insights informed the initial prototype design.

b. First Focus Group Discussion (FGD) with ODAPUS from Yayasan Sahabat Cempluk. The initial prototype designed based on insights from the exploratory interview was demonstrated to participants. User needs questionnaire was distributed to validate the initial design and gather broader user perspectives.

2. Quick Plan

   Rapid planning based on communication results to determine the scope of application development, main features to be developed, and development priorities.

3. Modeling Quick Design

   Creating initial application design including:

   a. User interface design (UI/UX)
   b. Database design
   c. Rule-based algorithm design for flare screening
   d. Use Case Diagram
   e. Activity Diagram

4. Construction of Prototype

   Building the application using:

   a. Programming language: Kotlin
   b. Platform: Android
   c. Backend: Firebase Realtime Database
   d. Authentication: Firebase Authentication

5. Deployment, Delivery & Feedback

   Delivering the application to users for testing through the second FGD with application demonstration and collecting feedback through the SUS questionnaire.

### 3.4 Testing Method

Application testing was conducted using the System Usability Scale (SUS) method to measure the application's usability level based on user perception. The SUS questionnaire consists of 10 statements with a Likert scale of 1-5. SUS testing was conducted with 10 ODAPUS respondents who had used the LUFY application.

## 3.5 Research Stages

### 3.5.1 Communication

The communication stage is carried out to explore user needs through two methods:

a. Initial Exploratory Interview with ODAPUS

The researcher conducted an Initial Exploration Interview with an ODAPUS (initials NL) on June 19, 2025, at Sardjito Hospital to understand the real conditions and challenges faced by ODAPUS in daily health management. This interview aimed to:

1. Identify physical and cognitive challenges faced by ODAPUS
2. Understand existing health management patterns
3. Explore preferences and limitations in technology use
4. Obtain initial insights for application design

The results of this interview were used as initial user requirements which then became the foundation for designing the application interface.

b. First Focus Group Discussion

The first FGD was conducted on August 9, 2025, at Yayasan Sahabat Cempluk via Zoom Meeting involving 10 ODAPUS. The purpose of the first FGD was to validate the initial prototype design and explore broader user needs for a mobile health application for SLE management through:

1. Initial Prototype Demonstration

   The researcher presented the initial application prototype in the form of high-fidelity design using Figma that had been designed before the FGD implementation based on preliminary insights obtained from the initial exploratory interview. The prototype displayed the interface design and usage flow of the planned features to obtain feedback from ODAPUS regarding the proposed design and functionality.

2. Distribution of User Needs Questionnaire

   The questionnaire was distributed to FGD participants and expanded to a total of 22 ODAPUS respondents. The questionnaire consists of 22 statements with a Likert scale of 1-5 (Strongly Disagree - Strongly Agree), as shown in Table 3.1.

### 3.5.2 Quick Plan

Based on communication results, application development planning was conducted covering:

a. Main Feature Identification

   1. Daily health condition recording (Daily Diary)

2. Medication reminder (Medication Reminder)
3. Self-administered flare screening (Self-administered Flare Screening)
4. Routine check-up reminder (Routine Check-up Reminder)
5. Educational information about SLE (Educational Content)

b. Development Priority

Development priority was established based on the level of urgency and user needs, with the daily health condition recording feature as the core feature that becomes the main focus of development to support ODAPUS self-management in monitoring their health conditions continuously.

### 3.5.3 Modeling Quick Design

a. User Interface Design (UI/UX)

User interface design was conducted considering feedback from the first FGD which emphasized:

1. Use of visual elements (icons and illustrations) more than text
2. Simple and not overly busy design
3. Easy-to-understand language
4. Clear and easily accessible menu

Interface design was conducted using Figma with a high-fidelity prototype approach.

b. Database Design

Database design uses Firebase Realtime Database with NoSQL structure. The database is designed to store user data, daily health records, medication reminder data, flare screening results data, routine check-up schedule data, and educational article data.

c. Rule-Based Flare Screening Algorithm Design

The algorithm is designed to analyze symptom combinations with hierarchical prioritization. Symptoms that threaten vital organs (shortness of breath, urine color changes) are given the highest priority, followed by analysis of symptom count and combinations of fever with other symptoms. Details of the algorithm implementation and validation with case studies are presented in the Rule-Based Algorithm Design for Flare Screening in Chapter IV.

d. Use Case Diagram Design

The Use Case Diagram is designed to illustrate the interaction between users (ODAPUS) and the LUFY application system. The Use Case Diagram shows the main

functionality that users can perform in the system. The LUFY application Use Case Diagram can be seen in Figure 4.1 in Chapter IV.

e. Activity Diagram Design

Activity Diagrams are designed to illustrate the user activity flow in using each application feature

### 3.5.4 Construction of Prototype

The LUFY application prototype was built with technical specifications:

a. Platform and Programming Language:
   1. Platform: Android (minimum SDK API Level 24)
   2. Language: Kotlin
   3. IDE: Android Studio

b. Backend and Database:
   1. Firebase Realtime Database for real-time data storage
   2. Firebase Authentication for user authentication
   3. SharedPreferences for local session data storage

### 3.5.5 Deployment, Delivery, & Feedback

The application prototype was distributed to users for testing through:

a. Second FGD

Application demonstration to 10 ODAPUS for:

   1. The application was demonstrated to participants
   2. Direct trial of application features
   3. Completing SUS questionnaire
   4. Collecting feedback for improvements

b. Improvement Iteration

Based on feedback obtained, improvements were made on:

   1. Less intuitive interface
   2. Features requiring adjustments
   3. Bugs or errors found

### 3.5.6 Usability Testing

Usability testing was conducted using the System Usability Scale (SUS) method with the following steps:

a. Questionnaire Preparation

The SUS questionnaire consists of 10 statements with a Likert scale of 1-5:

1. Odd-numbered statements (positive)
2. Even-numbered statements (negative)

b. Test Implementation
    1. Respondents: 10 ODAPUS who had used the application
    2. Time: After demonstration and trial use of the application
    3. Method: Self-administered SUS questionnaire completion

c. SUS Score Calculation
    1. Calculation using standard SUS formula:
    2. Odd statement score = value – 1
    3. Even statement score = 5 – value
    4. Subtotal = sum of all scores
    5. Final SUS score = subtotal × 2.5

d. Result Interpretation

    SUS scores are interpreted based on:

    1. Acceptability Range (Not Acceptable, Marginal, Acceptable)
    2. Grade Scale (A, B, C, D, F)
    3. Adjective Rating (Worst Imaginable, Poor, OK, Good, Excellent, Best Imaginable)

# CHAPTER IV
# RESULTS AND DISCUSSION

## 4.1 LUFY Application Development Results

The development of the LUFY application was conducted through two main iterations using the prototyping method. Each iteration involved the stages of Communication, Quick Plan, Modeling/Quick Design, Construction of Prototype, and Deployment, Delivery & Feedback as explained in Chapter III.

### 4.1.1 First Iteration

### A. Communication

a. Initial Exploratory Interview with ODAPUS

An initial exploratory interview was conducted on June 19, 2025, at Sardjito Hospital with one ODAPUS (initials NL) to understand the real conditions and challenges faced in daily health management.

**Respondent Profile**

- Housewife with daily responsibilities managing the household without domestic helper assistance
- Daily activities: managing household chores and transporting children to/from school
- Medical condition: SLE with joint manifestations, experiencing advanced-level brain fog, and thyroid comorbidity
- Recording habits: uses paper to record important matters

**Interview Results**

The interview explored several key aspects of daily life with SLE:Physical and Cognitive Challenges:

- Experiences recurrent joint pain during activities but continues to complete tasks before resting
- Brain fog with significant severity level, affecting memory and recall abilities
- Limited time and energy due to responsibilities as a housewife

Health Management Patterns:

- Has awareness for documentation, habitually records important matters on paper

- Difficulty accessing health education information independently due to time constraints

Technology Usage Observations:

- Accustomed to using paper-based recording methods for important information
- Prefers simple, straightforward tools due to time constraints and cognitive load
- Values features that do not require extended time or complex interactions

**Analysis and Insights for Initial Design Direction**

The interview provided important understanding of challenges faced by ODAPUS with demanding daily routines and cognitive limitations. Several key insights emerged:

Need for Quick and Simple Documentation Features

- Paper recording habit indicates awareness for health tracking and memory support
- Limited time and energy require input methods that are fast and efficient
- Digital application could provide more practical alternative than manual recording

Consideration for Cognitive Load

- Brain fog suggests need for clear, uncomplicated design
- Application should minimize memory burden and cognitive effort
- Interface must be intuitive to reduce learning curve

Time Efficiency as Priority

- Busy daily schedule requires features that can be used quickly
- Long or complex processes would not be sustainable for daily use

Accessibility of Educational Information

- Difficulty accessing information indicates need for integrated, easily accessible education features
- Educational content should be available within the application without requiring external searches

Recognition of Diverse User Needs

- This interview highlighted that ODAPUS have varying levels of time availability, energy, and daily constraints
- A single user profile is insufficient to represent the full spectrum of ODAPUS needs

- Motivated expansion to broader sample through FGD and questionnaire to capture diverse user perspectives

**Initial Design Approach Based on Interview**

Based on these insights, the researcher developed an initial prototype with the following approach:

- Comprehensive feature coverage: Symptom recording, medication reminders, flare screening, routine check-ups, and education
- Text-based interface: Detailed explanations to ensure users understand each feature
- Free-text input forms: Allow users to describe their conditions in their own words
- Complete navigation structure: Accommodate all planned features
- Focus on functionality: Ensure all necessary self-management tools are available

This initial design prioritized comprehensiveness and clarity through text based on the understanding that users need detailed information and flexible input methods. However, this design approach was created with limited user input and required validation from a broader ODAPUS population through FGD.

The Figma prototype resulting from these initial insights was then presented to a larger and more diverse group of ODAPUS in the First Focus Group Discussion to gather comprehensive feedback and validate the design approach.

b. First Focus Group Discussion

Figure 4. 1 First FGD with ODAPUS from the Sahabat Cempluk Foundation

The first FGD was conducted on August 9, 2025, through the Zoom Meeting platform, involving 10 ODAPUS (People with Lupus) participants from Yayasan Sahabat Cempluk. In this FGD, researchers presented the initial prototype design created using Figma in the form of a high-fidelity prototype to obtain feedback from ODAPUS regarding the proposed design and functionality.

**Prototype Design Demo Presentation Results:**

Splash Screen Interface

This interface is the initial page that appears when the application is first opened. The splash screen interface design can be seen in Figure 4.2.

Figure 4. 2 Splash Screen Interface

Register Interface

This interface is used for new account registration. The register interface design can be seen in Figure 4.3.

Figure 4. 3 Register Interface

Login Interface

This interface is used to log in to the application using the registered email and password. The login interface design can be seen in Figure 4.4.

Figure 4. 4 Login Interface

Home Interface

The home page displays a summary of the current health article, shortcuts to main features, and important information. The home interface design can be seen in Figure 4.5.

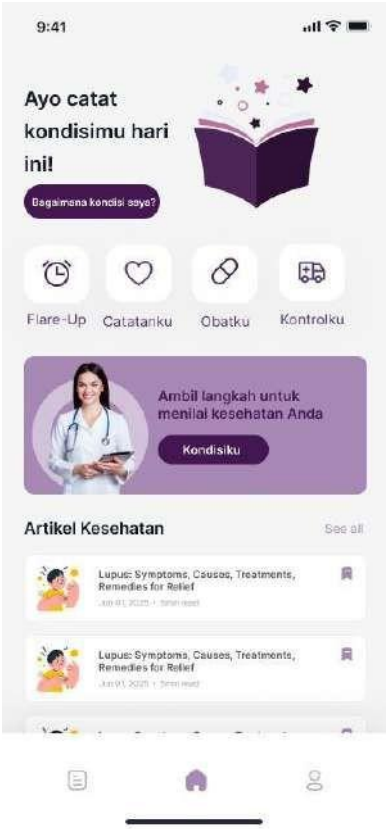



Figure 4. 5 Home Interface

Daily Diary Interface

Daily diary list page

Figure 4. 6 Daily Diary List Interface

Add/edit daily diary form page

Figure 4. 7 Daily Diary Form Interface

Medication Reminder Interface

Medication consumption reminder list page

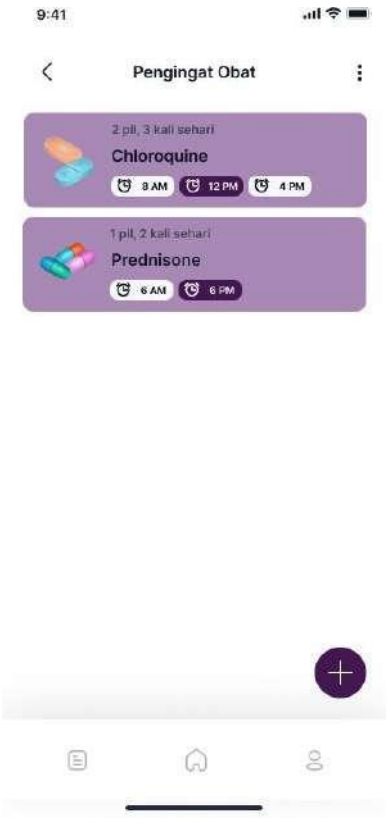



Figure 4. 8 Medication Reminder List Interface

Add/edit medication form page

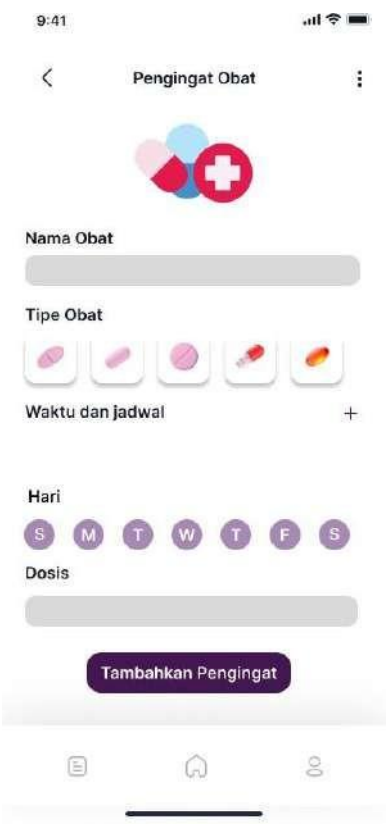



Figure 4. 9 Medication Reminder Form Interface

Flare Screening Interface

The flare screening page consists of:

Symptom selection page

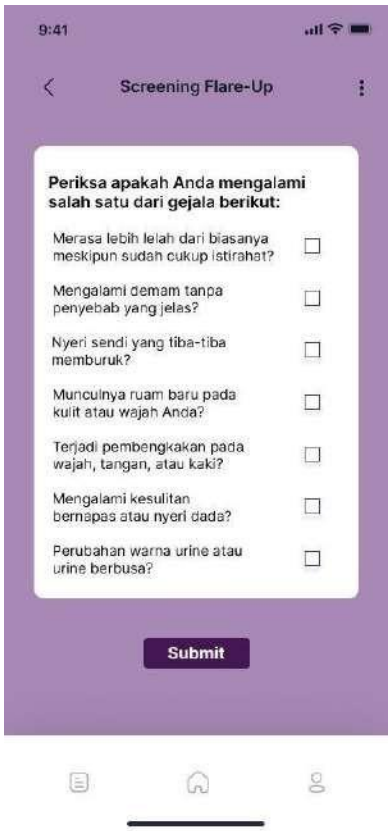



Figure 4. 10 Symptom Selection Interface

Screening result page

Figure 4. 11 Screening Result Interface

Appointment Reminder Interface

The appointment reminder page consists of:

Appointment schedule list page

Figure 4. 12 Appointment Schedule List Interface

Add/edit appointment schedule form page

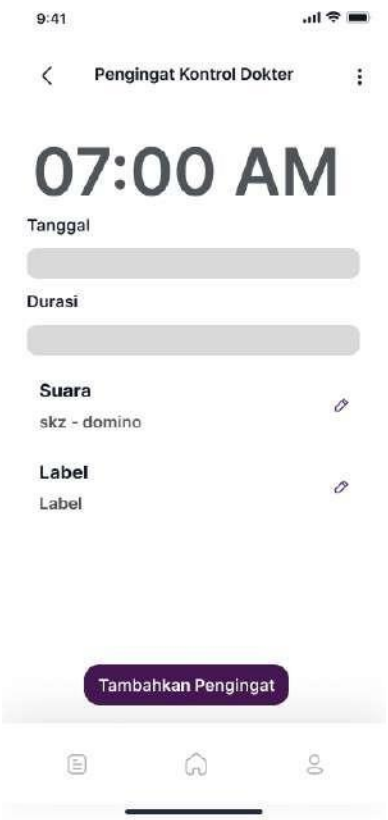



Figure 4. 13 Appointment Schedule Form Interface

Education Interface

The education page consists of:

Article list page

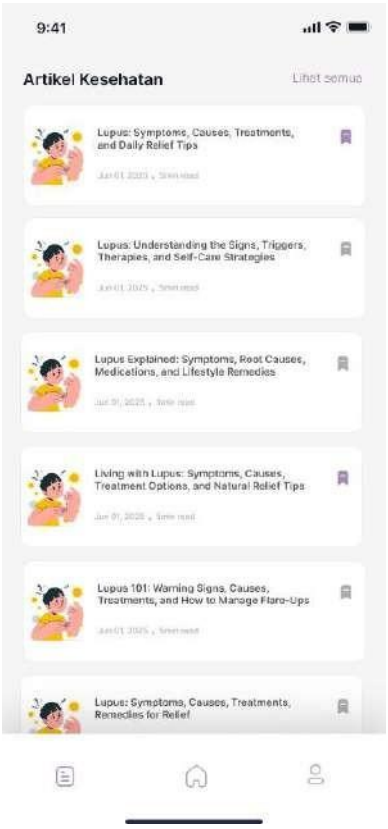



Figure 4. 14 Article List Interface

Article detail page

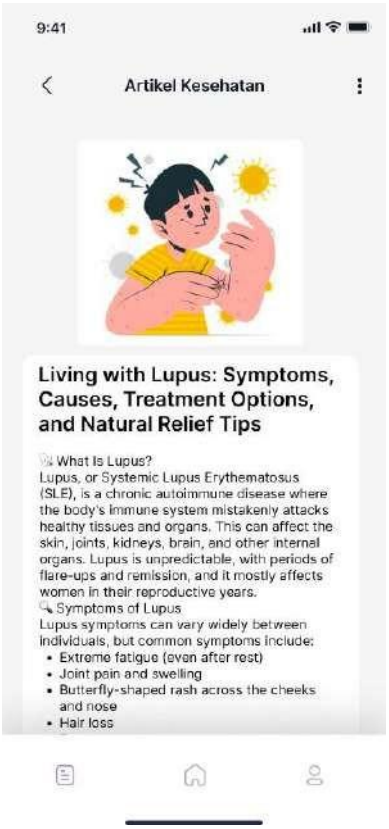



Figure 4. 15 Article Detail Interface

Profile Interface

The profile page displays user information and settings menu. The profile interface design can be seen in Figure 4.16.

Figure 4. 16 Profile Interface

The initial prototype design presented was created based on insights from the exploratory interview with NL and displayed the interface and usage flow of planned features. This prototype had the following design characteristics:

1. Text-heavy interface: Extensive use of text descriptions and instructions to provide clear information
2. Free-text input forms: Users required to type their symptoms, conditions, and notes manually to allow detailed descriptions
3. Comprehensive feature coverage: Including all necessary self-management tools to address time constraints and information accessibility challenges identified in the interview.

However, from this presentation, several major problems were identified through ODAPUS feedback:

1. Overly Complex Design
   - Interface contained too much information on a single screen
   - Navigation structure with too many menus
   - Users felt overwhelmed by the numerous options
2. Excessive Text Usage
   - Initial design was very text-heavy with long descriptions
   - Lack of visual elements such as icons and illustrations
   - Typing symptoms and conditions manually was considered time-consuming
3. Too Many Features
   - Participants were concerned that numerous features would confuse ODAPUS who rarely use applications

c. User Needs Questionnaire Results:

The user needs questionnaire was distributed to 22 ODAPUS respondents (10 from Yayasan Sahabat Cempluk and 12 other ODAPUS found by researchers).

Table 4. 1 User Needs Questionnaire Results

| No. | Questionnaire Statement | Conclusion |
|---|---|---|
| 1. | I usually record my daily health condition. | 50% (scale 4-5) - 50% of respondents agreed (scale 4–5), indicating that half of respondents are accustomed to recording their daily health condition. |
| 2. | I usually record my condition on paper or in a notebook. | 36% (4-5) - 36% of respondents agreed (scale 4–5), showing that only a minority of respondents usually record their condition on paper or in a notebook. |
| 3. | I usually record my condition on my phone, for example in a notes app. | 63% (4-5) - 63% of respondents agreed (scale 4–5), indicating that the majority of respondents usually record their condition on their phone, such as in a notes app. |
| 4. | I have felt forgetful or had difficulty remembering symptoms I experienced. | 63% (4-5) - 63% of respondents agreed (scale 4–5), showing that most respondents have felt forgetful or had |

| | | |
|---|---|---|
| | | difficulty remembering symptoms they experienced. |
| 5. | I feel that daily health recording helps me recognize lupus symptoms more quickly. | 77% (4-5) - 77% of respondents agreed (scale 4–5), indicating that a strong majority feel that daily health recording helps them recognize lupus symptoms more quickly. |
| 6. | I often have difficulty remembering medication schedules or doctor appointments. | 54% (4-5) - 54% of respondents agreed (scale 4–5), showing that slightly more than half often have difficulty remembering medication schedules or doctor appointments. |
| 7. | I am comfortable using alarms or notifications from my phone to remind me of health activities. | 72% (4-5) - 72% of respondents agreed (scale 4–5), indicating that most respondents are comfortable using alarms or notifications from their phone to remind them of health activities. |
| 8. | I feel disturbed by alarms that frequently appear. | 45% (scale 1-2) - 45% of respondents disagreed (scale 1–2), showing that less than half feel disturbed by alarms that frequently appear, suggesting most are tolerant of notifications. |
| 9. | I can distinguish between mild symptoms and flare-up symptoms. | 72% (4-5) - 72% of respondents agreed (scale 4–5), indicating that most respondents can distinguish between mild symptoms and flare-up symptoms. |
| 10. | When I feel I'm experiencing a flare, I know what I should do. | 72% (4-5) - 72% of respondents agreed (scale 4–5), showing that most respondents know what they should do when feeling they're experiencing a flare. |
| 11. | When experiencing a flare, I am still able to fill out a short form. | 72% (4-5) - 72% of respondents agreed (scale 4–5), indicating that most |

| | | |
|---|---|---|
| | | respondents are still able to fill out a short form when experiencing a flare. |
| 12. | I prefer to enter health data by selecting from provided options. | 72% (4-5) - 72% of respondents agreed (scale 4–5), showing that most respondents prefer to enter health data by selecting from provided options. |
| 13. | I feel that storing photos of physical symptoms (rash, swelling, etc.) can help the doctor during evaluation. | 77% (4-5) - 77% of respondents agreed (scale 4–5), indicating that a strong majority feel that storing photos of physical symptoms can help the doctor during evaluation. |
| 14. | I need information or education about lupus in the app. | 81% (4-5) - 81% of respondents agreed (scale 4–5), showing that the vast majority need information or education about lupus in the app. |
| 15. | I have felt difficulty or discomfort when using health apps before. | 31% (1-2) - 31% of respondents disagreed (scale 1–2), indicating that most respondents (69%) have felt difficulty or discomfort when using health apps before. |
| 16. | I have used health apps before. | 54% (1-2) - 54% of respondents disagreed (scale 1–2), showing that slightly more than half have not used health apps before. |
| 17. | I feel helped by the health apps I have used. | 36% (4-5) - 36% of respondents agreed (scale 4–5), indicating that only a minority feel helped by the health apps they have used. |
| 18. | I feel confused or have difficulty when using health apps. | 59% (1-2) - 59% of respondents disagreed (scale 1–2), showing that most respondents do not feel confused or have difficulty when using health apps. |

| | | |
|---|---|---|
| 19. | I want to use an app that can help me record my lupus condition. | 86% (4-5) - 86% of respondents agreed (scale 4–5), indicating that the overwhelming majority want to use an app that can help them record their lupus condition. |
| 20. | I prefer apps with a simple display that is not too cluttered. | 81% (4-5) - 81% of respondents agreed (scale 4–5), showing that the vast majority prefer apps with a simple display that is not too cluttered. |
| 21. | I am more comfortable if the app uses language that is easy to understand. | 86% (4-5) - 86% of respondents agreed (scale 4–5), indicating that the overwhelming majority are more comfortable if the app uses language that is easy to understand. |
| 22. | I feel comfortable using apps whose menus are clear and easily accessible. | 90% (4-5) - 90% of respondents agreed (scale 4–5), indicating that nearly all respondents feel comfortable using apps whose menus are clear and easily accessible. |

Important findings from the questionnaire supporting FGD feedback:

- 63% of respondents were already accustomed to recording health conditions using their phones
- 72% preferred entering data by selecting from provided options
- 77% felt that storing photos of physical symptoms could help doctors
- 86% wanted to use an application that could help record lupus conditions
- 81% wanted a simple display that wasn't too full
- 90% felt comfortable using apps whose menus are clear and easily accessible

These questionnaire results revealed important insights that both validated and challenged assumptions from the initial exploratory interview with NL:

**Validated Assumptions:**

- The high percentage (63%) of respondents already recording health conditions on their phones validated the digital solution direction, which was inspired by

NL's paper-based recording habit that indicated awareness for health documentation.

- 86% wanting to use an application to record lupus conditions confirmed the fundamental need for systematic health tracking identified through the initial interview.
- 81% preferring simple displays aligned with the simplicity principle derived from understanding NL's time constraints and cognitive load.

**Challenged Initial Design Approach:**

- 72% preferring to enter data by selecting from provided options directly contradicted the free-text input approach in the initial prototype, which was based on NL's detailed paper recording habit.
- 90% wanting clear and easily accessible menus suggested that the comprehensive, text-heavy navigation structure might be overwhelming rather than helpful.
- The strong preference for visual simplicity (81%) challenged the text-heavy interface approach that was initially assumed beneficial for users experiencing cognitive challenges like brain fog.

These contrasts highlighted the critical importance of involving a broader and more diverse ODAPUS population. While the initial exploratory interview with NL provided valuable foundational insights and direction, a single user's experience could not represent the full spectrum of ODAPUS needs and preferences. The FGD feedback, supported by questionnaire data from 22 respondents with varying profiles, provided the necessary diverse perspectives to refine and correct the initial design assumptions, ultimately leading to the significant design transformation documented in the second iteration.

**B. Quick Plan Results**

Based on communication results, a comprehensive evaluation of the initial prototype design was conducted and the need for redesign was identified with priorities:

a. Design Problems to be Fixed:

- Simplify interface by reducing information per screen
- Transform from text-heavy to visual-first approach
- Reduce number of features or combine similar features
- Simplify navigation structure

b. Redesign Priorities:
   - Highest Priority: Transformation to visual-first design using icons and illustrations
   - High Priority: Simplify homepage by displaying only essential information
   - High Priority: Merge routine check-up feature into daily diary menu
   - High Priority: Change input forms from free text to selection-based with visual icons
   - Medium Priority: Reduce instruction text and replace with visual guides

c. New Design Strategy:
   - Maximum 3-4 main pieces of information per screen
   - Each piece of information must have visual representation (icon/illustration)

**C. Modeling/Quick Design Results**

The modeling stage was conducted by performing a complete redesign of the Figma prototype based on first FGD feedback. The detailed redesign results and visual comparisons with the initial design will be presented in the second iteration's communication section.

a. System Component Design:

   The following system components were designed:

   Database Design

   Database design is the process of creating a design for the database that will be used in the LUFY application. This process can also be interpreted as determining the content and organization of data required to support this application. Figure 4.17 shows the database design of the LUFY mobile health application.

```
lufy-lupus-fighter-diary-default-rtdb/
│
├── users/
│   │
│   ├── {username}/                          ← Username as key (not Firebase
UID)
│   │   ├── nama_lengkap: String             (full name)
│   │   ├── email: String
│   │   ├── password: String
│   │   ├── tanggal_lahir: String            (DD/MM/YYYY format)
│   │   ├── jenis_kelamin: String            (Laki-laki/Perempuan)
│   │   ├── jenis_lupus: String              (SLE/DLE/SCLE/Others)
│   │   ├── lama_mengidap: Number            (years suffering from lupus)
│   │   └── created_at: Timestamp            (milliseconds since epoch)
│   │
│   └── {username2}/
│       └── ...
│
├── daily_diary/
│   │
│   ├── {username}/                          ← Username as key
│   │   │
│   │   ├── {diaryId}/                       ← Timestamp as ID
│   │   │   ├── id: Number                   (same as key)
│   │   │   ├── date: Timestamp              (milliseconds)
│   │   │   ├── symptoms: Array<String>      ["Extreme Fatigue", "Fever",
...]
│   │   │   ├── mood: String              (Happy/Sad/Normal/Frustrated/...)
│   │   │   ├── medication: String           (medication taken)
│   │   │   ├── notes: String                (additional notes)
│   │   │   ├── photoUri: String             (nullable, photo path)
│   │   │   ├── syncStatus: String           ("synced")
│   │   │   └── timestamp: Timestamp         (milliseconds)
│   │   │
│   │   └── {diaryId2}/
```

```
│   │       └── ...
│   │
│   └── {username2}/
│       └── ...
│
├── flareup_history/
│   │
│   ├── {username}/                          ← Username as key
│   │   │
│   │   ├── {screeningId}/                   ← Timestamp as ID
│   │   │   ├── id: Number                   (same as key)
│   │   │   ├── date: String                 ("DD Month YYYY")
│   │   │   ├── time: String                 ("HH:mm")
│   │   │   ├── timestamp: Timestamp         (milliseconds)
│   │   │   ├── selectedSymptoms: Array<String> (symptoms selected by
user)
│   │   │   ├── symptomsCount: Number        (number of symptoms selected)
│   │   │   ├── totalSymptoms: Number        (total available symptoms =
7)
│   │   │   ├── severity: String             (Ringan/Sedang/Berat -
Mild/Moderate/Severe)
│   │   │   ├── recommendation: String       (recommended action)
│   │   │   └── syncStatus: String           ("synced")
│   │   │
│   │   └── {screeningId2}/
│   │       └── ...
│   │
│   └── {username2}/
│       └── ...
│
├── medicine_reminders/
│   │
│   ├── {username}/                          ← Username as key
│   │   │
│   │   ├── {reminderId}/                    ← Timestamp as ID
```

```
│   │   │   ├── id: Number                    (same as key)
│   │   │   ├── name: String                  (medicine name)
│   │   │   ├── medicineType: Number         (1=Tablet, 2=Capsule, 3=Syrup,
etc)
│   │   │   ├── dosage: String                (dosage, e.g., "2 pills", "1
x 1")
│   │   │   ├── times: Array<String>          ["08:00", "19:00"] - reminder
times
│   │   │   │   ├── days: Array<String>              ["Monday", "Tuesday",
"Wednesday", ...]
│   │   │   ├── active: Boolean              (true/false - reminder enabled)
│   │   │   ├── alarmSoundUri: String         (alarm sound URI)
│   │   │   ├── notes: String                 (additional notes)
│   │   │   ├── syncStatus: String            ("synced")
│   │   │   └── timestamp: Timestamp          (milliseconds)
│   │   │
│   │   └── {reminderId2}/
│   │       └── ...
│   │
│   └── {username2}/
│       └── ...
│
├── routine_entries/
│   │
│   ├── {username}/                           ← Username as key
│   │   │
│   │   ├── {routineId}/                      ← Timestamp as ID
│   │   │   ├── id: Number                    (same as key)
│   │   │   ├── title: String                 (routine checkup title)
│   │   │   ├── location: String              (hospital/clinic name)
│   │   │   ├── time: String                  ("HH:mm")
│   │   │   ├── allDay: Boolean               (true/false - all day event)
│   │   │   │   │   │   ├──     repeatMode:     String
("Never"/"Daily"/"Weekly"/"Monthly"/"Custom")
```

```
|   |   |   ├── repeatSettings: Object      (nullable, only for "Custom"
mode)
|   |   |   |   ├── frequency: String       ("Monthly")
|   |   |   |   ├── interval: Number        (1 = every month)
|   |   |   |   ├── dayOfWeek: Number       (0-6, 0=Sunday)
|   |   |   |   └── weekOrder: Number       (1-5, which week of month)
|   |   |   ├── active: Boolean             (true/false)
|   |   |   ├── alarmSoundUri: String       (alarm sound URI)
|   |   |   ├── notes: String               (additional notes)
|   |   |   ├── syncStatus: String          ("synced")
|   |   |   └── timestamp: Timestamp        (milliseconds)
|   |   |
|   |   └── {routineId2}/
|   |       └── ...
|   |
|   └── {username2}/
|       └── ...
```

Figure 4.17 Database Design of the LUFY Application

The database uses Firebase Realtime Database with a NoSQL structure. A detailed explanation of the data structure to be created in this application is as follows:

**Users Node**

This node is used to store data of registered users. The node structure can be seen in Table 4.2.

Table 4.2 Users Node Structure

| Field | Data Type | Description |
|---|---|---|
| nama_lengkap | String | User full name |
| Email | String | User email |
| tanggal_lahir | String | Date of birth (format: DD/MM/YYYY) |
| jenis_kelamin | String | Gender (Male/Female) |
| Jenis_lupus | String | Type of lupus suffered (SLE/CLE/Drug- |

| | | |
|---|---|---|
| | | Induced/Neonatal) |
| lama_mengidap | number | Duration of living with lupus (in years) |
| created_at | Timestamp | Account creation timestamp (milliseconds since epoch) |

**DailyDiary Node**

This node is used to store data for users' daily health condition records. The node structure can be seen in Table 4.3.

Table 4.3 DailyDiary Node Structure

| Field | Data Type | Description |
|---|---|---|
| id | Number | Unique reminder ID (same as timestamp) |
| date | Timestamp | Entry date (milliseconds) |
| timestamp | Timestamp | Reminder creation timestamp (milliseconds since epoch) |
| symptoms | Array <String> | Array containing the symptoms experienced |
| mood | String | User's mood on that day (Happy/Normal/Sad/Frustrated) |
| medication | String | Medications taken on that day |
| notes | String | User's additional notes |
| photoUri | String (optional) | URI of symptom documentation photo (optional, null if missing) |
| syncStatus | String | Data synchronization status (fixed value: "synced") |

**Medications Reminder Node**

This node is used to store data on medications consumed by users. The node structure can be seen in Table 4.4.

Table 4.4 Medications Node Structure

| Field | Data Type | Description |
|---|---|---|

| | | |
|---|---|---|
| Id | Number | Unique reminder ID (same as timestamp) |
| name | String | Medicine name |
| medicineType | Number | Medicine type (1=Tablet, 2=Capsule, 3=Syrup, 4=Injection, 5=Other) |
| dosage | String | Medicine dosage |
| times | Array <String> | Reminder time array (format: "HH:mm") |
| days | Array <String> | Array of reminder days |
| notes | String | Additional notes for medication |
| active | Boolean | Reminder active status (true/false) |
| alarmSoundUri | String | Alarm sound URI for reminder |
| timestamp | Timestamp | Reminder creation timestamp (milliseconds since epoch) |
| syncStatus | String | Data synchronization status (fixed value: "synced") |

**FlareScreening Node**

This node is used to store the results of flare screening performed by users. The node structure can be seen in Table 4.5.

Table 4.5 FlareScreening Node Structure

| Field | Data Type | Description |
|---|---|---|
| id | Number | Unique screening ID (same as timestamp) |
| date | String | Screening date (format: "DD MMMM YYYY") |
| time | String | Screening time (format: "HH:mm") |
| timestamp | Timestamp | Screening creation timestamp (milliseconds since epoch) |
| selectedSymptoms | Array <String> | Symptom array selected by user |
| symptomsCount | Number | Number of symptoms selected |

| | | |
|---|---|---|
| totalSymptoms | Number | Total symptoms available for selection (fixed value: 7) |
| severity | String | Flare severity (Mild/Moderate/Severe) |
| recommendation | String | Recommendations based on severity |
| syncStatus | String | Data synchronization status (fixed value: "synced") |

**Routine Entries Node**

This node is used to store users routine control schedules. The node structure can be seen in Table 4.6.

Table 4.6 Routine Entries Node Structure

| Field | Data Type | Description |
|---|---|---|
| id | Number | Unique screening ID (same as timestamp) |
| title | String | Routine Control Title |
| location | String | Control Location |
| time | String | Control Time (format: "HH:mm") |
| timestamp | Timestamp | Entry creation timestamp (milliseconds since epoch) |
| notes | String | Additional Control Notes |
| allDay | Boolean | All-Day Reminder (True/False) |
| Active | Boolean | Entry Active Status (True/False) |
| repeatMode | String | Repeat Mode ("Jangan Pernah" / "Khusus") |
| repeatSettings | Object (optional) | Repeat Settings (only if repeatMode = "Khusus") |
| frequency | String | Repeat Frequency ("Bulanan" / "Mingguan") |
| interval | Number | Repeat Interval |
| dayOfWeek | Number | Day of the Week |

| | | |
|---|---|---|
| weekOrder | Number | Week of the Month |
| alarmSoundUri | String | Alarm sound URI for reminder |
| syncStatus | String | Data synchronization status (fixed value: "synced") |

**UML Design**

- Use Case Diagram

  The use case diagram in Figure 4.18 provides an overview of the functionality of the LUFY mobile health application to support the self-management of ODAPUS.

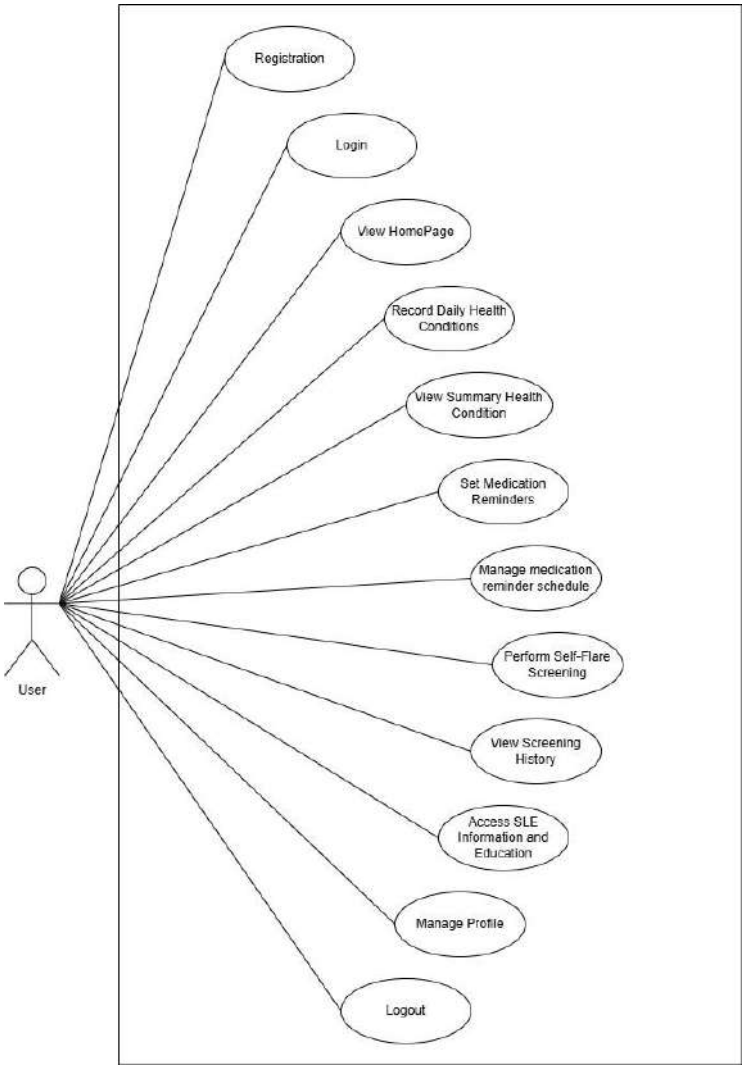



Figure 4.18 Use Case Diagram of the LUFY Application

The explanation of each functionality is as follows:

Table 4.7 Use Case Description

| No | Function | Description |
|---|---|---|
| 1 | Registration | Used by new users to create an account by providing information such as full name, email, password, date of birth, gender, type of lupus, and duration of living with lupus. User data is stored in Firebase database. |
| 2 | Login | Used by registered users to access the application by entering their username and password. After successful authentication, users are directed to the home page. |
| 3 | View Home Page | Displays a home page that includes flare-up screening features, daily logs, medication reminders, and access to educational information. |
| 4 | Record Daily Health Conditions | It allows users to record daily health information, including symptoms, severity, mood, medications, activities, notes, and photos. Users can also add reminders for routine checkups. Data is stored in Firebase with a timestamp and can be viewed or edited. |
| 5 | View Summary Health Condition | Enables users to view a summary of their recorded daily health conditions also reminders for routine checkups. |
| 6 | Set Medication Reminders | Allows users to create medication reminders by entering medication name, type, dosage, reminder times, days, and notes. Uses Android AlarmManager to send notifications even when the app is closed. |
| 7 | Manage Medication Reminder Schedule | Enables users to view, toggle ON/OFF, or delete existing medication reminders. Changes are automatically synchronized with Firebase. |
| 8 | Perform Self-Flare Screening | The users select experienced symptoms from a list. The system analyzes symptoms using a rule-based algorithm with hierarchical priority, then classifies flare severity (Mild, Moderate, Severe) and provides appropriate action recommendations. |
| 9 | View Screening History | Displays a chronological list of previous screening results including date, time, symptoms selected, severity category, and recommendations. |
| 10 | Access SLE Information and Education | Provides educational articles about SLE. |

| | | |
|---|---|---|
| 11 | Manage Profile | Enables users to view profile information including full name, email, date of birth, gender, type of lupus, duration of living with lupus, and change password. |
| 12 | Logout | Used to exit the application and end the current session. Clears authentication data and returns users to the login page for security purposes. |

- Activity Diagram

  Activity diagrams describe the activity flow for each feature of the LUFY application. The following are the activity diagrams for the main features:

  **Register Activity Diagram**

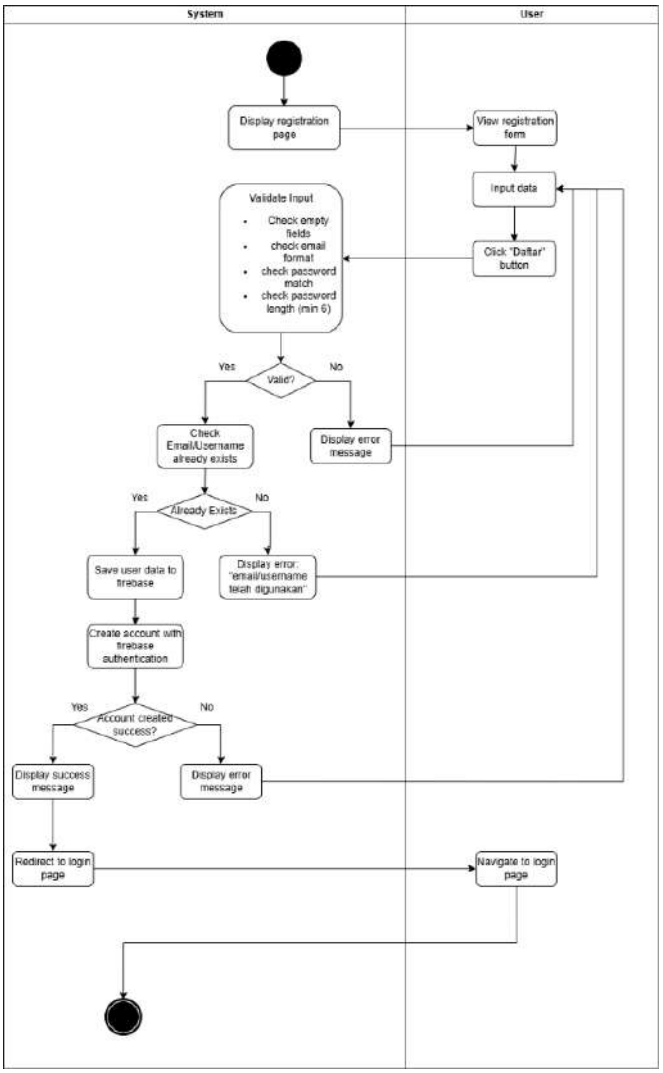



Figure 4. 19 Register Activity Diagram

**Login Activity Diagram**

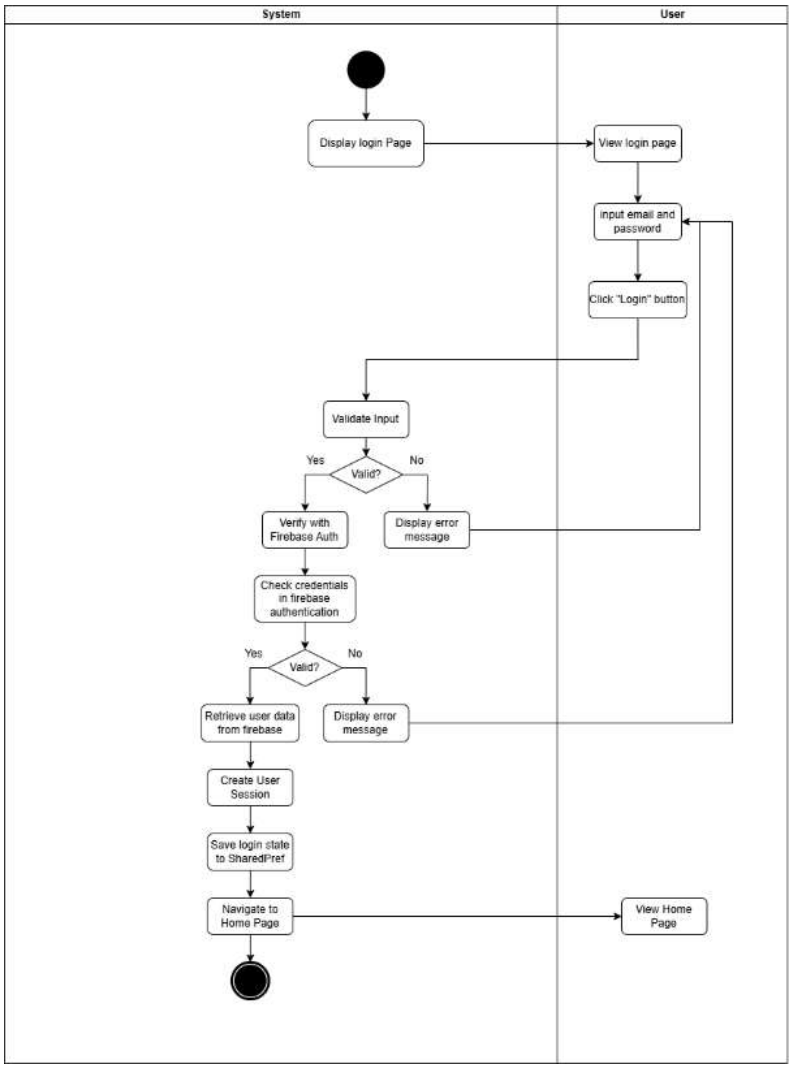



Figure 4. 20 Login Activity Diagram

**Daily Diary Activity Diagram**

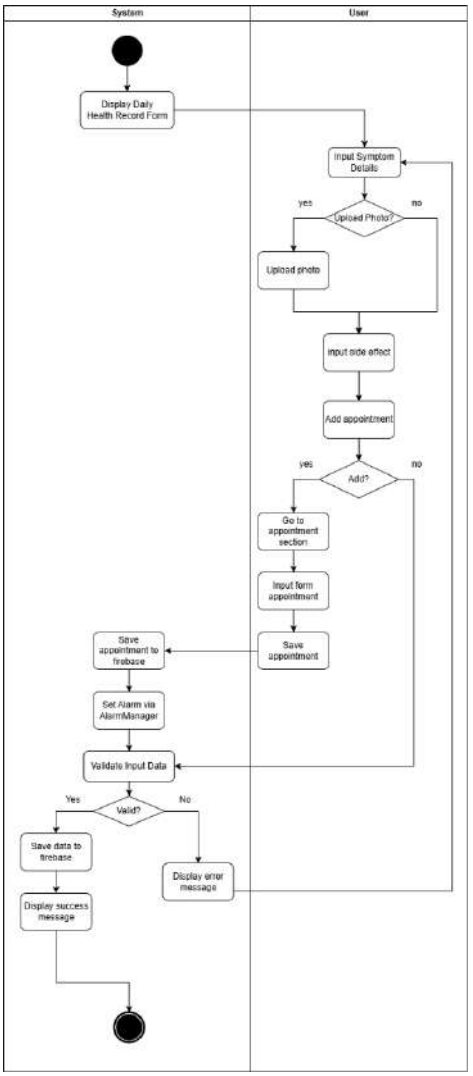



Figure 4. 21 Daily Diary Activity Diagram

**Medication Reminder Activity Diagram**

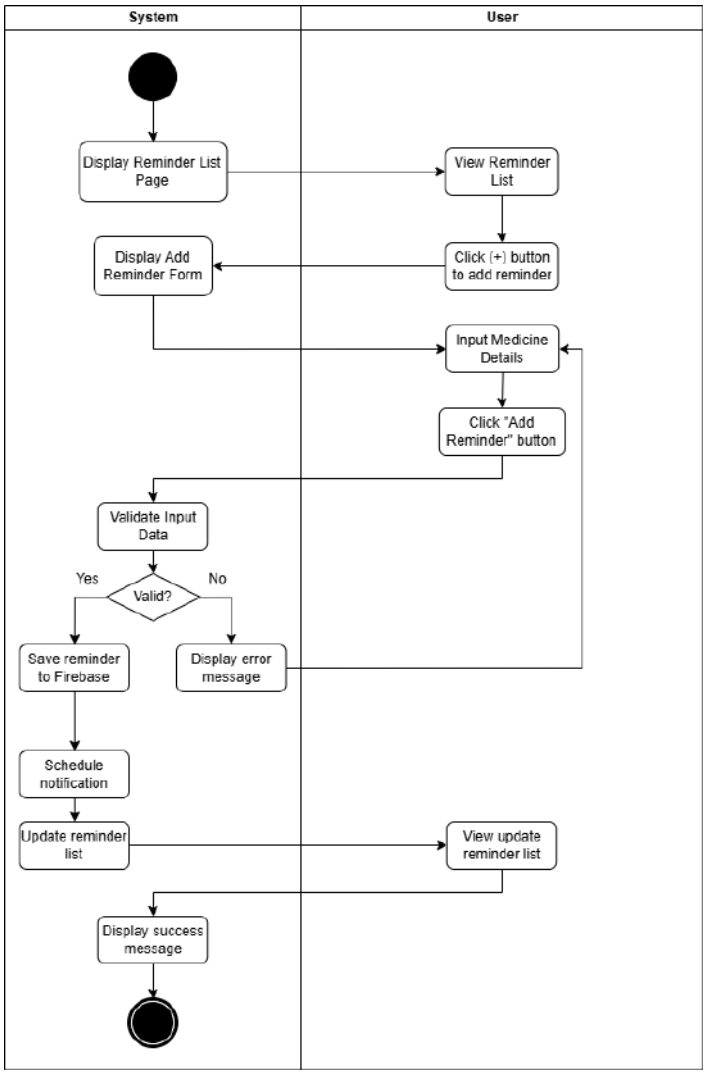



Figure 4. 22 Medication Management Activity Diagram

**Flare Screening Activity Diagram**

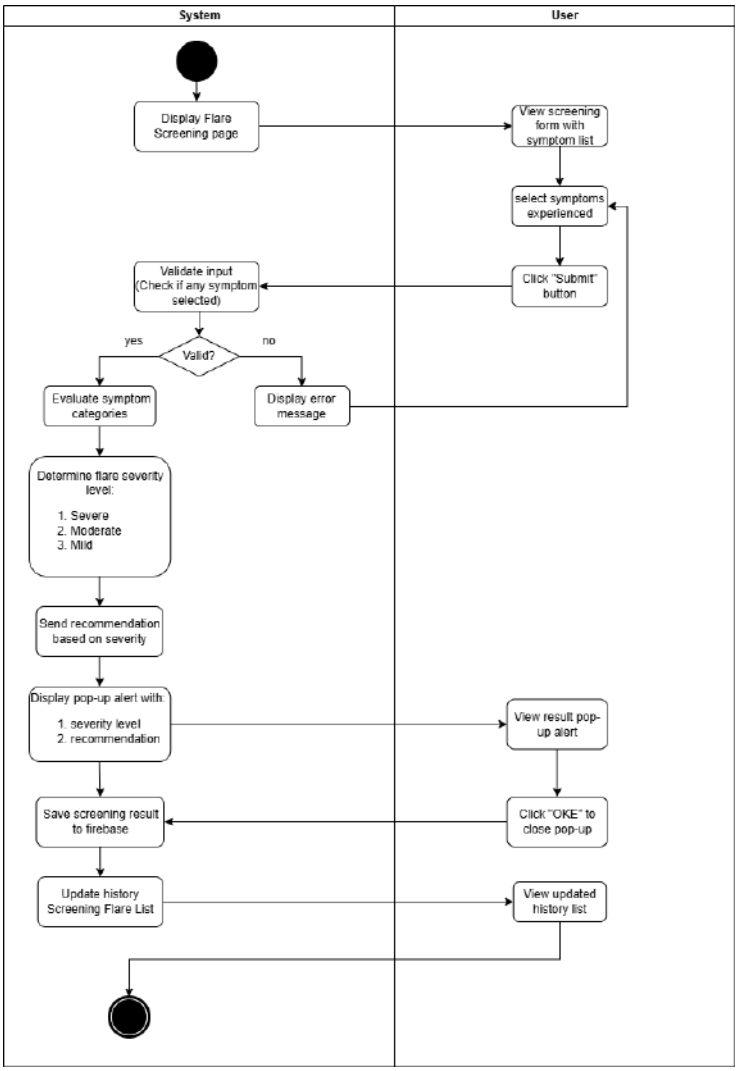



Figure 4. 23 Flare Screening Activity Diagram

**Rule-Based Algorithm Design for Flare Screening**

The flare screening feature was implemented as a rule-based decision support algorithm designed to assist ODAPUS in identifying potential flare risk based on self-reported symptoms. This feature functions as an early screening tool to support self-care management and does not replace clinical diagnosis or medical evaluation.

1. Symptom Data Used

The symptoms used in the flare screening algorithm were selected based on:

- Clinical domains of disease activity in SLEDAI-2K, particularly manifestations related to organ involvement and systemic activity, and

- Patient-Reported Outcomes (PRO), emphasizing symptoms that can be directly perceived and reported by patients without clinical examination.

A total of ten symptoms were included and coded for analysis, as shown in Table 4.8.

Table 4. 8 Symptom Data Results

| Code | Symptom | Risk Category |
|---|---|---|
| 001 | Chest pain/shortness of breath | Organ threatening |
| 002 | Urine color changes (dark/red/bloody) | Organ threatening |
| 003 | Fever (>38°C) | Non-organ threatening |
| 004 | Swelling (face, legs, hands) | Non-organ threatening |
| 005 | Extreme fatigue | Non-organ threatening |
| 006 | Joint pain | Non-organ threatening |
| 007 | Skin rash/photosensitivity | Non-organ threatening |
| 008 | Mouth or nasal ulcers | Non-organ threatening |
| 009 | Hair loss (alopecia) | Non-organ threatening |
| 010 | Headache | Non-organ threatening |

Symptoms G001 and G002 were classified as organ-threatening symptoms because they may indicate potential cardiopulmonary or renal involvement. The remaining symptoms were categorized as non-organ-threatening symptoms, representing systemic, musculoskeletal, mucocutaneous, and patient-reported manifestations of lupus activity.

2. Screening Rule

The screening rules were developed using a risk stratification approach, where flare risk is determined based on the presence and combination of symptom types, rather than symptom severity or progression over time. This approach aligns with the system's design, which supports single-time symptom input. The flare screening rules are presented in Table 4.9.

Table 4. 9 Flare Screening Rule

| **Priority** | **Condition (IF)** | **Flare Category (THEN)** | **Recommendation** |
|---|---|---|---|
| 1 | At least one organ-threatening symptom (chest pain/shortness of breath (G001) OR urine color changes (G002)) | SEVERE | Emergency Department IMMEDIATELY |
| 2 | Two or more non-organ threatening symptoms | MODERATE | Contact a doctor within 24 hours |
| 3 | No organ-threatening symptoms and maximum one non-organ threatening symptom | MILD | Self-monitoring and routine symptom logging |

These rules were intentionally designed to be conservative and to avoid overestimation of clinical severity, given the absence of clinical examination, laboratory data, and symptom severity assessment.

3. Algorithm Validation with Case Studies

   To validate the logical consistency of the algorithm, a case study simulation was conducted.

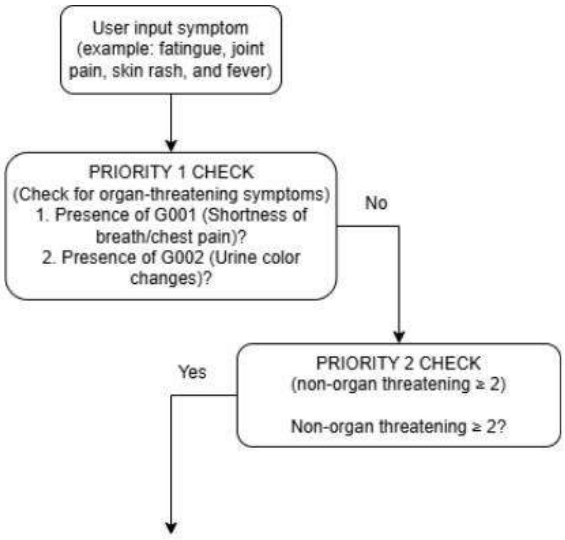
   Case Study:

   Dina, a 28-year-old ODAPUS, reports the following symptoms:

   - Excessive fatigue (G005)
   - Joint pain (G006)
   - Skin rash (G007)
   - Fever with a body temperature of 38.5°C (G003)

   Dina reports four non-organ-threatening symptoms and no organ-threatening symptoms. According to the screening rules, the system classifies her flare risk as

Moderate and recommends contacting a doctor within 24 hours. The screening process flow is illustrated in Figure 4.24.




| Experienced Symptoms | Number of Symptoms | Flare Category | Recommendation |
|---|---|---|---|
| Excessive fatigue, joint pain, skin rash, fever | 4 | Moderate | Contact doctor 24 hours |

Figure 4. 24 Case Study

**D. Construction of Prototype Results**

No construction in the first iteration. The first iteration fully focused on needs identification and prototype redesign in Figma.

**E. Deployment, Delivery & Feedback Results**

No functional application deployment in the first iteration. Feedback was collected through the first FGD and questionnaire, which then became the basis for redesign in the Modeling/Quick Design stage.

### 4.1.2 Second Iteration

**A. Communication Results**

The second iteration began with internal validation of the Figma design resulting from first iteration redesign. Researchers conducted:

a. Review of visual consistency across all screens

b. Validation of user flow to ensure no navigation ambiguity
c. Testing of interactive prototype in Figma

The second iteration began with presentation of the redesign results from the first iteration. Researchers validated that all feedback from the first FGD had been accommodated in the new design.

a. Redesign Focus

Based on first iteration feedback, redesign was focused on 4 core components that were the main concerns:

1. Homepage
2. Symptom Selection (Flare Screening)
3. Daily Diary Form
4. Menu Structure/Navigation

Other components (Splash Screen, Login, Register, Medication Reminder Form, Profile, Educational Content) used the initial design with minor visual adjustments for consistency (color scheme, typography, iconography) but did not undergo significant structural changes as the initial designs were already sufficiently simple and did not receive specific criticism from ODAPUS.

b. Design Comparison Before and After Redesign

The following are comparisons showing the transformation of the 4 core components based on first iteration feedback:

1. Homepage Transformation

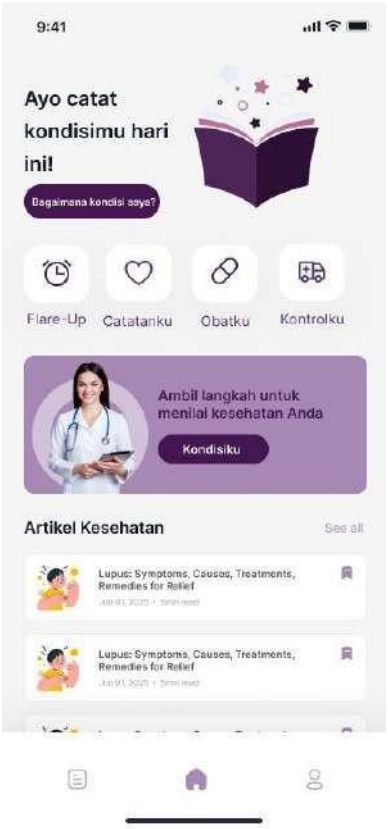



Figure 4. 25 Home Page Initial Design

Figure 4. 26 Home Page Final Design

- Initial Design: Displayed too much information on one screen with long scrolling, used lists with long text descriptions, dense layout
- Revised Design: Only displays 4 main cards (Quick access shortcuts, Today's medication reminder, Upcoming check-up schedule, Latest screening result), uses visual icons that are easy to scan, spacious layout with white space
- Rationale: Questionnaire data showed 90% of respondents liked applications with graphs/images. Change to card-based with visual icons enables quick understanding without reading long texts.

2. Flare Screening Feature Transformation (Symptom Selection)

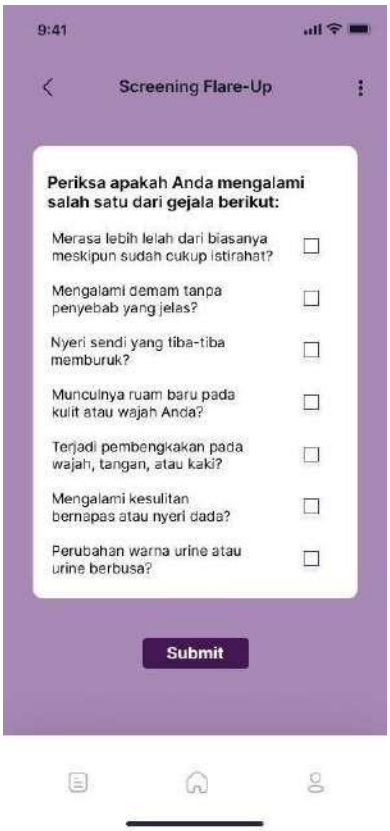



Figure 4. 27 Screening Flare Initial Design

Figure 4. 28 Screening Flare Final Design

- Initial Design: Checkbox list with long text descriptions for each symptom, vertical list format, no visual representation
- Revised Design: Card-based grid layout 2 columns, each symptom with intuitive icon (lung icon for shortness of breath, kidney icon for urine color change, thermometer icon for fever, etc.), short label 2-3 words, visual feedback when selected
- Rationale: 72% of respondents were still able to fill out forms during flares but forms must be simple. Visual icons enable symptom identification in 1-2 seconds per item.

3. Daily Diary Transformation (Input Form)

Figure 4. 29 Daily Diary Initial Design

Figure 4. 30 Daily Diary Final Design

- Initial Design: Free text input form requiring complete sentences for symptoms, condition, medications.
- Revised Design:
  Symptoms: Selection through visual icons with multi-select
  Mood: Selection through emojis
  Medications: text area field
  Notes: Optional text area field
  Photo upload: Optional camera button
- Rationale: 72% of respondents preferred input by selecting options. Completion time reduced from 8 minutes to 1.5 minutes.

4. Integration of Routine Check-up Menu into Daily Diary

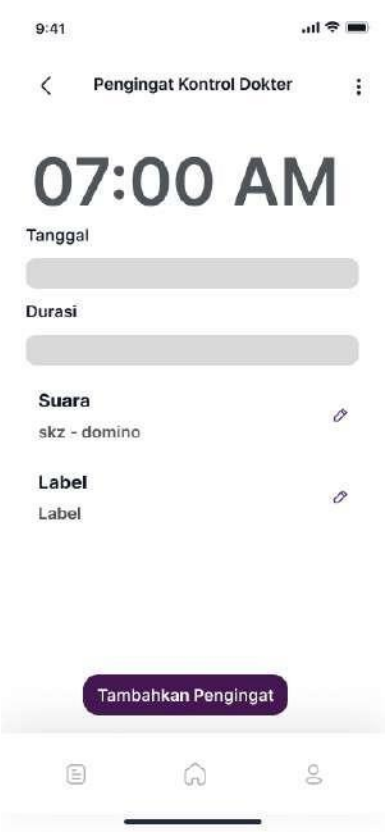



Figure 4. 31 Appointment Initial Design

Figure 4. 32 Appointment Final Design

- Initial Design: Routine check-up reminder feature as separate menu in bottom navigation
- Revised Design: Feature integrated directly into Daily Diary page with "Add Check-up Schedule" section
- Rationale: ODAPUS rarely create check-up schedules (1-2 times per 2-3 months) unlike daily medication reminders. This integration reduces menu complexity.

## B. Quick Plan Results

An Android application implementation plan was prepared with specifications:

Technical Specifications:

a. Platform: Android (minimum SDK API Level 24)
b. Programming language: Kotlin
c. Backend: Firebase Realtime Database

d. Authentication: Firebase Authentication
e. Local storage: SharedPreferences
f. Notification: AlarmManager
g. UI Framework: Android Framework

**C. Modeling/Quick Design Results**

Modeling in the second iteration focused on technical implementation details without changing the interface design resulting from first iteration redesign. The final interface design consists of:

1. Splash Screen Interface

This interface is the initial page that appears when the application is first opened. The splash screen interface design can be seen in Figure 4.33.

Figure 4. 33 Splash Screen Interface

2. Register Interface

This interface is used for new account registration. The register interface design can be seen in Figure 4.34.

Figure 4. 34 Register Interface

3. Login Interface

This interface is used to log in to the application using the registered username and password. The login interface design can be seen in Figure 4.35.

Figure 4. 35 Login Interface

4. Home Interface

The home page displays shortcuts to main features and information education. The home interface design can be seen in Figure 4.36.

Figure 4. 36 Home Interface

5. Daily Diary Interface

Figure 4. 37 Daily Diary Form Interface

6. Medication Reminder Interface

Medication consumption reminder list page

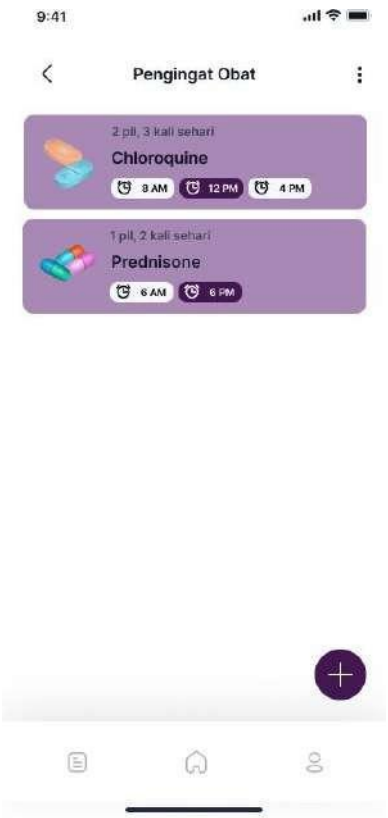



Figure 4. 38 Medication Reminder List Interface

Add/edit medication form page

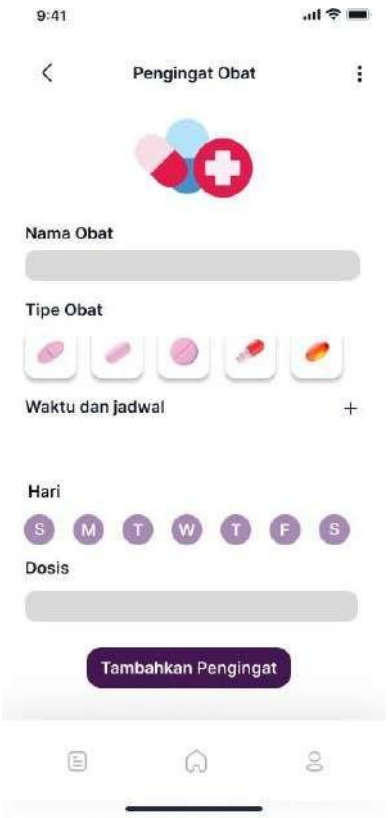



Figure 4. 39 Medication Reminder Form Interface

7. Flare Screening Interface

The flare screening page consists of:

Symptom selection page

Figure 4. 40 Symptom Selection Interface

Screening result page

Figure 4. 41 Screening Result Interface

8. Education Interface

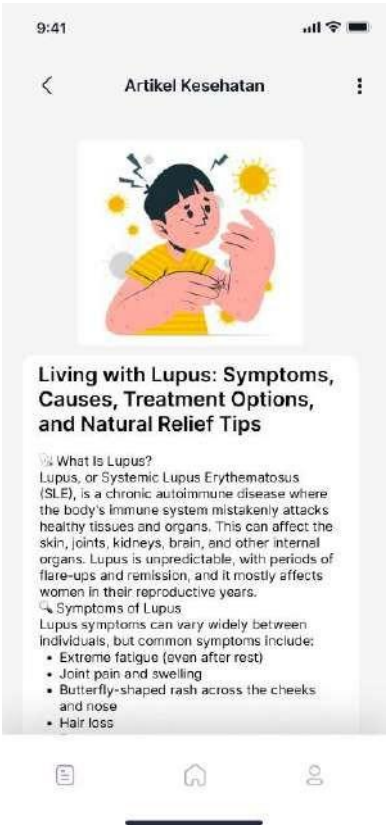



Figure 4. 42 Article Detail Interface

9. Profile Interface

The profile page displays user information and settings menu. The profile interface design can be seen in Figure 4.43.

Figure 4. 43 Profile Interface

## D. Construction of Prototype Results

A functional Android application was successfully built with complete implementation:

a. Database Implementation

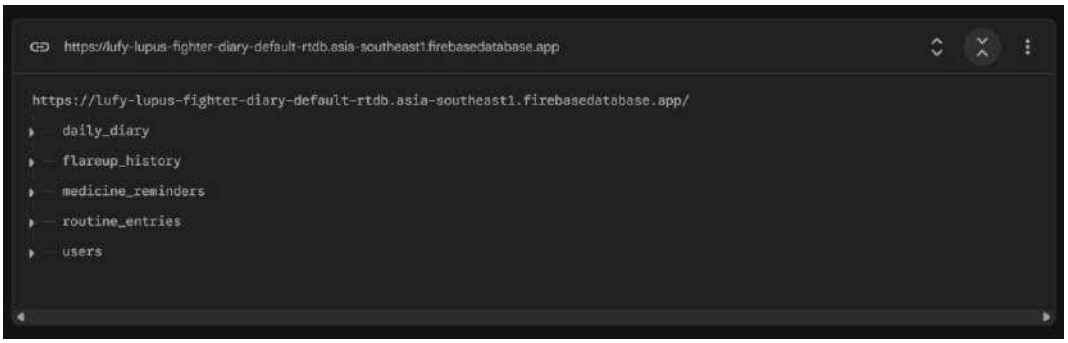



Figure 4. 44 Firebase Realtime Database Structure

b. Authentication Implementation

The splash screen page is the first display shown when the application is opened. The implementation of the splash screen can be seen in Figure 4.45. After the splash screen, users will be directed to the login page if they are not authenticated, or to the home page if they have previously logged in.

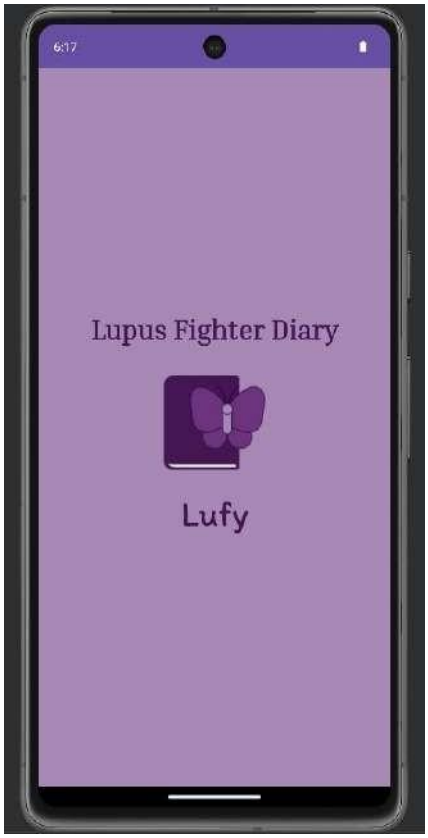



Figure 4. 45 Splash Screen Implementation

The implementation of the login and register pages can be seen in Figure 4.46 and Figure 4.47. On these pages, the system uses Firebase Authentication for the authentication process.

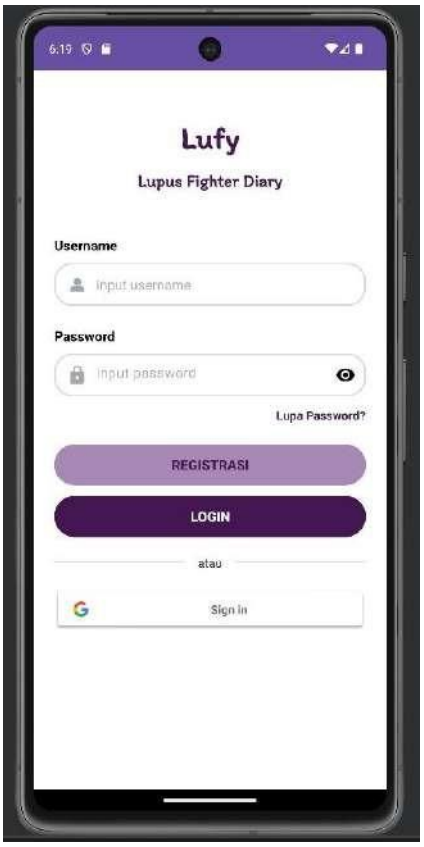



Figure 4. 46 Login Page Implementation

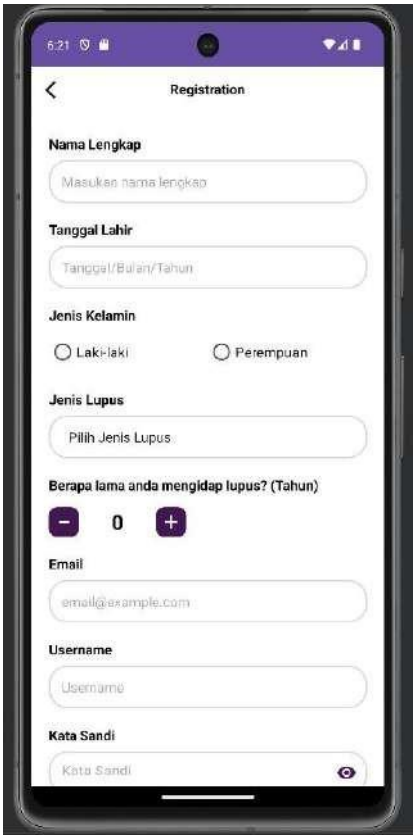



Figure 4. 47 Register Page Implementation

c. Homepage Implementation

The home page displays shortcuts to main features and information education. The implementation of the home page can be seen in Figure 4.48.

Figure 4. 48 Home Page Implementation

d. Flare Screening Feature Implementation

On this page, ODAPUS can select the symptoms they are currently experiencing. The implementation can be seen in Figure 4.49.

Figure 4. 49 Symptom Selection Page Implementation

e. Storing Screening Results

The implementation of the screening result page can be seen in Figure 4.50 and Figure 4.51.

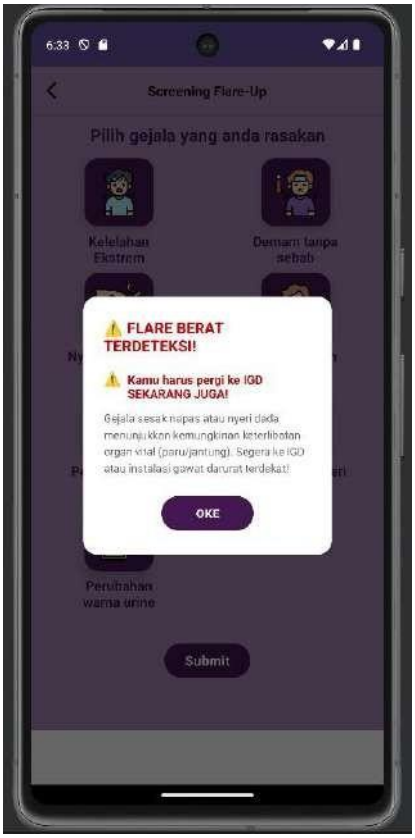



Figure 4. 50 Screening Result Page Implementation

Figure 4. 51 Symptom Selection Page Implementation

f. Daily Diary Implementation

The daily health logging feature allows ODAPUS to record their health condition on a daily basis. The implementation can be seen in Figure 4.52.

Figure 4. 52 Daily Health Log Form Implementation

g. Medication Reminder Implementation

The medication reminder feature allows ODAPUS (people living with lupus) to record medication schedules and receive timely notifications to support treatment adherence. The implementation can be seen in Figure 4.53 and Figure 4.54.

Figure 4. 53 Medication Reminder List Implementation

Figure 4. 54 Add Medication Reminder Form Implementation

h. Other Features Implementation

The implementation of the routine control reminder feature and educational information feature as follows:

Figure 4. 55 Implementation of Routine Control Reminder

Figure 4. 56 Implementation of Educational Article Page

## E. Deployment, Delivery & Feedback Results

Figure 4. 57 Second FGD with ODAPUS from the Sahabat Cempluk Foundation

The second FGD was conducted on December 12, 2025, with 10 ODAPUS participants. Unlike the first FGD which only demonstrated Figma design, the second FGD demonstrated the completed functional Android application. Testing Process:

a. Application Demonstration:
    1. Researcher conducted screen sharing via Zoom
    2. Step-by-step demo for each main feature
b. Testing:
    1. Participants installed APK on their respective smartphones
    2. Tried scenarios: creating diary entry, flare screening, creating medication reminder, adding check-up schedule, reading articles
    3. Free exploration of other features
c. SUS Questionnaire Completion:

Table 4. 10 SUS Score per Respondent

| No | Statement | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | I feel that I would like to use this application regularly to help manage my Lupus condition. | 5 | 5 | 4 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 4.7 |
| 2 | I feel that this application is too complicated or confusing. | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1.3 |
| 3 | This application is easy to use for recording and monitoring my condition. | 5 | 5 | 4 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 4.8 |
| 4 | I feel that I need assistance from someone with technical expertise (such as IT personnel or healthcare professionals) to be able to use this application. | 1 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1.6 |
| 5 | The features in this application are well integrated and | 5 | 5 | 4 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 4.8 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | function properly. | | | | | | | | | | | |
| 6 | This application feels inconsistent (for example, the interface or features change frequently and are confusing). | 1 | 1 | 1 | 3 | 1 | 1 | 2 | 2 | 1 | 1 | 1.4 |
| 7 | I am confident that most ODAPUS users will quickly understand how to use this application. | 5 | 4 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 4.8 |
| 8 | This application feels cumbersome or difficult to use in daily activities. | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1.2 |
| 9 | I feel confident when using this application. | 5 | 5 | 4 | 5 | 5 | 5 | 3 | 5 | 5 | 5 | 4.7 |
| 10 | I need to learn many things before I can use this application smoothly. | 1 | 3 | 2 | 5 | 2 | 1 | 3 | 5 | 2 | 3 | 2.7 |

Table 4. 11 SUS Positive Statements

| No | Positive Statement | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | I feel that I would like to use this application regularly to help manage my Lupus condition. | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 3 |
| 3 | This application is easy to use for recording and monitoring my condition. | 3 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | The features in this application are well integrated and function properly. | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 |
| 7 | I am confident that most ODAPUS users will quickly understand how to use this application. | 4 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 |
| 9 | I feel confident when using this application. | 4 | 4 | 3 | 4 | 4 | 4 | 2 | 4 | 4 | 4 |
| Sum | | 19 | 19 | 16 | 20 | 20 | 20 | 15 | 19 | 20 | 19 |

Table 4. 12 SUS Negative Statements

| No | Negative Statement | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | I feel that this application is too complicated or confusing. | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 4 | 4 |
| 4 | I feel that I need assistance from someone with technical expertise (such as IT personnel or healthcare professionals) to be able to use this application. | 4 | 2 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 4 |
| 6 | This application feels inconsistent (for example, the interface or features change frequently and are confusing). | 4 | 4 | 4 | 2 | 4 | 4 | 3 | 3 | 4 | 4 |
| 8 | This application feels cumbersome | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | or difficult to use in daily activities. | | | | | | | | | | |
| 10 | I need to learn many things before I can use this application smoothly. | 4 | 2 | 3 | 0 | 3 | 4 | 2 | 0 | 3 | 2 |
| Sum | | 20 | 16 | 16 | 14 | 19 | 19 | 15 | 13 | 18 | 18 |

Table 4. 13 SUS Total scores of each respondent

| No | Statement | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | I feel that I would like to use this application regularly to help manage my Lupus condition. | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 3 |
| 2 | I feel that this application is too complicated or confusing. | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 4 | 4 |
| 3 | This application is easy to use for recording and monitoring my condition. | 3 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 |
| 4 | I feel that I need assistance from someone with technical expertise (such as IT personnel or healthcare professionals) to be able to use this application. | 4 | 2 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 4 |
| 5 | The features in this application are well integrated and function properly. | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | This application feels inconsistent (for example, the interface or features change frequently and are confusing). | 4 | 4 | 4 | 2 | 4 | 4 | 3 | 3 | 4 | 4 |
| 7 | I am confident that most ODAPUS users will quickly understand how to use this application. | 4 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 |
| 8 | This application feels cumbersome or difficult to use in daily activities. | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 |
| 9 | I feel confident when using this application. | 4 | 4 | 3 | 4 | 4 | 4 | 2 | 4 | 4 | 4 |
| 10 | I need to learn many things before I can use this application smoothly. | 4 | 2 | 3 | 0 | 3 | 4 | 2 | 0 | 3 | 2 |
| Sum | | 39 | 35 | 32 | 34 | 39 | 39 | 30 | 32 | 38 | 37 |

SUS Score Calculation:

For each respondent, the score is calculated using the following formula:

1. Odd-numbered statements (1, 3, 5, 7, 9):

   Score = Value – 1

2. Even-numbered statements (2, 4, 6, 8, 10):

   Score = 5 – Value

3. Total score = Σ score × 2.5

Calculation for all respondent:

1. Respondent 1 = 39 × 2.5 = 97.5
2. Respondent 2 = 35 × 2.5 = 87.5
3. Respondent 3 = 32 × 2.5 = 80

4. Respondent 4 = 34 × 2.5 = 85
5. Respondent 5 = 39 × 2.5 = 97.5
6. Respondent 6 = 39 × 2.5 = 97.5
7. Respondent 7 = 30 × 2.5 = 75
8. Respondent 8 = 32 × 2.5 = 80
9. Respondent 9 = 38 × 2.5 = 95
10. Respondent 10 = 37 × 2.5 = 92.5

Average All Respondent = 97.5 + 87.5 + 80 + 85 + 97.5 + 97.5 + 75 + 80 + 95 + 92.5/10 = 88.75

Evaluation Results:

Overall SUS Score: 88.75 out of 100

1. Category: "Excellent" (Bangor et al., 2009)
2. Far above digital health application benchmark (68)

Analysis Per Aspect:

1. Ease of use (Item 3): average 4.8
2. Ease of learning (Item 7): average 4.8
3. User confidence (Item 9): average 4.7
4. Desire to use regularly (Item 1): average 4.7
5. Good feature integration (Item 5): average 4.8
6. Low complexity (Item 2): average 1.3 (lower is better)
7. High consistency (Item 6): average 1.4 (lower is better)

Second Iteration Conclusion:

The SUS score of 88.75 proves that the redesign based on first iteration feedback successfully improved usability significantly. The transformation from text-heavy to visual-first, interface simplification, and integration of routine check-up features proved to be aligned with ODAPUS needs.

## 4.2 Discussion

### 4.2.1 Achievement of Research Objectives and Answers to Research Questions

**A. Research Problem 1: Design and Development of mHealth Application**

This study addresses the first research problem by explaining how a mobile health (mHealth) application can be designed and developed to support self-management of Systemic Lupus Erythematosus (SLE) for people with lupus (ODAPUS) in Indonesia. In line with the

self-management support framework discussed in Section 2.4, the application was developed using an iterative and user-centered approach to ensure that the system effectively supports daily self-management activities.

The development process was conducted through a two-iteration prototyping approach involving ODAPUS from the early stages. The first iteration focused on identifying user needs and developing the initial application design through an in-depth interview with an ODAPUS representative (NL), followed by prototype evaluation through a Focus Group Discussion (FGD). Feedback from this stage indicated that the initial design was overly complex, text-heavy, and contained too many features, which could hinder effective self-management.

Based on the findings from the first iteration, the second iteration focused on refining and implementing the application design. Key improvements included a transition from text-heavy interfaces to a visual-first approach, simplification of navigation, integration of the routine check-up feature into the daily diary, and the use of icons and illustrations to enhance usability. During the second FGD, users did not provide additional critical comments regarding the application's design or features when explicitly asked for feedback, indicating that no major usability issues were identified at this stage. Therefore, the design was considered sufficiently acceptable to support self-management activities, and further major design iterations were not deemed necessary.

The implementation resulted in a functional Android-based application comprising five main features that align with the self-management support components discussed in Section 2.4. Through these features, the application supports ODAPUS in monitoring symptoms, managing daily health activities, conducting flare screening, organizing routine check-ups, and accessing relevant health education within the Indonesian context.

**B. Research Problem 2: Application Usability Evaluation**

The second research problem was addressed through usability evaluation using the System Usability Scale (SUS). The developed application achieved an average SUS score of 88.75, which is categorized as "Excellent" and exceeds the standard benchmark score of 68. This result indicates that the application demonstrates a high level of usability and is well accepted as a self-management support tool for ODAPUS.

Analysis of individual SUS items shows that the application's main strengths lie in ease of use, clarity, and consistency. Most respondents felt confident when using the application and perceived its features as well integrated. These results reflect the effectiveness of the iterative design process, particularly the simplification of the interface and the use of a visual-first

approach to support daily self-management activities, in line with the self-management support framework discussed in Section 2.4.

However, several respondents provided lower scores on items related to the need for learning before using the application smoothly (Statement 10) and, in one case, the need for technical assistance (Statement 4). These responses may be influenced by respondents' demographic characteristics and prior experience with health applications. Although some respondents frequently used applications such as Klik Sardjito and JKN Mobile, these systems primarily function as administrative and appointment tools rather than self-management applications. Consequently, prior familiarity with such applications may not fully prepare users for interacting with a self-management system that requires active symptom monitoring and reflection.

In addition, usability testing was conducted under real conditions, where some ODAPUS participants reported feeling physically unwell during the evaluation session. Given the fluctuating nature of SLE, such conditions may have affected concentration and comprehension when completing the usability assessment. Overall, the SUS results indicate that the application is easy to use, while also showing that clearer initial guidance and simpler interactions are still needed to better support ODAPUS.

### 4.2.2 Design Evolution and User Input Influence

One important finding of this study is how user input directly influenced the evolution of the application design and contributed to improved usability. The most significant change was the transition from a text-heavy interface to a visual-first design, as illustrated in Figures 4.25–4.32. This design evolution aligns with usability principles discussed in Section 2.6.1, which emphasize that clear visual elements enhance user understanding and engagement. Questionnaire results further support this finding, with 90% of respondents preferring applications with clear and easily accessible menus (Table 4.1, Statement 22) and 72% preferring data entry through predefined options (Table 4.1, Statement 12). These design changes are reflected in the System Usability Scale (SUS) results (Table 4.10), particularly in the high average score for ease of use (average score of 4.8 on Statement 3) and the low score on inconsistency (low average score of 1.4 on Statement 6), indicating that the design changes effectively improved the user experience.

### 4.2.3 Research Strengths

This research has several strengths that need to be identified:

1. Participatory Approach with Real Users
   - Involved ODAPUS from the start through FGD and questionnaire
   - 10 FGD participants + 22 questionnaire respondents provided comprehensive input
2. Iterative Process that Produced Significant Improvements
   - Design transformation based on feedback resulted in SUS score of 88.75
   - Identification and correction of design errors before full implementation
3. Complete Functional Implementation
   - Ready-to-use Android application with integrated Firebase backend
   - All planned features successfully implemented
4. Flare Screening Feature as Innovation
   - Systematic rule-based algorithm with hierarchical priorities
   - Prioritizes symptoms threatening vital organs
5. Standardized Usability Evaluation
   - SUS enables objective comparison with other applications
   - Score of 88.75 as empirical evidence of excellent usability
6. Complete Process Documentation
   - Visual comparison of design evolution
   - Reference for similar research in the future
7. Comprehensive Self-Management Feature Integration
   - Monitoring, medication, screening, appointment, education in one platform
   - Integration of routine check-up into diary as example of thoughtful design
8. Very High Usability Score
   - 88.75 far above benchmark of 68
   - Reflects success of participatory approach
9. Local Context Adaptation
   - Indonesian language
   - Involving Indonesian ODAPUS
   - Addresses research gap (sub-section 2.1.3)

### 4.2.4 Research Limitations

Despite having various strengths, this research also has several limitations that need to be acknowledged:

1. Limited Number of Respondents

- Only 10 respondents for SUS

2. No Clinical Validation - Critical Limitation

   The flare screening algorithm has not been validated by rheumatology specialists. This is a critical limitation because:

   - Clinical Risk: False negatives could delay treatment for severe flares affecting vital organs, while false positives may cause unnecessary anxiety and emergency department visits.
   - Algorithm Limitations: The current rule-based system does not account for individual medical history, comorbidities, or complex symptom interactions that clinicians consider in real diagnosis.
   - Safety Implications: Although designed as a self-management support tool (not a diagnostic device), clinical validation is essential to ensure recommendations are safe and align with current medical standards. Without validation, this application remains a research prototype and cannot be responsibly deployed for broader clinical use.
   - Need for Prospective Study: Future validation must compare app screening results against specialist diagnosis using gold standards (e.g., SLEDAI, physician global assessment) and calculate sensitivity, specificity, and predictive values of the algorithm.

3. Evaluation Limited to Usability Aspects
   a. Does not measure clinical effectiveness, impact on adherence, quality of life, or flare frequency
   b. Requires longitudinal studies
4. Short-term Testing
   a. Respondents only used for 15-20 minutes
   b. Does not measure long-term engagement, real-world usage patterns
5. Not Tested on Various Clinical Conditions
   a. Not yet tested for ODAPUS with severe active flares, specific comorbidities, low health literacy, or physical limitations
6. Platform Limited to Android
   a. Not accessible for iOS users
7. No Longitudinal Study

   a. Does not measure continued use, changes in clinical outcomes, or factors affecting continued use

8. Limited Educational Content
   a. Not yet adapted to various health literacy levels
   b. Does not yet include videos or interactive modules
9. Screening Algorithm Limitations
   a. Does not account for complex individual medical history
   b. Does not use machine learning
10. No System Performance and Scalability Assessment
   a. Does not assess performance on various device specifications, database scalability, system reliability, or data security measures

# CHAPTER V
# CONCLUSION AND RECOMMENDATIONS

## 5.1 Conclusion

Based on the research results and discussion that have been conducted, it can be concluded as follows:

1. The LUFY mHealth application has been successfully designed and developed to support self-management of SLE for ODAPUS in Indonesia through a prototyping approach involving ODAPUS from the early stages. The application was built using the Android platform with Kotlin and Firebase Realtime Database. The needs identification process resulted in five main features: (1) daily health condition recording, (2) routine check-up reminders, (3) medication reminders, (4) self-administered flare screening, (5) educational information about SLE. The design evolution from a text-heavy approach to visual-first based on ODAPUS input resulted in significant improvements in ease of use.
2. The LUFY application has excellent usability based on evaluation using the System Usability Scale (SUS). Testing with 10 ODAPUS respondents resulted in an average SUS score of 88.75 ("Excellent" category), far exceeding the digital health application benchmark of 68. This indicates that the LUFY application is well accepted by ODAPUS as a self-management support tool.

## 5.2 Recommendations

Based on the research limitations that have been identified, the following are recommendations for future research and development:

1. Develop an iOS version to increase reach to Apple device users.
2. Conduct clinical validation of the flare screening feature by involving rheumatology specialists to improve credibility and accuracy.
3. Conduct long-term research with a larger and more diverse sample to measure engagement, usage patterns, and result generalization.
4. Conduct experimental research to measure the application's impact on health outcomes, medication adherence, quality of life, and flare frequency.

5. Develop a machine learning-based algorithm that can adapt to individual patient symptom patterns.
6. Develop more comprehensive educational content with medical professional validation and add video formats and interactive modules.
7. Implement end-to-end encryption, automatic backup mechanisms, and evaluate database scalability to support increased user numbers.
8. Conduct research to evaluate application effectiveness when users experience active flares or have specific clinical conditions and physical limitations.

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# APPENDIX

hasil kuesioner FGD 1

| Timestamp | Inisial Nama Depan | Jenis Kelamin | Usia | Usia | Pendidikan Terakhir |
|---|---|---|---|---|---|
| 09/08/2025 11:10:08 | Rere | Perempuan | 26-35 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 11:10:23 | Intan | Perempuan | 17-25 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 11:11:32 | Miftahun Nurul Jannah | Perempuan | 36-45 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 11:12:09 | Melinda | Perempuan | 36-45 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 11:13:39 | Shufa | Perempuan | 17-25 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 11:13:58 | Azalia | Perempuan | 17-25 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 11:14:56 | Amirotul soliah | Perempuan | 17-25 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 11:20:23 | najel | Perempuan | 26-35 Tahun | | Sarjana (S1) |
| 09/08/2025 11:21:12 | Laras | Perempuan | 17-25 Tahun | | SMP/Sederajat |
| 09/08/2025 11:22:41 | Suci | Perempuan | 17-25 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 11:23:14 | Amirotul soliah | Perempuan | 17-25 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 11:25:56 | Naura | Perempuan | 17-25 Tahun | | Sarjana (S1) |
| 09/08/2025 11:28:46 | k | Perempuan | 17-25 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 11:30:35 | Suzana | Perempuan | 36-45 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 12:01:08 | S | Perempuan | 17-25 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 12:03:54 | Kustinah | Perempuan | 26-35 Tahun | | SMA/SMK/Sederajat |
| 09/08/2025 21:05:05 | DS | Perempuan | 17-25 Tahun | | SMA/SMK/Sederajat |
| 20/09/2025 9:52:27 | Rike | Perempuan | 17-25 Tahun | | SMA/SMK/Sederajat |
| 23/09/2025 17:01:36 | Dhiya | Perempuan | 17-25 Tahun | | Sarjana (S1) |
| 24/09/2025 13:39:18 | Marfuah | Perempuan | 26-35 Tahun | | Sarjana (S1) |
| 25/09/2025 14:06:02 | Adeviani Fiardhani | Perempuan | 26-35 Tahun | | Pascasarjana (S2/S3) |
| 03/10/2025 9:11:45 | Jeje | Perempuan | 17-25 Tahun | | SMA/SMK/Sederajat |

| Domisili Saat Ini (diisi ses | Status Pernikahan | Pekerjaan Saat Ini | Sejak Kapan Anda Didiag | Saya terbiasa mencatat k | Saya biasanya mencatat l |
|---|---|---|---|---|---|
| Sumberharjo, Prambanan | Menikah | Menjaga toko roti | 1-3 tahun yang lalu | 2 | 2 |
| Juwiring, Klaten, Jawa Te | Belum Menikah | Pelajar/Mahasiswa | 4-6 tahun yang lalu | 2 | 2 |
| Pesanggrahan, Jakarta S | Menikah | Ibu Rumah Tangga | 1-3 tahun yang lalu | 5 | 5 |
| Jogjakarta | Menikah | Ibu Rumah Tangga | 1-3 tahun yang lalu | 4 | 3 |
| Bogor | Belum Menikah | Pekerja Kreatif - Content | 1-3 tahun yang lalu | 3 | 3 |
| sapuran, wonosobo, jawa | Belum Menikah | Pelajar/Mahasiswa | 1-3 tahun yang lalu | 3 | 3 |
| Patikraja, Banyumas, Jaw | Belum Menikah | Tidak Bekerja | 7-10 tahun yang lalu | 4 | 4 |
| sumatera utara | Belum Menikah | Tidak Bekerja | 4-6 tahun yang lalu | 3 | 3 |
| pekuncen, banyumas, jaw | Belum Menikah | Tidak Bekerja | 4-6 tahun yang lalu | 5 | 4 |
| Sidosari 003/001, Wuwuh | Belum Menikah | Pelajar/Mahasiswa | 1-3 tahun yang lalu | 5 | 5 |
| Patikraja, Banyumas, Jaw | Belum Menikah | Kerja | 7-10 tahun yang lalu | 4 | 4 |
| Sukodadi, Lamongan, Jav | Belum Menikah | Tidak Bekerja | 7-10 tahun yang lalu | 5 | 4 |
| graha indah, balikpapan u | Belum Menikah | Pegawai Negeri/Swasta | 4-6 tahun yang lalu | 4 | 1 |
| Godean/Sleman/jogjakart | Menikah | Ibu Rumah Tangga | 1-3 tahun yang lalu | 4 | 4 |
| Kecamatan Bantarsari Ka | Belum Menikah | Tidak Bekerja | 4-6 tahun yang lalu | 3 | 3 |
| Kecamatan kanigaran, ko | Menikah | Ibu Rumah Tangga | 7-10 tahun yang lalu | 3 | 3 |
| Muara Badak, Kutai Karta | Belum Menikah | Pelajar/Mahasiswa | 1-3 tahun yang lalu | 5 | 1 |
| Kec Gubeng/Kota Suraba | Menikah | Swasta | Kurang dari 1 tahun yang | 3 | 3 |
| Koto tangah/Kota Padang | Belum Menikah | Tidak Bekerja | 1-3 tahun yang lalu | 4 | 1 |
| Klaten | Belum Menikah | Tidak Bekerja | Kurang dari 1 tahun yang | 3 | 4 |
| Jatikramat, Jatiasih, Beka | Menikah | Ibu Rumah Tangga | 4-6 tahun yang lalu | 2 | 2 |
| Serang, Banten | Belum Menikah | Tidak Bekerja | Kurang dari 1 tahun yang | 3 | 3 |

| Saya biasanya mencatat | Saya pernah merasa lupa | Saya merasa pencatatan | Saya sering kesulitan me | Saya nyaman menggunal | Saya dapat membedakan |
|---|---|---|---|---|---|
| 3 | 3 | 3 | 3 | 3 | 3 |
| 3 | 2 | 4 | 2 | 4 | 4 |
| 5 | 2 | 5 | 2 | 4 | 5 |
| 4 | 4 | 2 | 4 | 5 | 4 |
| 5 | 5 | 5 | 3 | 5 | 3 |
| 2 | 2 | 2 | 3 | 3 | 4 |
| 4 | 4 | 4 | 2 | 4 | 4 |
| 5 | 2 | 5 | 3 | 3 | 5 |
| 5 | 4 | 5 | 5 | 5 | 4 |
| 5 | 1 | 5 | 1 | 5 | 5 |
| 4 | 4 | 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 | 5 | 2 |
| 5 | 5 | 5 | 4 | 5 | 5 |
| 4 | 4 | 4 | 4 | 4 | 4 |
| 3 | 5 | 3 | 4 | 4 | 5 |
| 3 | 2 | 3 | 4 | 4 | 5 |
| 5 | 5 | 5 | 5 | 5 | 3 |
| 3 | 4 | 4 | 5 | 3 | 2 |
| 5 | 4 | 5 | 4 | 5 | 2 |
| 3 | 3 | 4 | 3 | 3 | 4 |
| 3 | 4 | 4 | 4 | 3 | 5 |
| 4 | 4 | 4 | 2 | 5 | 4 |

| Saat merasa mengalami f | Saat mengalami flare, say | Saya lebih suka mengisi c | Saya merasa menyimpan | Saya membutuhkan infor | Saya pernah merasa kesu |
|---|---|---|---|---|---|
| 2 | 3 | 3 | 3 | 3 | 3 |
| 4 | 5 | 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 | 5 | 3 |
| 4 | 4 | 4 | 4 | 5 | 2 |
| 3 | 4 | 4 | 3 | 5 | 2 |
| 3 | 3 | 3 | 3 | 3 | 4 |
| 4 | 4 | 4 | 4 | 4 | 2 |
| 5 | 5 | 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 5 | 5 | 3 |
| 5 | 5 | 5 | 5 | 5 | 5 |
| 4 | 4 | 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 | 5 | 1 |
| 5 | 2 | 5 | 5 | 5 | 1 |
| 4 | 4 | 4 | 4 | 4 | 2 |
| 5 | 3 | 5 | 3 | 5 | 3 |
| 5 | 5 | 5 | 5 | 5 | 3 |
| 3 | 2 | 5 | 5 | 5 | 3 |
| 4 | 4 | 4 | 4 | 4 | 3 |
| 3 | 4 | 5 | 5 | 5 | 3 |
| 3 | 2 | 3 | 4 | 3 | 3 |
| 5 | 5 | 3 | 5 | 5 | 3 |
| 4 | 4 | 3 | 5 | 5 | 1 |

| Saya merasa terganggu c | Saya pernah menggunaka | Saya merasa terbantu de | Saya merasa bingung ata | Saya ingin menggunakan | Saya lebih suka aplikasi d |
|---|---|---|---|---|---|
| 3 | 2 | 3 | 2 | 4 | 3 |
| 4 | 4 | 4 | 2 | 4 | 4 |
| 4 | 5 | 5 | 2 | 5 | 4 |
| 1 | 3 | 3 | 2 | 5 | 3 |
| 3 | 4 | 4 | 3 | 5 | 3 |
| 4 | 2 | 2 | 3 | 2 | 2 |
| 2 | 2 | 2 | 2 | 4 | 4 |
| 4 | 2 | 4 | 3 | 4 | 4 |
| 1 | 2 | 2 | 2 | 4 | 5 |
| 1 | 1 | 5 | 1 | 5 | 5 |
| 2 | 4 | 4 | 2 | 4 | 4 |
| 5 | 1 | 2 | 1 | 5 | 5 |
| 2 | 1 | 1 | 1 | 5 | 5 |
| 1 | 3 | 4 | 2 | 4 | 4 |
| 3 | 3 | 3 | 3 | 5 | 5 |
| 2 | 4 | 5 | 3 | 3 | 5 |
| 1 | 1 | 1 | 3 | 5 | 5 |
| 3 | 3 | 3 | 3 | 4 | 4 |
| 2 | 3 | 3 | 3 | 5 | 5 |
| 3 | 2 | 3 | 3 | 3 | 4 |
| 5 | 2 | 2 | 2 | 5 | 5 |
| 3 | 2 | 3 | 1 | 5 | 5 |

| Saya lebih nyaman jika a | Saya suka jika aplikasi m | Saya merasa nyaman menggunakan aplikasi yang menunya jelas dan mudah diakses. | | | |
|---|---|---|---|---|---|
| 3 | 3 | 3 | | | |
| 4 | 4 | 4 | | | |
| 5 | 5 | 5 | | | |
| 3 | 4 | 4 | | | |
| 5 | 5 | 5 | | | |
| 1 | 1 | 1 | | | |
| 4 | 4 | 4 | | | |
| 4 | 4 | 4 | | | |
| 5 | 5 | 5 | | | |
| 5 | 5 | 5 | | | |
| 4 | 4 | 4 | | | |
| 5 | 5 | 5 | | | |
| 5 | 5 | 5 | | | |
| 4 | 4 | 4 | | | |
| 5 | 5 | 5 | | | |
| 5 | 5 | 5 | | | |
| 5 | 5 | 5 | | | |
| 4 | 4 | 4 | | | |
| 5 | 5 | 5 | | | |
| 4 | 4 | 5 | | | |
| 5 | 5 | 5 | | | |
| 5 | 5 | 5 | | | |

Hasil Kuesioner FGD 2

| Timestamp | Inisial Nama Depan | Domisili Saat Ini (diisi sesuai urutan Kecamatan/Ka | Jenis Kelamin | Usia |
|---|---|---|---|---|
| 12/12/2025 17:11:52 | Shifa | Bogor | Perempuan | 17-25 Tahun |
| 12/12/2025 17:14:10 | S | Kecamatan Bantarsari Kabupaten Cilacap Jawa Te | Perempuan | 17-25 Tahun |
| 12/12/2025 17:16:50 | Amirotul soliah | Patikraja, Banyumas, Jawa Tengah | Perempuan | 18-25 Tahun |
| 12/12/2025 17:46:11 | suci | Kajoran, Magelang, Jawa Tengah | Perempuan | 18-25 Tahun |
| 12/12/2025 17:51:34 | k | Balikpapan | Perempuan | 18-25 Tahun |
| 12/12/2025 17:53:39 | Kustinah | Kecamatan kanigaran, kota probolinggo, jawa timu | Perempuan | 26-35 Tahun |
| 12/12/2025 17:54:33 | via | Adipala, Cilacap, Jawa Tengah | Perempuan | 18-25 Tahun |
| 12/12/2025 18:05:12 | Intan | Klaten | Perempuan | 18-25 Tahun |
| 12/12/2025 18:31:33 | Naura | Surabaya | Perempuan | 18-25 Tahun |
| 16/12/2025 9:42:57 | Dewi Shinta | Muara Badak | Perempuan | 18-25 Tahun |
| 26/12/2025 12:11:46 | Adeviani | Bekasi | Perempuan | 26-35 Tahun |

| Pendidikan Terakhir | Status Pernikahan | Pekerjaan Saat Ini | Sejak Kapan Anda Didiagnosa Lupus |
|---|---|---|---|
| SMA/SMK/Sederajat | Belum Menikah | Pegawai Negeri/Swasta | 1-3 tahun yang lalu |
| SMA/SMK/Sederajat | Belum Menikah | Tidak Bekerja | 4-6 tahun yang lalu |
| SMA/SMK/Sederajat | Belum Menikah | Jaga toko | 4-6 tahun yang lalu |
| SMA/SMK/Sederajat | Belum Menikah | Pelajar/Mahasiswa | 1-3 tahun yang lalu |
| SMA/SMK/Sederajat | Belum Menikah | Pegawai Negeri/Swasta | 7-10 tahun yang lalu |
| SMA/SMK/Sederajat | Menikah | Ibu Rumah Tangga | Lebih dari 10 tahun yang lalu |
| SMA/SMK/Sederajat | Belum Menikah | Tidak Bekerja | 4-6 tahun yang lalu |
| SMA/SMK/Sederajat | Belum Menikah | Pelajar/Mahasiswa | 4-6 tahun yang lalu |
| Sarjana (S1) | Belum Menikah | Pegawai Negeri/Swasta | 7-10 tahun yang lalu |
| SMA/SMK/Sederajat | Belum Menikah | Pelajar/Mahasiswa | 1-3 tahun yang lalu |
| Pascasarjana (S2/S3) | Menikah | Ibu Rumah Tangga | 1-3 tahun yang lalu |

| Frekuensi menggunakan aplikasi kesehatan sebelu | Apakah ada aplikasi kesehatan yg pernah digunaka | Saya merasa ingin menggunakan aplikasi ini secar |
|---|---|---|
| 3 | Jkn | 5 |
| 5 | Klik Sardjito dan jkn | 5 |
| 1 | | 4 |
| 5 | Klik Sardjito Aja | 5 |
| 1 | tidak | 5 |
| 1 | Belum | 5 |
| 4 | jkn mobile, klik sardjito aja | 5 |
| 3 | - | 4 |
| 1 | tidak | 5 |
| 2 | tidak ada | 4 |
| 4 | Aplikasi kesehatan basic sih, cuma untuk ngetrack | 4 |

| Saya merasa aplikasi ini terlalu rumit atau membin | Aplikasi ini mudah digunakan untuk mencatat dan r | Saya merasa perlu bantuan orang yang paham tekn |
|---|---|---|
| 1 | 5 | 1 |
| 1 | 5 | 3 |
| 2 | 4 | 2 |
| 1 | 5 | 1 |
| 1 | 5 | 1 |
| 2 | 5 | 1 |
| 1 | 4 | 2 |
| 2 | 5 | 2 |
| 1 | 5 | 2 |
| 1 | 5 | 1 |
| 3 | 4 | 3 |

| Fitur-fitur dalam aplikasi ini saling terhubung dan t | Aplikasi ini terasa tidak konsisten (misalnya tampil | Saya yakin sebagian besar pengguna ODAPUS akan |
|---|---|---|
| 5 | 1 | 5 |
| 5 | 1 | 4 |
| 4 | 1 | 5 |
| 5 | 3 | 5 |
| 5 | 1 | 5 |
| 5 | 1 | 5 |
| 4 | 2 | 4 |
| 5 | 2 | 5 |
| 5 | 1 | 5 |
| 5 | 1 | 5 |
| 4 | 3 | 5 |

| Aplikasi ini terasa merepotkan atau sulit digunakan | Saya merasa percaya diri saat menggunakan aplika | Saya harus mempelajari banyak hal terlebih dahulu |
|---|---|---|
| 1 | 5 | 1 |
| 1 | 5 | 3 |
| 2 | 4 | 2 |
| 1 | 5 | 5 |
| 1 | 5 | 2 |
| 1 | 5 | 1 |
| 2 | 3 | 3 |
| 1 | 5 | 5 |
| 1 | 5 | 2 |
| 1 | 5 | 3 |
| 3 | 4 | 2 |

| Berikan kesan serta kritik atau saran yang memban |
|---|
| |
| Aplikasi ini sangat membantu karena saya orangny |
| |
| good job |
| Semoga kedepannya bisa disebar luaskan aplikasi |
| semoga aplikasi ini dapat memudahkan kami para |
| Sudah bagus dan mudah dipahami |
| sangat membantu untuk seorang odapus, karena b |
| harus tersedia di IOS |
| Sempet ada bug pas saya pake aplikasi nya.. Trus k |

Implementation of the Flare Screening Rules

The following is the implementation of rules that serves as the core logic of the screening feature:

```
private fun analyzeFlareLevel(symptoms: Set<String>): FlareAnalysis {
        val symptomCount = symptoms.size
        val totalSymptoms = 7

        // Gejala berat (critical symptoms)
        val hasCriticalSymptoms = symptoms.contains(SESAK_DADA) ||
symptoms.contains(URINE)

        // Gejala sistemik
        val hasDemam = symptoms.contains(DEMAM)
        val hasPembengkakan = symptoms.contains(PEMBENGKAKAN)

        // Gejala ringan
        val mildSymptoms = setOf(KELELAHAN, NYERI_SENDI, RUAM)
        val mildSymptomsCount = symptoms.intersect(mildSymptoms).size

        // ==========================================
        // LOGIC FLARE BERAT (SEVERE)
        // ==========================================

        // 1. Ada gejala critical (sesak/nyeri dada ATAU perubahan warna
urine)
        if (hasCriticalSymptoms) {
            return FlareAnalysis(
                severity = "Berat",
                title = "⚠️ FLARE BERAT TERDETEKSI!",
                warning = "Kamu harus pergi ke IGD SEKARANG JUGA!",
                description = if (symptoms.contains(SESAK_DADA)) {
                    "Gejala sesak napas atau nyeri dada menunjukkan
kemungkinan keterlibatan organ vital (paru/jantung). Segera ke IGD atau
instalasi gawat darurat terdekat!"
                } else {
                    "Perubahan warna urine menunjukkan kemungkinan lupus
nephritis (gangguan ginjal). Segera ke IGD atau instalasi gawat darurat
terdekat!"
```

```
                },
                isEmergency = true
            )
        }

        // 2. ≥4 gejala muncul bersamaan
        if (symptomCount >= 4) {
            return FlareAnalysis(
                severity = "Berat",
                title = "⚠️ FLARE BERAT TERDETEKSI!",
                warning = "Kamu harus pergi ke IGD SEKARANG JUGA!",
                description = "$symptomCount gejala muncul bersamaan menunjukkan aktivitas lupus yang tinggi. Kondisi ini memerlukan evaluasi medis segera di IGD.",
                isEmergency = true
            )
        }

        // 3. Demam + (ruam/nyeri sendi/pembengkakan)
        if (hasDemam && (symptoms.contains(RUAM) || symptoms.contains(NYERI_SENDI) || hasPembengkakan)) {
            return FlareAnalysis(
                severity = "Berat",
                title = "⚠️ FLARE BERAT TERDETEKSI!",
                warning = "Kamu harus pergi ke IGD SEKARANG JUGA!",
                description = "Kombinasi demam dengan gejala sistemik lain menunjukkan peradangan aktif yang memerlukan perhatian medis segera. Segera ke IGD.",
                isEmergency = true
            )
        }

        // ==========================================
        // LOGIC FLARE SEDANG (MODERATE)
        // ==========================================
```

```
        // 1. ≥3 gejala ringan ATAU
        // 2. Ada demam ATAU pembengkakan (tanpa gejala critical)
        if (symptomCount >= 3 || hasDemam || hasPembengkakan) {
            return FlareAnalysis(
                severity = "Sedang",
                title = "$symptomCount dari $totalSymptoms gejala terdeteksi",
                warning = "Segera hubungi dokter dalam 24 jam!",
                description = "Anda mengalami beberapa gejala yang menunjukkan peradangan sistemik atau kemungkinan awal gangguan organ. Disarankan untuk:\n\n" +
                        "• Hubungi dokter dalam 24 jam\n" +
                        "• Hindari aktivitas berat\n" +
                        "• Pantau perkembangan gejala\n" +
                        "• Lanjutkan obat maintenance\n" +
                        "• Evaluasi kemungkinan infeksi\n\n" +
                        "Jika gejala memburuk dalam 24-48 jam, segera ke IGD.",
                isEmergency = false
            )
        }

        // ==========================================
        // LOGIC FLARE RINGAN (MILD)
        // ==========================================

        // 1-2 gejala dari kelompok ringan (kelelahan, nyeri sendi, ruam)
        return FlareAnalysis(
            severity = "Ringan",
            title = "$symptomCount dari $totalSymptoms gejala terdeteksi",
            warning = "Pantau kondisi Anda dengan cermat",
            description = "Anda mengalami gejala ringan yang biasanya terkait dengan aktivitas muskuloskeletal atau kulit. Saran penanganan:\n\n" +
```

```
                    "• Istirahat cukup\n" +
                    "• Hindari paparan sinar matahari\n" +
                    "• Minum obat sesuai resep\n" +
                    "• Kurangi aktivitas berat\n" +
                    "• Catat perkembangan gejala 24-48 jam\n" +
                    "• Tetap terhidrasi dengan baik\n\n" +
                    "Jika gejala bertambah atau memburuk, segera hubungi
dokter.",
            isEmergency = false
        )
    }
```

Implementation of reminder scheduling using AlarmManager:

```
private fun syncFromFirebaseOnLoad() {
        Log.d(TAG, "🔄 Auto-syncing from Firebase on activity load...")

        medicineManager.syncFromFirebase { success, message ->
            if (success) {
                Log.d(TAG, "✅ Sync berhasil: $message")
                // Reload medicines setelah sync
                loadMedicines()
            } else {
                Log.w(TAG, "⚠️ Sync gagal (mungkin belum login): $message")
                // Tetap load dari local jika sync gagal
                loadMedicines()
            }
        }
    }
```

```
private fun saveMedicine(name: String, dosage: String) {
        val medicine = Medicine(
            name = name,
            dosage = dosage,
            medicineType = selectedMedicineType,
            times = selectedTimes.sorted(),
            days = selectedDays.toList(),
            isActive = true,
            alarmSoundUri = selectedAlarmSoundUri?.toString() ?: ""
        )

        medicineManager.saveMedicine(medicine)
        MedicineAlarmManager.setAlarm(this, medicine)
        showSuccessAndDeviceGuide()
    }

private fun checkExactAlarmPermission() {
        if (Build.VERSION.SDK_INT >= Build.VERSION_CODES.S) {
            val alarmManager = getSystemService(ALARM_SERVICE) as
android.app.AlarmManager
            if (!alarmManager.canScheduleExactAlarms()) {
                AlertDialog.Builder(this)
                    .setTitle("⏰ Izin Alarm Diperlukan")
                    .setMessage("Aplikasi memerlukan izin untuk mengatur
alarm tepat waktu agar pengingat obat dapat bekerja dengan baik.")
                    .setPositiveButton("Buka Pengaturan") { _, _ ->
                        val intent =
Intent(Settings.ACTION_REQUEST_SCHEDULE_EXACT_ALARM)
                        startActivity(intent)
                    }
                    .setNegativeButton("Nanti", null)
                    .show()
            }
        }
    }
```