الجمهورية الجزائرية الديمقراطية الشعبية

REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE

وزارة التعليم العالي والبحث العلمي

Ministry of Higher Education and Scientific Research

جامعة أبي بكر بلقايد - تلمسان -

University Aboubakr Belkaïd - Tlemcen - Faculty of TECHNOLOGY

MASTER THESIS

Submitted in partial fulfillment of the requirements for the **degree of MASTER**
Field : Biomedical Engineering
Specialization : Biomedical and Hospital Informatics

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Thesis Theme: Project 1275

MediGuide

Mobile Medication Reminder Application for Elderly Users

Publicy definded on 24/06/2026 before the following committee composed of :

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Academic Year: 2025 / 2026

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ



Acknowledgment

First and foremost, I thank **Allah**, the Most Gracious and the Most Merciful, who granted me the strength, patience, and determination to overcome every challenge and complete this work. Without His guidance and blessings, this achievement would not have been possible.

I would also like to express my deepest gratitude to **myself** for the perseverance, dedication, and resilience I maintained throughout this journey. Despite the difficulties, moments of doubt, and countless hours of work, I remained committed to achieving this goal.

My sincere and heartfelt thanks go to my beloved **parents** for their unconditional love, continuous encouragement, sacrifices, and prayers. Their support has been the foundation of every success I have achieved.

I would also like to thank my **brothers** and **sisters** for their constant motivation, understanding, and encouragement throughout my studies.

Special thanks go to **my family** and **friends** who supported me emotionally and morally during the preparation of this project. Their kindness, encouragement, and confidence in my abilities helped me move forward during challenging times.

I would like to express my sincere appreciation to all **the professors** and academic staff of the **Department of Biomedical Engineering** for the knowledge, guidance, and support they provided throughout my university education.

Finally, I would like to extend my deepest gratitude to my supervisors, Mr./Mrs. [**Yasmine BENCHIB and Morad BEN OSMAN**], for the valuable guidance, constructive feedback, patience, and continuous support provided throughout the realization of this project.

From the bottom of my heart, thank you to everyone who contributed, directly or indirectly, to the completion of this work.

MEGROUS HAFSA

Dedication

I dedicate this work to the resilient and courageous people of Palestine, especially to our brothers and sisters in Gaza, who continue to stand with dignity and hope despite injustice and hardship.

May this humble achievement be a small light of solidarity and a reminder that they are never forgotten.

I also dedicate this work to every moment of effort, patience, and perseverance that accompanied me throughout this journey. Behind every page of this dissertation are countless hours of learning, challenges, determination, and continuous improvement.

This work represents the result of years of study, dedication, and personal growth. It is a reflection of the obstacles that were overcome, the lessons that were learned, and the passion that motivated me to keep moving forward despite difficulties.

I dedicate it to the belief that hard work, creativity, and persistence can transform ideas into reality and challenges into achievements.

Finally, I dedicate this work to my future self, as a reminder that every accomplishment begins with a dream, grows through effort, and becomes possible through patience and determination.

MEGROUS HAFSA

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List of Abbreviations

Abbreviation	Full Meaning
AI	Artificial Intelligence
ANADE	Agence Nationale d'Appui et de Développement de l'Entrepreneuriat
ANDI	Agence Nationale de Développement de l'Investissement
ANSEJ	Agence Nationale de Soutien à l'Emploi des jeunes
API	Application Programming Interface
APK	Android Package Kit
AOT	Ahead-Of-Time (compilation method used by Dart/Flutter)
AR	Arabic (language code)
BEA	Banque Extérieure d'Algérie
BNA	Banque Nationale d'Algérie
CASNOS	Caisse d'Assurance Sociale des Non-Salariés
CEO	Chief Executive Officer
CNAS	Caisse Nationale des Assurances Sociales
CNRC	Centre National du Registre du Commerce
CPA	Crédit Populaire d'Algérie
CPU	Central Processing Unit

Abbreviation	Full Meaning
DA	Dinar Algérien (Algerian Dinar)
DGI	Direction générale des Impôts
EN	English (language code)
EURL	Entreprise unipersonnelle à responsabilité limitée
FCM	Firebase Cloud Messaging
FNSEJ	Fonds National de Soutien à l'Emploi des Jeunes
FR	French (language code)
GB	Gigabyte
GPS	Global Positioning System
IBS	Impôt sur les bénéfices des sociétés
IDE	Integrated Development Environment
IT	Information Technology
MB	Megabyte
mHealth	Mobile Health (use of mobile technology in healthcare)
MVP	Minimum Viable Product
NIF	Numéro d'Identification fiscale
NoSQL	Non-relational (Not Only SQL) database
OS	Operating System
PDF	Portable Document Format

Abbreviation	Full Meaning
PME	Petite et moyenne entreprise (Small and Medium-Sized Enterprise)
QR	Quick Response (code)
RAM	Random Access Memory
RBAC	Role-Based Access Control
RTL	Right-To-Left (text direction for Arabic)
SARL	Société à responsabilité limitée
SDK	Software Development Kit
SUS	System Usability Scale
TAP	Taxe sur l'Activité Professionnelle
TTS	Text-To-Speech
UI	User Interface
UML	Unified Modeling Language
USA	United States of America
UX	User Experience
WCR	Working Capital Requirement

ABSTRACT

The aging of Algerian population is experiencing a growing prevalence of chronic diseases that require continuous medication management. Medication non-adherence remains a significant challenge among elderly patients, often resulting from forgetfulness, dose confusion, reduced visual acuity, and the absence of accessible, Arabic-adapted digital health tools.

This project presents MediGuide, a mobile medication reminder application specifically designed for elderly Algerian users. The application provides three interconnected interfaces: a pharmacist interface for digital prescription management, a simplified patient interface featuring large buttons, high-contrast visuals, and multilingual voice reminders in Arabic, French, and English, and a caregiver interface enabling real-time monitoring of medication adherence and automated missed-dose alerts.

MediGuide was developed using Flutter for the mobile frontend and Firebase for backend services, ensuring secure data management and automatic synchronization. The application delivers multimodal reminders through visual notifications, audible alerts, and voice guidance to support elderly users in following their treatment schedules.

The proposed solution contributes to improving medication adherence, reducing medication errors, and strengthening communication between patients, pharmacists, and caregivers in a culturally adapted Algerian context.

Keywords: Medication adherence, Elderly patients, Mobile health, Mobile application, Pharmacist, Caregiver, Flutter, Firebase, Algeria.

RÉSUMÉ

La population algérienne vieillissante connaît une prévalence croissante des maladies chroniques nécessitant une prise en charge médicamenteuse continue. La non-adhérence thérapeutique demeure un défi majeur chez les patients âgés, souvent due à l'oubli, à la confusion des doses, à la baisse de l'acuité visuelle et à l'absence d'outils numériques accessibles et adaptés à la langue arabe.

Ce projet présente MediGuide, une application mobile de rappel médicamenteux conçue spécifiquement pour les utilisateurs algériens âgés. L'application propose trois interfaces interconnectées : une interface pharmacien pour la gestion numérique des ordonnances, une interface patient simplifiée dotée de grands boutons, de visuels à contraste élevé et de rappels vocaux multilingues en arabe, en français et en anglais, ainsi qu'une interface aidant familial permettant la surveillance en temps réel de l'observance médicamenteuse et l'envoi automatique d'alertes en cas de dose non prise.

MediGuide a été développée avec Flutter pour la partie mobile et Firebase pour les services backend, garantissant une gestion sécurisée des données et une synchronisation automatique. L'application délivre des rappels multimodaux combinant des notifications visuelles, des alertes sonores et un guidage vocal, afin d'accompagner les personnes âgées dans le suivi de leur traitement.

La solution proposée contribue à améliorer l'observance médicamenteuse, à réduire les erreurs de prise et à renforcer la communication entre patients, pharmaciens et aidants, dans un contexte algérien adapté.

Mots-clés : Observance médicamenteuse, Personnes âgées, Santé mobile, Application mobile, Pharmacien, Aidant, Flutter, Firebase, Algérie.

الملخص

يشهد المجتمع الجزائري تزايداً ملحوظاً في نسبة شيخوخة السكان، مما يصاحبه ارتفاع في معدلات الإصابة بالأمراض المزمنة التي تستلزم إدارة دوائية مستمرة. ويُعدّ عدم الالتزام بتناول الأدوية تحدياً بالغ الأهمية لدى المرضى المسنين، وغالباً ما يُعزى ذلك إلى النسيان، والخلط بين الجرعات، وضعف حدة البصر، وغياب الأدوات الرقمية الصحية الميسّرة والمكيّفة مع اللغة العربية.

يقدّم هذا المشروع تطبيقMediGuide ، وهو تطبيق هاتفي لتذكير المرضى بأدويتهم، مُصمَّم خصيصاً للمستخدمين الجزائريين المسنين. يوفّر التطبيق ثلاث واجهات مترابطة: واجهة مخصصة للصيدلاني لإدارة الوصفات الطبية رقمياً، وواجهة مبسّطة للمريض تتضمن أزراراً كبيرة الحجم، ومرئيات عالية التباين، وتذكيرات صوتية متعددة اللغات بالعربية والفرنسية والإنجليزية، وواجهة لمرافق المريض من العائلة تتيح مراقبة الالتزام الدوائي في الوقت الفعلي وإرسال تنبيهات تلقائية عند إغفال أي جرعة.

تم تطوير MediGuide باستخدام Flutter للواجهة الأمامية و Firebaseلخدمات الواجهة الخلفية، مما يكفل إدارة آمنة للبيانات ومزامنة تلقائية. يُقدّم التطبيق تذكيرات متعددة الوسائط تجمع بين الإشعارات المرئية والتنبيهات الصوتية والإرشاد الصوتي، لمساعدة المسنين على الالتزام بمواعيد علاجهم.

يُسهم الحل المقترح في تحسين الالتزام الدوائي، والحدّ من أخطاء تناول الأدوية، وتعزيز التواصل بين المرضى والصيادلة ومرافقي العائلة، في سياق جزائري يراعي الخصوصية الثقافية.

الكلمات المفتاحية :الالتزام الدوائي، كبار السن، الصحة المتنقلة، تطبيق هاتفي، الصيدلاني، مرافق المريض، Flutter، Firebase، الجزائر.

General Introduction

Population ageing is becoming one of the most significant demographic transformations of the twenty-first century. According to the United Nations **[11],** the proportion of people aged 60 years and above is increasing rapidly worldwide, creating new challenges for healthcare systems. As chronic diseases become more prevalent with age, ensuring proper medication management and adherence among older adults has become a major public health priority.

Scientific evidence consistently demonstrates that non-adherence medication constitutes a critical and widespread challenge among this population. Studies indicate that between 40 and 75% of elderly patients do not take their medications correctly or on time **[1], [3].** The primary contributing factors include age-related cognitive decline, reduced visual acuity, polypharmacy complexity, and limited familiarity with digital technologies. The consequences of non-adherence are well-documented: disease progression, increased frequency of hospital admissions, and significant economic burdens on both families and the healthcare system.

Mobile health applications have emerged as a promising intervention for addressing this challenge. Systematic reviews have demonstrated that reminder-based mobile applications can improve medication adherence by 30 to 50%, particularly when they incorporate simplified, accessible notification modalities **[1], [2].** Furthermore, studies involving structured caregiver or pharmacist support have yielded even more compelling results, with adherence rates rising substantially when human guidance accompanies digital reminders **[5].**

Nevertheless, a critical examination of existing mHealth solutions reveals persistent and significant gaps, particularly in the Algerian context. Very few applications offer complete Arabic language support with a proper right-to-left layout. Most existing interfaces are inadequately adapted for elderly users, featuring small fonts, complex navigation structures, and insufficient color contrast. The pharmacist, who occupies a central role in medication management, is rarely integrated into available digital solutions. Furthermore, no existing application provides a shared dose-confirmation mechanism enabling the patient, pharmacist, and family caregiver to collectively verify medication intake.

These observations constitute the primary motivation for the development of MediGuide, a mobile medication reminder application designed from the ground up for elderly users in Algeria.

MediGuide is built around three complementary and interconnected interfaces: a pharmacist interface for digital prescription management and patient monitoring; a simplified patient interface incorporating large interactive elements, high-contrast visuals, and multilingual voice reminders in Arabic, French, and English; and a family caregiver interface enabling real-time adherence monitoring and automated missed-dose alerts.

Problem Statement

The core problem this project addresses is the absence of a culturally adapted, accessible, and pharmacist-integrated digital solution for medication adherence among elderly patients in Algeria. Current applications fail to simultaneously satisfy the linguistic requirements of Arabic-speaking users, the interface accessibility needs of aging populations, and the collaborative monitoring expectations of Algerian family and pharmacy networks. This gap results in continued reliance on informal and unreliable reminder practices, contributing directly to the high rates of non-adherence and their associated clinical consequences.

Research Questions

This project is guided by the following research questions:

1. What are the critical design and functional requirements that a mobile health application must fulfill in order to be accessible, usable, and culturally appropriate for elderly medication management in the Algerian context?

2. How does the integration of a pharmacist and a family caregiver as active participants within a mobile medication reminder system influence the completeness and reliability of adherence monitoring for elderly patients?

Proposed Solution: MediGuide

To address these identified challenges, this project proposes MediGuide, a mobile application developed using Flutter for the frontend and Firebase for backend services. The application delivers multimodal reminders through visual notifications, audible alerts, and Arabic voice guidance. Its tri-stakeholder architecture directly connects the elderly patient, the community

pharmacist, and the family caregiver within a single, cohesive system, ensuring that medication schedules are not only communicated but actively monitored and confirmed.

Objectives

The principal objective of this project is to design, develop, and evaluate MediGuide as a practical and inclusive solution that demonstrably improves medication adherence among elderly users in Algeria.

This principal objective is pursued through the following specific objectives:

1. Conduct a systematic analysis of the barriers to medication adherence among elderly Algerian users and identify the functional and design requirements of an accessible mHealth solution.

2. Design a senior-optimized user interface incorporating accessibility best practices, including large touch targets, high-contrast color schemes, and multilingual voice guidance.

3. Integrate the three primary stakeholders the elderly patient, the community pharmacist, and the family caregiver within a unified digital platform supporting real-time communication and adherence monitoring.

4. Implement a reliable multimodal reminder and dose-confirmation system ensuring that each scheduled medication intake is notified, acknowledged, and recorded.

5. Develop a fully functional Minimum Viable Product (MVP) of MediGuide and evaluate its usability and effectiveness through testing sessions conducted with real elderly users.

Chapter 1:

State of the Art (Literature Review) and Analysis of Existing Application

1.1 Introduction

Before the design and development of MediGuide, it is essential to establish a thorough understanding of the current landscape of scientific research and existing mobile health solutions in the domain of medication adherence for the whole population in general and for elderly users especially. This chapter presents a systematic literature review and a critical comparative analysis of mobile health applications currently available on the market. It identifies the strengths and limitations of existing solutions and delineates the specific gaps that MediGuide aims to address, with particular attention to the Algerian socio-cultural and technological context.

1.2State of the Art (Literature Review)

A systematic review of approximately ten peer-reviewed publications, published between 2020 and 2025 sourced from recognized academic databases including the Cochrane Library, BMC, JMIR, Springer and BMJ Open, was conducted to establish the scientific foundation of this work. The principal findings are summarized below.

The effectiveness of mobile reminder applications in improving medication adherence is well-established in the scientific literature. A landmark Cochrane systematic review **[1]** and a large meta-analysis **[2]** independently demonstrated that simple reminder applications can improve adherence rates by 30% to 50%, yielding measurable clinical benefits including better glycemic and blood pressure control, and a reduction in emergency hospital admissions.

However, evidence specifically targeting elderly populations highlights considerably greater challenges. A study conducted by Babaskin et al. **[3]** among 816 senior participants revealed that 74% to 81% of respondents strongly preferred a single unified application over multiple specialized tools. The same study identified visual impairments, reported by 57% to 62% of participants and difficulty in learning to use new applications, reported by 32% to 64%, as the primary barriers to adoption. These findings were corroborated by Ramdowar et al. **[4]**, whose comprehensive review and user testing with ten elderly participants consistently identified complex navigation, small text elements and inadequate color contrast as the dominant usability obstacles.

A growing body of evidence suggests that technology-mediated interventions can play an important role in maintaining medication adherence among older adults. Pratiwi et al. **[5],** in a systematic review of adherence-support strategies, reported that mobile reminders, electronic monitoring systems, caregiver involvement, and digital health technologies contribute positively to medication-taking behavior. The review further emphasized that the effectiveness of these interventions increases when technological solutions are combined with human support mechanisms, such as family assistance or healthcare professional follow-up.

Studies conducted in comparable socio-economic contexts reinforce these findings. Apte et al. **[6]** are currently conducting a large randomized trial evaluating a combined digital reminder and pill organizer intervention among 752 elderly participants aged 60 to 80, taking three or more medications daily. Early indicators confirm that digital tools combined with simplified physical aids are effective in resource-limited environments. Similarly, Reddy et al. **[7]** demonstrated that sustainable adoption of mHealth solutions in rural and peri-urban settings requires applications that are operationally straightforward and capable of functioning reliably without continuous internet access.

Recent developments in mobile healthcare applications have increasingly incorporated monitoring and communication features beyond simple medication reminders. SmartCare, proposed by Ababtain et al. **[8],** integrates medication adherence support, caregiver monitoring, disease management tools, and location-tracking services within a unified platform. This approach demonstrates the growing trend toward collaborative healthcare ecosystems in which patients, caregivers, and healthcare professionals interact through a shared digital environment.

Concerning solutions developed specifically for Arabic-speaking populations, Ababtain et al. **[8]** developed and evaluated SmartCare in Saudi Arabia, a mobile application combining medication reminders, GPS-based elderly location tracking, an AI chatbot and a caregiver monitoring dashboard. SmartCare represents the most comprehensive published solution in the regional context and serves as a direct point of comparison for "***MediGuide***".

The adoption of mobile health technologies among older adults is influenced not only by the availability of digital tools but also by users' perceptions and prior experience with technology. Lee et al. **[9]** found significant differences in attitudes and knowledge between users and non-users

of mobile health applications among adults aged 50 years and older. Their findings suggest that ease of use, perceived usefulness, and confidence in technology are essential factors affecting the successful adoption of medication management applications.

User interface design plays a critical role in the acceptance of mHealth applications among elderly populations. According to Alsswey and Al-Samarraie [10], cultural adaptation and age-sensitive interface design significantly influence elderly users' willingness to adopt mobile health technologies. Their study highlights the importance of simple navigation structures, readable text, appropriate color schemes, and culturally familiar interface elements when designing applications intended for older adults.

1.3 Synthesis of the Literature

The systematic review reveals that while mobile reminder applications demonstrably improve medication adherence across general populations, no existing solution comprehensively addresses the specific needs of elderly users in the Algerian context. Three convergent conclusions emerge from the reviewed evidence: first, simplicity of interface and reliability of reminders are prerequisites for adoption among elderly users; second, integration of human support whether professional or familial substantially amplifies the effectiveness of digital interventions; and third, cultural and linguistic adaptation is not a secondary consideration but a primary determinant of real-world usability.

1.4 Comparative Analysis of Existing Applications — Evolution 2022–2025

To further support the identification of functional and usability gaps in existing mHealth solutions, a structured comparative analysis was conducted on a selection of widely used medication management applications. The selected systems represent different technological approaches, ranging from simple reminder-based tools to integrated healthcare platforms. This comparison focuses on key dimensions relevant to elderly users, including usability, caregiver involvement, linguistic accessibility, and adherence support features.

App Name	Region	Year	Main Features	Strengths for Seniors	Weaknesses for Seniors	Arabic/French	Pharmacist Role	Family Sharing	Shared Confirm.
Medisafe **[12]**	USA	2025	Medication reminders, drug interaction alerts, family sharing, health dashboard	Very strong adherence support, caregiver ecosystem, reliable reminders	UI can be complex for first-time elderly users	Partial	Weak	Strong	Partial
MyTherapy **[13]**	Germany	2024	Medication reminders, health diary, symptom tracking, reports export	Simple interface, strong multilingual support, high usability for elderly	Limited advanced caregiver features in free version	Strong	Medium	Medium	Medium
Dosecast **[14]**	USA	2023	Flexible scheduling, refill tracking, time-zone support	Highly customizable, good for complex prescriptions	Less modern UI compared to newer apps	No	Weak	Weak	No
Round Health **[15]**	USA	2023	Minimalist reminders, Apple Watch sync, refill tracking	Extremely simple UI, ideal for elderly with low tech skills	iOS only, limited features (no interactions)	No	No	No	No

Sehhaty (صحتي) **[16]**	Saudi Arabia	2022	E-prescriptions, appointments, pharmacy services	Government-backed, fully Arabic, trusted system	Not a dedicated adherence app	Strong	Medium	No	No
Docic **[17]**	Tunisia	2022	Medical records, doctor communication, prescriptions storage	Regional Arabic/French support, patient record sharing	Not designed for daily medication reminders	Strong	Medium	Weak	No
Pill Reminder **[18]**	Global	2024	Basic alarms, simple medication reminders	Very easy to use, lightweight	No advanced features (no caregiver, no AI)	Partial	No	weak	No

Table 1:Comparative Analysis of Existing Medication Management Applications (2022–2025)

1.5 Gap Analysis — What Is Still Missing

The combined evidence from the literature review and the application analysis consistently reveals that existing solutions, despite their individual merits, fail to simultaneously address the convergent requirements of elderly medication management in the Algerian context. Six major gaps are identified.

Absence of genuine Arabic RTL support: Although a few apps (like Sehhaty) offer Arabic RTL, they lack senior-friendly design, pharmacist integration, or voice guidance and making them unsuitable for the target users

Interfaces inadequate for elderly users: Existing applications universally fail to implement the combination of large interactive elements, high-contrast color schemes, linear navigation without hidden sub-menus and minimal cognitive load required by the target demographic **[4].**

Exclusion of the pharmacist from the digital care pathway: Despite occupying a central role in medication management, particularly in the Algerian context where the community pharmacist is often the most accessible healthcare professional, the pharmacist is absent from virtually all existing digital adherence solutions.

Absence of shared dose confirmation: No existing solution provides a mechanism enabling the patient, pharmacist, and family caregiver to jointly verify medication intake, creating persistent uncertainty for all three stakeholders.

Inadequate adaptation to the Algerian socio-cultural context: Beyond linguistic considerations, the specific family dynamics, trust relationships with pharmacists, and daily routines characteristic of Algerian elderly users are not reflected in any currently available solution.

Lack of senior-centered Arabic voice guidance: While some applications offer partial multilingual support, none provides text-to-speech reminders in Arabic adapted for elderly users with limited digital literacy.

1.6 Requirements and High-Level Features

Based on the gap analysis, the following high-level requirements were identified for MediGuide.

The interface must implement extreme simplicity: large touch targets, a high-contrast color palette, linear navigation requiring a minimal number of steps to complete any core action and the complete absence of hidden menus or multi-level navigation structures.

Full multilingual support is required, encompassing complete Arabic right-to-left layout, French, and English, both at the interface level and for voice reminder delivery with medication names and instructions presented in a locally appropriate format.

The application must integrate the three primary stakeholders: the elderly patient, the community pharmacist, and the family caregiver, within a single, unified platform that supports real-time communication, prescription management, and adherence monitoring.

A reliable reminder and dose-confirmation system must be implemented, combining visual notifications, audible alerts, and Arabic voice guidance with a closed-loop confirmation mechanism that updates all three stakeholders upon dose intake or non-intake.

All collected health data must be managed securely, with role-based access control ensuring that each user can access exclusively the information and functionalities pertinent to their role.

1.7 Methodology and Technologies

1.7.1 Development Methodology

An Agile iterative development methodology was adopted for this project. This approach prioritizes the rapid delivery of functional increments, continuous usability testing with representative users, and iterative refinement based on observed feedback. It was selected for its flexibility, its alignment with the human-centered design philosophy of the project and its suitability for a single-developer academic context in which requirements evolve progressively through user engagement.

1.7.2 Selected Technologies

Flutter (Google, open-source) is a cross-platform UI development kit that enables the production of natively compiled Android and iOS applications from a single Dart codebase. Flutter was selected for its high-performance rendering engine, its extensive accessibility widget library and its capacity to support custom senior-friendly interfaces with large elements and high-contrast color schemes.

Firebase (Google Cloud Platform) provides the complete backend infrastructure for MediGuide, including authentication, real-time NoSQL database (Firestore), cloud messaging (FCM) and data storage. Firebase was selected for its native real-time synchronization capabilities and its robust push notification delivery infrastructure.

Dart is the statically-typed, object-oriented programming language underlying Flutter, optimized for asynchronous operations and reactive user interfaces.

1.7.3 Justification of Technology Choices

The Flutter and Firebase combination was selected based on four primary criteria: zero licensing cost for development at the scale of this project; a rapid development cycle permitting iterative refinement based on user feedback; a robust push notification infrastructure via Firebase Cloud Messaging, essential for reliable reminder delivery; and extensive documentation and active developer communities that substantially reduce troubleshooting overhead in a single-developer academic project.

1.8 Expected Results

The successful implementation of MediGuide is expected to yield the following outcomes upon evaluation with real users: a measurable improvement in self-reported medication adherence among elderly participants; a user satisfaction score demonstrating acceptable usability according to recognized benchmarks; a task completion rate for core application functions demonstrating that elderly users with limited prior digital experience can operate the application independently; and positive qualitative feedback from pharmacists and family caregivers regarding the perceived utility and ease of integration of the application into their daily practice.

1.9 Conclusion

This chapter has established the scientific and analytical foundation for the MediGuide project. The systematic literature review confirms that medication non-adherence among elderly patients represents a critical and persistent healthcare challenge, particularly in the Algerian context and that mobile health applications represent a demonstrably effective intervention when appropriately designed and supported. The comparative analysis of existing applications demonstrates that, while the field has matured significantly over the period 2022 to 2025, no currently available solution adequately addresses the convergent requirements of linguistic adaptation, interface accessibility, pharmacist integration, shared confirmation and cultural appropriateness that characterize the Algerian elderly population. The identified gaps provide a clear and well-grounded justification for the development of MediGuide and define the functional envelope within which the following chapters will detail the design, implementation and evaluation of the proposed solution

Chapter 2:

Needs Analysis and System Requirement

2.1 Introduction

Following the literature review and the critical gap analysis conducted in Chapter 1, it has become evident that existing medication reminder applications still present significant shortcomings in addressing the specific challenges faced by elderly users, particularly within the Algerian socio-cultural and technological context. Despite the proliferation of mobile health (mHealth) solutions, most of these applications fail to adequately account for the physical, cognitive, sensory and digital literacy limitations that characterize this vulnerable population.

The development of an effective and inclusive medication adherence system, therefore, necessitates a thorough and systematic understanding of the real needs, expectations and constraints of all stakeholders involved in the therapeutic process. In the case of MediGuide, the system is designed not only for elderly patients but also actively integrates two other essential actors: pharmacists and family caregivers. Each of these stakeholders plays a distinct yet complementary role in ensuring treatment compliance and patient safety.

This chapter aims to provide a comprehensive needs analysis of these three user profiles. It identifies their respective requirements and constraints to establish clear functional and non-functional requirements for the application. Furthermore, it highlights the major technical, ergonomic and cultural challenges that must be addressed during the design and implementation phases. The ultimate objective is to lay a solid theoretical and practical foundation for developing a usable, accessible and culturally adapted solution that effectively improves medication adherence among elderly users in Algeria.

2.2 User Profiles

2.2.1Elderly Patient (Primary User)

The elderly patient constitutes the primary target user of the MediGuide application. Typically aged 60 years and above, this group often suffers from multiple chronic conditions such

as diabetes, hypertension, cardiovascular diseases, and other long-term illnesses that necessitate continuous and complex medication regimens.

Many elderly individuals face age-related impairments, including reduced vision, declining memory, decreased manual dexterity and limited digital literacy. These challenges are further compounded in the Algerian context where some seniors reside in rural areas with unstable or limited internet connectivity, while others have low proficiency in French or English, relying primarily on Arabic for communication.

In response to these realities, MediGuide adopts a highly simplified and accessible design philosophy. The interface incorporates large buttons, high-contrast colors, intuitive navigation, full multilingual support and voice reminders in the user's preferred language. The overarching goal is to empower elderly users to manage their medications safely and independently, thereby reducing medication errors, cognitive overload and dependency on others.

2.2.2 Pharmacist

The pharmacist represents one of the central stakeholders in the MediGuide system. As a healthcare professional specialized in medication dispensing and therapeutic management, the pharmacist plays a pivotal role in ensuring the safety, accuracy, and effectiveness of patients' treatment plans.

Elderly patients with chronic diseases frequently require complex polypharmacy regimens, which significantly increase the risks of dosage errors, drug interactions, missed doses and adverse effects. In this context, pharmacists need an efficient, reliable and user-friendly digital tool to create, modify and monitor medication schedules effectively.

MediGuide addresses these needs by enabling pharmacists to easily create, update and supervise complete treatment plans. The application facilitates accurate verification of prescriptions, helps prevent medication conflicts, and improves coordination and communication with both patients and family caregivers. Furthermore, it reduces the administrative burden on pharmacists while ensuring that medication instructions remain clear, precise, and easily understandable for elderly users.

2.2.3 Family Caregiver

The family caregiver constitutes a vital support actor within the MediGuide ecosystem. In the Algerian context, the caregiver is typically a close family member such as a son, daughter, spouse or relative who plays a central role in assisting the elderly patient with daily healthcare needs and medication management.

Caregivers are generally more comfortable with digital technologies than elderly patients and often act as intermediaries between the patient and healthcare professionals. However, continuously monitoring medication adherence, tracking appointments, and ensuring treatment compliance can become emotionally stressful and time-consuming, particularly when the elderly patient suffers from multiple chronic conditions or cognitive impairments.

MediGuide addresses these challenges by providing caregivers with real-time access to medication schedules, instant alerts for missed or delayed doses and comprehensive adherence reports. The application also facilitates seamless communication between caregivers, pharmacists, and patients. By reducing uncertainty and improving coordination, MediGuide helps alleviate caregiver burden, decreases anxiety and contributes to safer, more effective and better-supported healthcare management for elderly patients.

2.3 Functional Requirements

Functional requirements define the core services, features and interactions that the MediGuide application must deliver to effectively meet the needs of its three primary user groups: elderly patients, pharmacists and family caregivers. These requirements specify the expected behavior of the system and form the foundation for ensuring proper medication management, real-time communication, and continuous monitoring.

The functional requirements were derived from the needs analysis and are organized according to the three user roles, while also including shared features that enable seamless

interaction among all stakeholders. They focus on delivering a practical, intuitive and reliable solution that addresses the daily challenges of medication adherence in the Algerian context.

2.3.1 Medication Management

The MediGuide application must provide robust medication management functionalities, primarily through the pharmacist interface. Pharmacists should be able to create, modify and organize comprehensive medication schedules for elderly patients. Each treatment plan shall include essential details such as medication name, dosage, frequency, treatment duration, timing of intake, meal-related instructions and any special recommendations or warnings.

The system must effectively support **polypharmacy** management, allowing the handling of multiple medications simultaneously which is common among elderly patients with chronic conditions. This includes features for detecting potential drug interactions, setting customized schedules and ensuring clear, easy-to-understand instructions tailored to the patient's profile.

This module forms the foundation of the application, as accurate and well-structured medication plans are essential for subsequent reminders, adherence tracking and shared confirmation among patients, pharmacists and caregivers.

2.3.2 Reminder and Notification System

The reminder and notification system constitutes one of the core functionalities of the MediGuide application, designed to deliver timely and effective alerts to elderly patients at scheduled medication times to enhance treatment adherence and minimize the risk of missed or delayed doses.

To accommodate the diverse needs and preferences of elderly users, the system supports multi-modal notifications, including visual alerts with large, high-contrast displays, audible notifications, and multilingual voice reminders in Arabic, French, and English using text-to-speech technology. In addition, the application automatically notifies family caregivers in real time when a dose is missed or significantly delayed, enabling prompt intervention and support, while also generating reminders for medical appointments, prescription renewals, and important treatment updates.

By integrating these comprehensive features, MediGuide ensures continuous follow-up, reduces medication errors and promotes a collaborative approach to healthcare management among patients, pharmacists and caregivers.

2.3.3 Authentication and User Management

The MediGuide application must implement a secure and user-friendly authentication system to protect sensitive health data while ensuring easy access for all user categories, allowing elderly patients, pharmacists, and family caregivers to create accounts, log in with email and password credentials, recover forgotten passwords, and securely manage their profiles.

A role-based access control (RBAC) mechanism is essential for defining and enforcing specific permissions based on each user's role, ensuring that elderly patients can only access their personal medication schedules and confirmation tools, pharmacists can manage prescriptions and monitor their patients, and family caregivers can view adherence reports and receive alerts without accessing unrelated medical data. Furthermore, the system must support secure session management and data encryption to maintain confidentiality and comply with privacy standards, thereby building trust among users, especially elderly patients and their families.

2.3.4 Communication and Monitoring

MediGuide must provide effective communication and real-time monitoring tools to strengthen coordination among elderly patients, pharmacists and family caregivers. The system should enable seamless information exchange, allowing caregivers and pharmacists to track medication adherence, view treatment progress and receive timely updates regarding the patient's condition.

Key monitoring features include tracking missed or delayed doses, visualizing adherence rates, accessing treatment history, and reviewing important health information. By facilitating continuous supervision and proactive intervention, these functionalities significantly enhance patient safety, reduce medication errors and improve the overall quality of healthcare follow-up.

2.3.5 Multilingual and Accessibility Features

Given that MediGuide targets elderly users with diverse educational and linguistic backgrounds, the application must offer high accessibility and inclusivity. The system shall support full multilingual functionality, including Arabic (with proper Right-to-Left layout), French and English to accommodate users' linguistic preferences.

To address age-related limitations, the user interface incorporates large buttons, clear and readable fonts, high-contrast colors, and simplified navigation. Additionally, voice reminders and audio assistance using text-to-speech technology are integrated to support users with visual or cognitive impairments. These accessibility features are essential to ensure that the application remains usable and effective for the target elderly population.

2.4 Non-Functional Requirements

Non-functional requirements define the quality attributes, performance criteria, and operational constraints that MediGuide must satisfy to ensure a reliable, secure, efficient and user-friendly experience. These requirements are critical for delivering a stable healthcare solution suitable for elderly patients, pharmacists and family caregivers.

2.4.1 Performance

The application must deliver fast response times and smooth navigation to provide a comfortable and frustration-free user experience, particularly for elderly users who may have limited familiarity with digital interfaces. The system should efficiently handle real-time notifications, medication reminders, data synchronization and adherence tracking without noticeable delays, even on low-end smartphones.

2.4.2 Security and Privacy

Given that MediGuide manages highly sensitive personal and medical information, robust security and privacy measures are essential. The application shall implement secure authentication mechanisms, encrypted data transmission and strict data protection protocols in compliance with relevant privacy standards.

Role-based access control (RBAC) must be enforced to ensure that users can only access information and functionalities relevant to their roles. Additionally, regular data backup and recovery mechanisms should be integrated to prevent data loss and maintain system integrity.

2.4.3 Usability and Accessibility

The user interface must be highly intuitive, simple, and specifically designed for elderly users with varying levels of digital literacy. Navigation should remain consistent and straightforward across all screens to minimize cognitive load.

Key accessibility features include large fonts, high-contrast color schemes, simplified workflows, multilingual support (Arabic with RTL layout, French, and English) and voice assistance. These elements are crucial to ensure independent and effective usage by elderly patients while reducing frustration and errors.

2.4.4 Reliability and Availability

MediGuide must demonstrate high reliability and availability to provide continuous support for medication management. The system should operate stably with minimal crashes, technical interruptions or data inconsistencies, even in areas with limited or unstable internet connectivity.

Furthermore, the application must guarantee dependable delivery of notifications and reminders, ensuring that critical alerts for missed doses or medical appointments reach users promptly and consistently.

2.5 System Design and Architecture

The design and architecture of MediGuide were carefully developed to create a simple, secure, reliable and scalable mobile application tailored to the specific needs of elderly patients, pharmacists, and family caregivers. The architectural choices prioritize usability, efficient data management, real-time communication and seamless integration between the different stakeholders.

2.5.1 General Architecture

MediGuide adopts a **client-server architecture** consisting of three main layers:

Firstly, Mobile Application Layer: The frontend interface through which elderly patients, pharmacists, and family caregivers interact with the system.

Secondary, Backend Layer: Responsible for business logic, user authentication, medication scheduling, notification management, and inter-user communication.

Lastly, Database Layer: Ensures secure and efficient storage of all application data.

This architecture provides high scalability, easier maintenance, centralized data control, and strong support for offline functionality through local caching and automatic synchronization.

2.5.2 Mobile Application Design

The mobile application was designed following a user-centered design approach, with particular attention to the physical, cognitive, and technological limitations of elderly users, emphasizing simplicity, clarity, and accessibility through large buttons and touch targets, high-contrast colors and readable typography, intuitive and consistent navigation, and minimal cognitive load.

The application is structured into dedicated modules, including medication management, reminders and notifications, adherence tracking, caregiver monitoring, and user profile management, with each module optimized to ensure quick and independent access to essential features.

2.5.3 Database Design

The database serves as the core component for organizing and managing all application data. It securely stores critical information such as user profiles, medication plans, treatment schedules, adherence records, notifications, and alerts.

The design ensures proper entity relationships, efficient data retrieval, and data consistency. Security measures, including role-based access and encryption, are implemented to protect sensitive medical information and maintain patient privacy in accordance with ethical and legal standards.

2.5.4 Notification Mechanism

The notification system is a central feature of MediGuide, designed to deliver timely and effective reminders to support medication adherence by supporting multi-modal notifications, including visual push notifications, audio and voice reminders in Arabic, French, and English and real-time alerts sent to family caregivers in case of missed or delayed doses.

This mechanism significantly contributes to reducing medication errors, improving treatment compliance and providing peace of mind to both patients and their families.

2.6 Technologies and Development Tools

The development of MediGuide was based on a carefully selected set of modern technologies and tools chosen for their reliability, performance, cross-platform capabilities and suitability for healthcare applications targeting elderly users. The technological stack was designed to ensure fast development, high usability, real-time functionality and strong offline support.

2.6.1 Flutter Framework

Flutter, an open-source UI software development kit created by Google, was selected as the primary framework for building MediGuide. It allows the development of high-performance, natively compiled applications for multiple platforms (Android, iOS, and potentially web) from a single codebase.

Flutter was chosen due to its excellent rendering engine, rich widget library, and hot reload feature, which significantly accelerated the development process. Moreover, its flexibility in creating custom, accessible and visually appealing interfaces made it particularly suitable for designing senior-friendly screens with large elements and high contrast.

2.6.2 Dart Programming Language

Dart serves as the programming language for Flutter. It is an object-oriented, garbage-collected language optimized for building fast and reactive user interfaces. Dart offers a clean syntax, strong type system, and asynchronous programming support, which facilitated the implementation of complex features such as real-time synchronization, medication scheduling, and notification management.

2.6.3 Firebase Backend Services

Firebase, Google's mobile and web application development platform, was adopted as the backend solution for MediGuide, providing a comprehensive suite of cloud services, including **Firebase Authentication** for secure user login and role management, **Firestore as a flexible**, real-time NoSQL database, and **Firebase Cloud Messaging (FCM)** for reliable push notifications.

The integration of Firebase enabled rapid backend development, real-time data synchronization across the three user roles and seamless offline functionality through local data persistence.

2.6.4 Development Environments

Android Studio was employed primarily for Android-specific tasks, including SDK management, virtual device emulation, performance profiling and compatibility testing across various Android versions and screen sizes.

2.7 System Conception

System conception is a fundamental phase in the development of the MediGuide application. It aims to translate the identified user needs and functional requirements into a coherent, structured and technically feasible model that will guide the subsequent implementation and maintenance of the system.

This phase involves modeling user interactions with the application, defining the main system components and their relationships, organizing data structures and designing the overall workflows. To achieve a clear and comprehensive representation, various UML diagrams (such as Use Case, Class, Sequence and Entity-Relationship diagrams) are employed.

The conception of MediGuide places particular emphasis on simplicity**,** accessibility, and seamless communication between the three key stakeholders: elderly patients, pharmacists, and family caregivers. By adopting a user-centered design approach, the system ensures efficient medication management, real-time monitoring and improved coordination, ultimately contributing to better therapeutic adherence and healthcare outcomes.

2.7.1 Use Case Diagram

The Use Case Diagram represents the functional requirements of the MediGuide system by illustrating the interactions between the main actors and the core functionalities of the application, providing a clear visual overview of how different stakeholders engage with the system to achieve effective medication management and improve therapeutic adherence among elderly patients. The primary actors identified in the system are the **Elderly Patient**, who is the main end-user receiving medication reminders, confirming dose intake, viewing their treatment schedule and managing their personal profile; **the Pharmacist**, who is the healthcare professional responsible for creating and managing medication plans, adding new patients, monitoring adherence and communicating with patients and caregivers; and the **Family Caregiver**, who is the supporting actor monitoring the patient's medication intake in real-time, receiving alerts for missed doses and following up on treatment progress.

The main use cases include user authentication and role-based access, creation and management of medication schedules, automatic medication reminders including visual, audio and vibration alerts, confirmation of medication intake by the patient, real-time adherence monitoring and reporting, alert and notification management for missed or delayed doses, profile management and personal health data and communication between pharmacists, patients and caregivers.

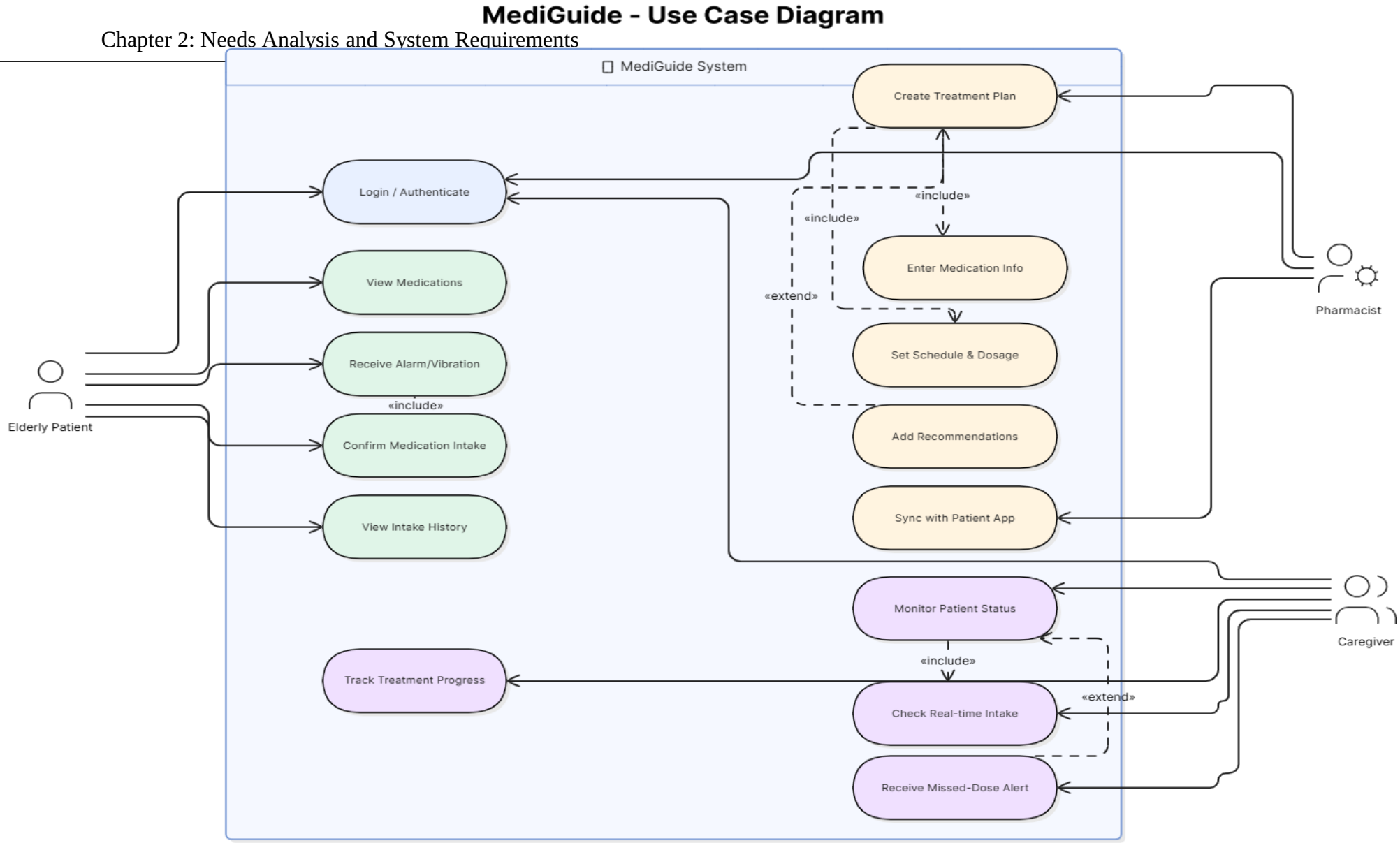


Figure 1:Use Case Diagram of the MediGuide System

This diagram demonstrates the strong interconnection between the three user roles, highlighting the collaborative nature of the system. It ensures that elderly patients receive simplified and accessible support, while pharmacists and caregivers maintain effective oversight. The design emphasizes usability, safety and coordination essential elements for improving medication adherence in the Algerian elderly population.

2.7.2 Class Diagram

The Class Diagram illustrates the static structure of the MediGuide system by defining the main classes, their attributes and methods and the relationships among them. It serves as a fundamental blueprint for the object-oriented design of the application, facilitating a clear understanding of the system's data model and internal organization.

The principal classes identified in the MediGuide system are as follows: **User**, the base class representing all system users and containing common attributes such as user ID, name, email, phone, role and profile image; **Patient**, which extends the User class and includes specific attributes such as linked pharmacist, linked caregiver, chronic diseases and allergies; **Pharmacist**, which extends the User class with additional attributes like pharmacy name, license number and specialization**; Caregiver**, which extends the User class and maintains relationships with patients through the linked patients attribute; **Prescription**, which represents a medical prescription with attributes including prescription ID, patient ID, pharmacist ID, medicine name, dose, schedule, duration, start date and status; **Medication**, which defines individual medication details such as medicine name, dosage form, strength and instructions; **Reminder**, which manages medication reminders with attributes like reminder ID, prescription ID, reminder time, frequency and is active; **Notification**, which handles system notifications with attributes such as notification ID, user ID, title, body, type, read and created at; **and Adherence Log**, which records the patient's medication intake history, including log ID, prescription ID, taken at, status and notes..

These classes are interconnected through various relationships, primarily **composition**, **aggregation**, and **inheritance**. For instance, a Patient can have multiple Prescription instances, while each Prescription is associated with one Pharmacist and generates multiple Reminder and Notification objects

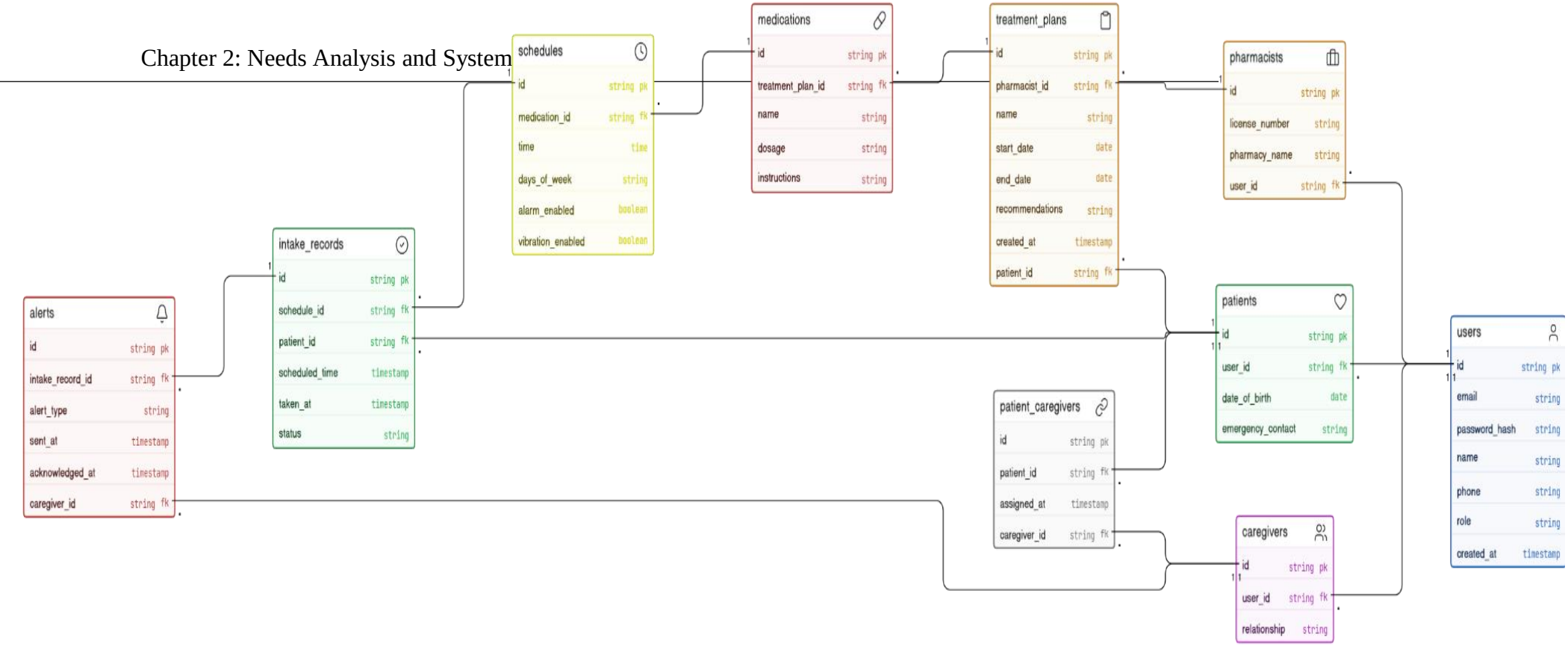


Figure 2:Class Diagram of the MediGuide System

The Class Diagram plays a crucial role in organizing the system's architecture. It ensures data consistency, supports future scalability, and provides a solid foundation for the implementation phase. By clearly defining class responsibilities and relationships, the diagram facilitates maintainability and enhances collaboration between the different modules of the application.

2.7.3 Activity Diagram

The Activity Diagram depicts the dynamic workflow of medication management and adherence monitoring within the MediGuide system. It illustrates the sequential and parallel activities performed by the different actors: the pharmacist, the elderly patient, the family caregiver, and the system itself to ensure accurate medication intake and continuous treatment follow-up.

The process begins when the **pharmacist** creates a comprehensive treatment plan by entering the medication details, dosage, schedule, duration, and special instructions. The system then securely stores this information in the database and automatically synchronizes it with the patient's and caregiver's applications.

At the predefined medication time, the system triggers a multi-modal reminder (visual, auditory, and vibrational) and sends a notification to the patient. The **elderly patient** receives the alert and confirms the intake of the medication through a simple and accessible interface. Upon confirmation, the system updates the adherence record in real time.

In the event of a missed or delayed dose, the system automatically logs the incident and sends an immediate alert to the **family caregiver**, enabling timely intervention and support. This closed-loop mechanism ensures continuous monitoring and rapid response when necessary.

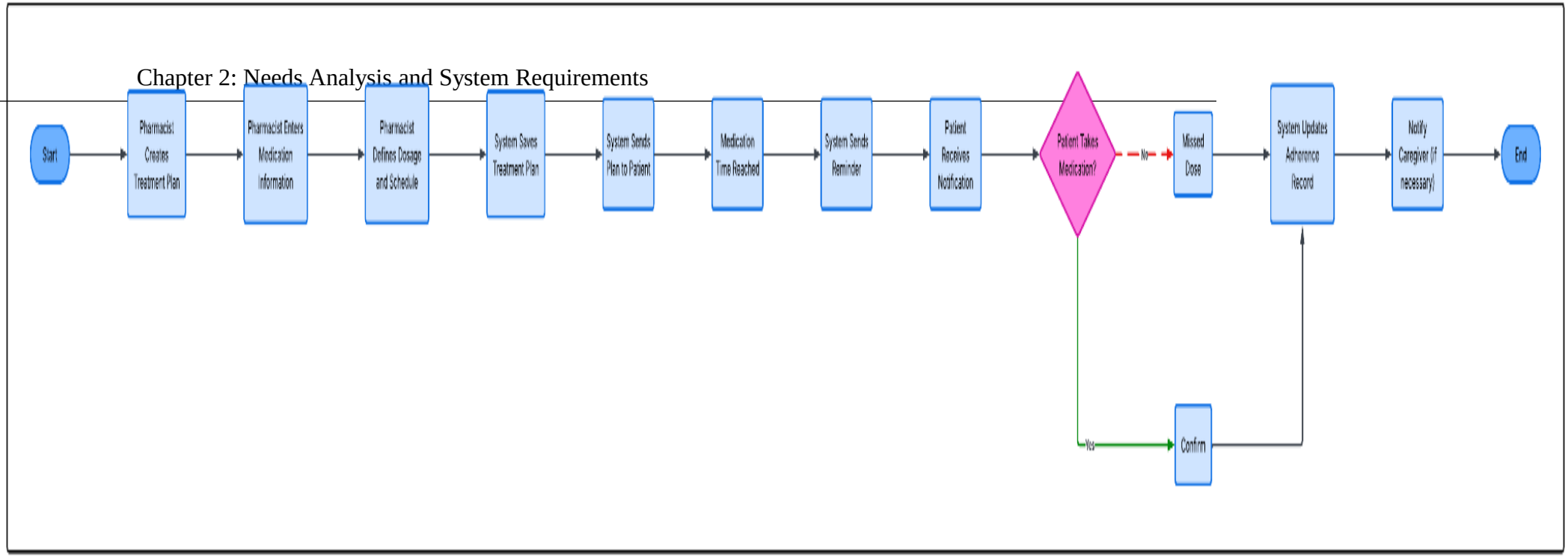


Figure 3:Activity Diagram of Medication Management and Adherence Monitoring Process

2.8 Conclusion of the Chapter

This chapter provided a thorough needs analysis and a detailed definition of the system requirements for the MediGuide application. It began by identifying the specific profiles, challenges, and expectations of the three primary stakeholders: elderly patients, pharmacists, and family caregivers, with particular attention to the Algerian socio-cultural and healthcare context.

Based on this analysis, both functional and non-functional requirements were systematically established. These requirements ensure that the application offers an efficient, secure, accessible, and user-centered solution for medication management. Core functionalities such as treatment plan creation, multi-modal reminders, medication intake confirmation, real-time adherence monitoring, and inter-stakeholder communication were clearly defined to promote effective collaboration and reduce medication-related risks.

Furthermore, the chapter outlined the overall system architecture, including the client-server model, database design, notification mechanisms, and the technological stack chosen for development, namely Flutter for the cross-platform interface and Firebase for backend services. The system conception phase was also presented through key UML diagrams to visually represent the structural and behavioral aspects of the application.

In conclusion, this chapter establishes a solid theoretical and technical foundation for the MediGuide project. By clearly defining user needs, functional specifications, and system architecture, it paves the way for the successful implementation phase that follows, ensuring that the final application will be practical, scalable, and well-adapted to the real needs of elderly patients in Algeria.

Chapter 3:

System Implementation

3.1 Introduction

Following the needs analysis, requirements specification, and system design phases presented in the previous chapter, this chapter focuses on the practical implementation of the MediGuide application. The main objective of this phase is to translate the theoretical design and defined requirements into a fully functional, reliable and user-friendly mobile application capable of effectively addressing medication adherence challenges among elderly patients in Algeria.

The implementation process encompasses the development of all core system modules, including user authentication and role-based access control, medication schedule management, multi-modal reminder and notification systems, real-time adherence monitoring, inter-user communication, and profile management. Special emphasis has been placed on usability, accessibility and performance to ensure the application is intuitive and suitable for elderly users who may have varying levels of digital literacy, visual impairments, or cognitive limitations.

This chapter presents the development environment and tools utilized, the practical realization of the system architecture, and the graphical user interfaces designed for the three main user categories: elderly patients, pharmacists, and family caregivers. Furthermore, it describes the key implementation decisions and technical solutions adopted to achieve seamless synchronization, offline functionality, and secure data handling. Finally, the chapter discusses the testing strategies and validation procedures conducted to ensure the reliability, correctness, and overall quality of the MediGuide system.

3.2 Development Environment

The development of the MediGuide application was carried out in a modern and efficient technological environment, carefully selected to meet the requirements of cross-platform development, real-time data synchronization, cloud services, security and accessibility for elderly users. The chosen tools and technologies ensure high productivity, scalability, maintainability and optimal performance.

3.2.2 Android Studio

Android Studio is the official Integrated Development Environment (IDE) provided by Google for Android application development. It includes a powerful built-in emulator, flexible build system, advanced debugging tools and comprehensive support for testing on various devices and Android versions.

Installation Procedure :

1. Download Android Studio from the official website.
2. Run the installer and select the required components (Android SDK, Emulator, etc.).
3. Complete the initial setup after installation.

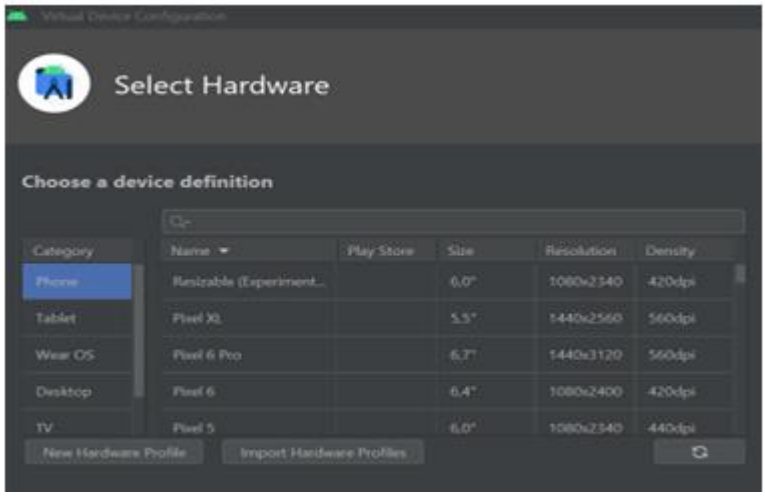


Figure 4:Android Studio Main Interface

3.2.3 Dart Programming Language

Dart is a modern, object-oriented programming language developed by Google. It is optimized for building high-performance applications for mobile, web, and desktop platforms. Dart stands out for its clean syntax, fast compilation to native code (AOT) and excellent integration with the Flutter framework.

3.2.4 Flutter Framework

Flutter is an open-source UI software development kit created by Google. It allows developers to build natively compiled applications for mobile (Android and iOS), web and desktop from a single codebase. Flutter uses the Dart language and provides high performance through its own rendering engine (Skia). It is particularly well-suited for creating accessible and visually appealing interfaces for elderly users.

3.2.5 Firebase Cloud Platform

Firebase is a comprehensive mobile and web application development platform provided by Google. It offers a wide range of backend services, including authentication, real-time database, cloud storage, push notifications and analytics. In MediGuide, Firebase is used for user authentication, real-time data synchronization, notifications and secure data storage.

Firebase Configuration Steps in Flutter:

1. Create a new project in the Firebase Console.
2. Add Android/iOS applications to the Firebase project.
3. Download the google-services.json file and place it in the android/app folder.
4. Add Firebase dependencies to the build.Gradle files.
5. Configure authentication methods (Email/Password) in the Firebase Console.

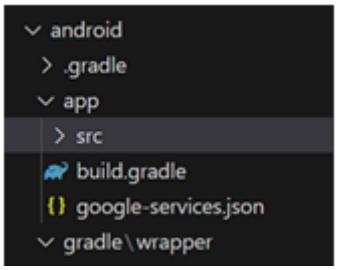


Figure 5:Google Services. json File

3.3. Presentation of Interfaces

A user interface in a mobile application is the primary means through which users interact with the application's features. In MediGuide, we have designed distinct and user-specific interfaces tailored to the needs of each stakeholder: the elderly patient, the pharmacist, and the family caregiver. Special attention was given to simplicity, accessibility, and usability, particularly for elderly users.

3.3.1. Home Screen

The Home Screen, also referred to as the Splash Screen, is the first interface users encounter when launching the MediGuide application. It features a clean and calming teal background with a large white Caduceus symbol (the international medical symbol) centered on the screen. Below the symbol, the application name “MediGuide” is displayed in a clear, bold, and readable font. At the bottom of the screen, a prominent white, rounded button with an arrow invites the user to proceed with the message “Get Started”.



Figure 6:Home Screen

This initial screen is intentionally minimalist and visually soothing, aiming to create a positive first impression while conveying a sense of trust, care and professionalism. The design prioritizes simplicity and visual clarity which are essential for elderly users

3.3.2. Welcome Screen

After tapping on the Home Screen, the user is directed to the Welcome Screen. This screen displays the title **"Medicine Reminder"** in large, bold text, followed by the motivational slogan **"Never miss your medication again"**. Two clear and accessible buttons are shown: a teal **"Login"** button for existing users and a white **"Create Account"** button for new users. A warm message "**Made with ❤ for your health,**" appears at the bottom.

This screen serves as an inviting introduction that encourages users to log in or register while reinforcing the caring purpose of the application.

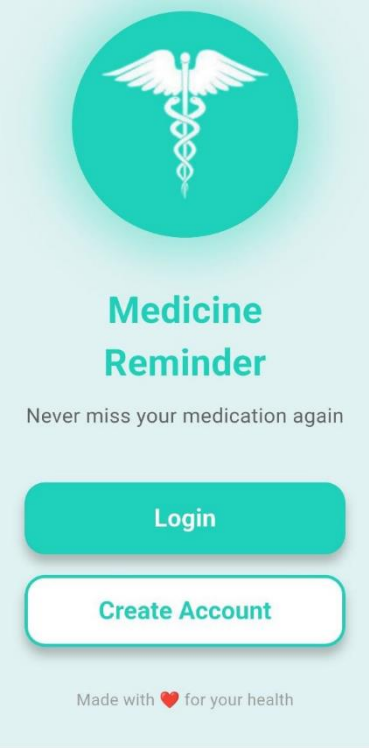


Figure 7:Welcome Screen

3.3.3. Registration Screen (Sign Up)

The Registration Screen allows new users to create an account in the MediGuide application. The interface is clean and well-organized, featuring a teal circular logo with the medical symbol at the top, followed by the title **"Sign Up"**. Users are required to fill in several fields, including full name, email address, phone number, password, and to select their role (Patient by default). All input fields are spacious with clear icons and labels to ensure readability for elderly users. A large, prominent teal **"Register"** button is placed at the bottom for easy registration. At the very bottom, a link labeled **"Already have an account? Sign in"** tak**es** user**s** back to the login screen.

This screen is designed to be simple, intuitive, and non-intimidating, encouraging new users, especially elderly patients or their family members, to join the platform with minimal effort.

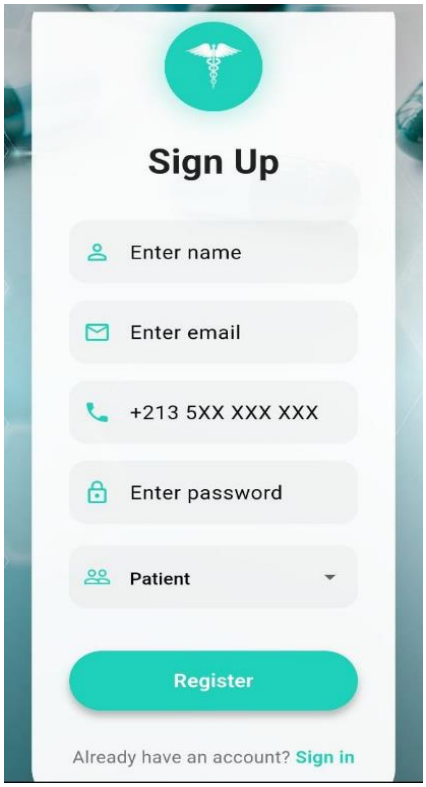


Figure 8:Registration Screen (Sign Up)

3.3.4. Login Screen

The Login Screen allows registered users to access their MediGuide accounts. The interface maintains a clean, modern design, with a teal circular logo featuring the medical symbol at the top, followed by the title **"Login"** in bold text. Users can enter their email address and password in spacious, well-labeled input fields. A "Forgot password?" link is provided below the password field for convenience. A large, prominent teal **"Login"** button is placed in the center, with an alternative **"Sign in with Google"** option for faster authentication. At the bottom, a link **"Don't have an account? Sign up"** directs new users to the registration screen.

This screen is designed to be simple, secure, and user-friendly, with large touch targets and a clear visual hierarchy to accommodate elderly users.

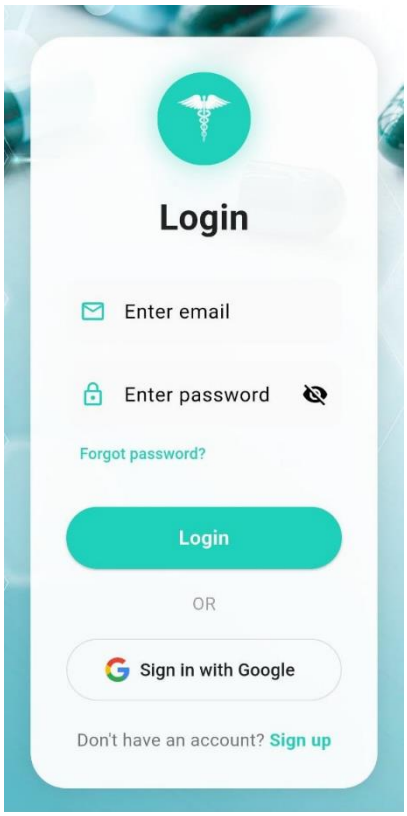


Figure 9:Login Screen

3.3.5. Forgot Password Screen

The Forgot Password Screen allows users who have forgotten their password to recover access to their account. The interface is simple and reassuring, featuring the MediGuide logo at the top, followed by the clear title **"Forgot Password?"**. Below, a short explanatory text states: "Enter your email, and we'll send you a link to reset your password". Users are prompted to enter their registered email address in a spacious input field. A large, prominent teal button labeled **"Send Reset Link"** enables the user to request the recovery email. Additionally, a "Back to Sign In" option is available at the bottom for easy navigation.

This screen is designed with minimal elements and clear instructions to reduce anxiety and confusion, especially for elderly users who may not be familiar with digital processes.

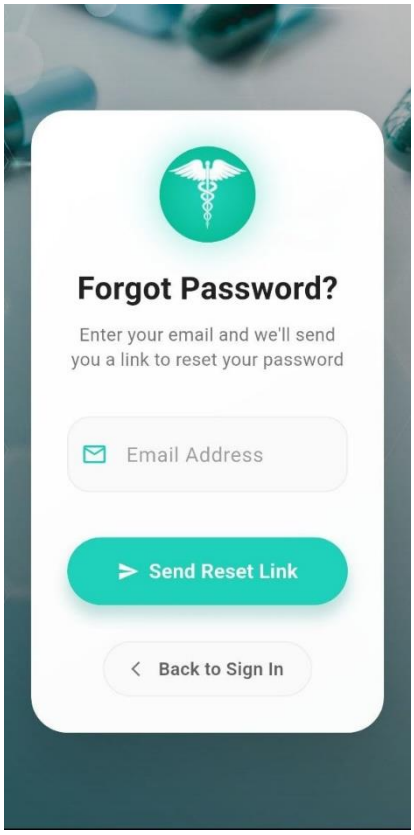


Figure 10:Forgot Password Screen

3.3.6. Pharmacist Dashboard

The Pharmacist Dashboard is the central hub of the MediGuide application for pharmacists. It is designed to provide a comprehensive, real-time, and efficient overview of all professional activities. The interface combines statistical summaries, quick actions, and patient management tools in a clean and professional layout, allowing pharmacists to effectively support elderly patients' medication adherence.

The dashboard is structured as follows:

- **Header Section**: Displays a personalized greeting ("Welcome back pharmacist name") with quick access icons for refreshing data, changing language, and viewing notifications.
- **Statistics Overview**: Three key performance cards showing **Total Patients**, **Pending Prescriptions**, and **Delivered Prescriptions**.
- **Quick Action Grid**: Large, intuitive cards providing direct access to the main features.
- **Disease Filters**: Horizontal scrollable chips to filter patients by chronic conditions (Diabetes, Hypertension, etc.).
- **Patients List**: A dynamic list of linked patients with options to view details or delete.
- **Recent Prescriptions**: A section showing the latest prescriptions with their status.

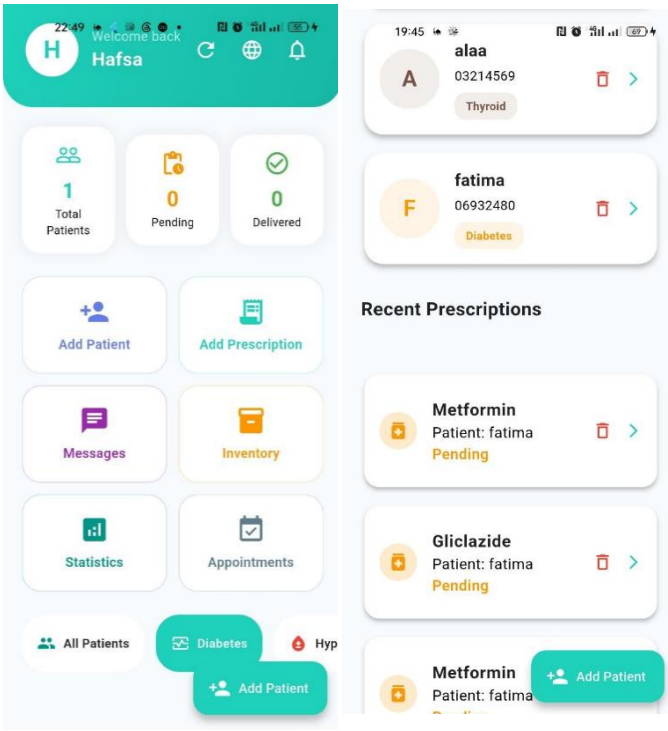


Figure 11:Pharmacist Dashboard

Key Sub-Pages and Their Functions:

Add Patient Screen.

The Add Patient Screen allows the pharmacist to register a new patient or link an existing one to their account. This screen is designed as a multi-step process using a Stepper widget to guide the pharmacist smoothly through the registration or linking procedure. In the first step, the pharmacist can search for an existing patient using their phone number. If the patient is found, the system offers the option to link them directly to the pharmacist's account and assign a caregiver if needed. If the patient is not found, the pharmacist proceeds to the second step to create a new patient profile by entering essential information such as full name, email address, phone number, a temporary password, chronic disease selection, and optional caregiver assignment. The system automatically links the new patient to the pharmacist and notifies the assigned caregiver. This interface plays a fundamental role in expanding the pharmacist's patient network and ensuring

seamless integration between patients, pharmacists, and caregivers from the very beginning of the treatment journey.

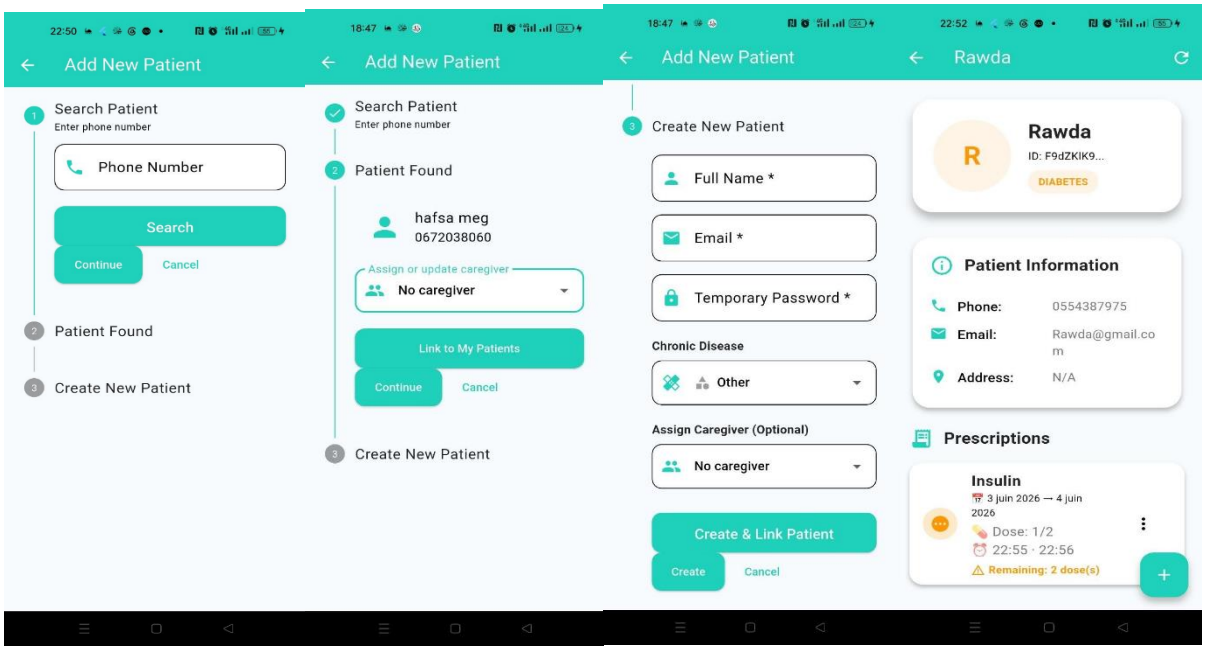


Figure 12:Add Patient Screen

Add Prescription Screen

The Add Prescription Screen is one of the core interfaces in the Pharmacist Dashboard. It allows the pharmacist to create a complete and detailed digital prescription for a patient. The screen is designed as a comprehensive form that includes several important sections. First, the pharmacist selects or searches for a patient. Then, they enter the medication name (with support for QR code scanning and suggestions from a chronic medicine catalog), dosage, quantity, frequency, meal timing, and treatment period using a date range picker. The pharmacist can also add multiple reminder times, choose a color and icon for visual identification, select the chronic disease type, and add notes. After filling all the required information, the system generates a complete schedule and saves the prescription, automatically synchronizing it with the patient's application. Additionally, the stock is updated through the Inventory Service, and notifications are sent to both the patient and the assigned caregiver. This screen plays a fundamental role in ensuring accurate prescription management and seamless coordination between the pharmacist, patient, and caregiver.

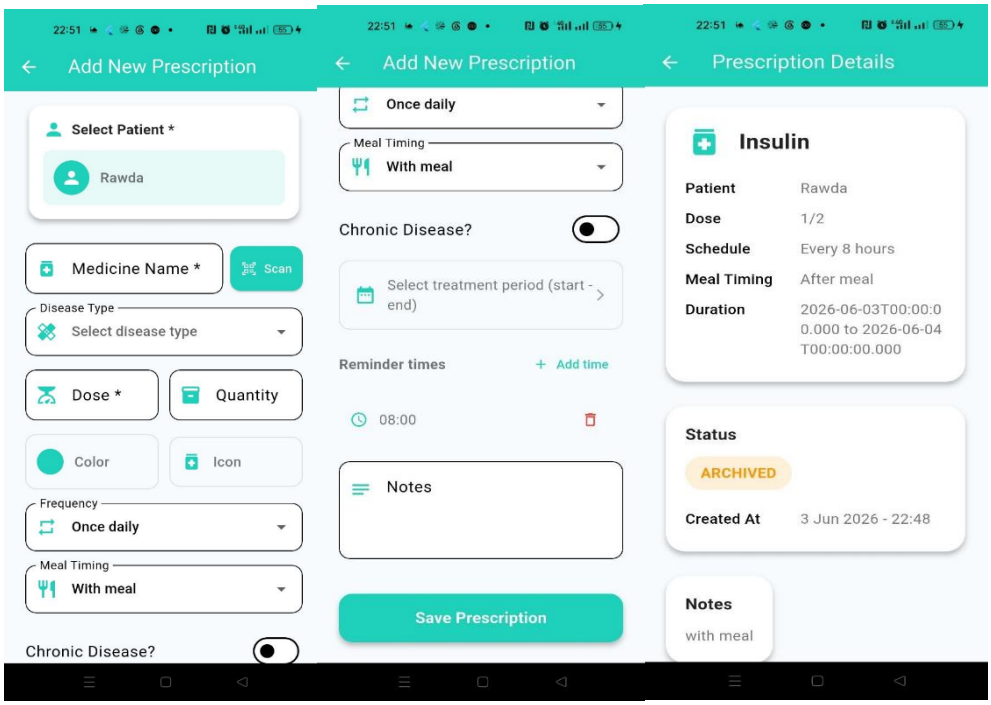


Figure 13:Add Prescription Screen

Manage Inventory Screen

The Manage Inventory Screen is a vital component of the Pharmacist Dashboard, enabling the pharmacist to monitor and control the pharmacy's stock levels efficiently. The screen displays all medicines with their current quantities, reorder thresholds, and expiry dates in a real-time, searchable list. Color-coded indicators and warning icons immediately highlight items that are running low. The pharmacist can add new medicines, update existing stock details, or remove discontinued items. A dedicated restocking function allows quick quantity adjustments and automatically resets the low-stock notification flag. At the top of the screen, summary cards provide an instant overview of total inventory items and the number of low-stock products. When the screen loads, the RefillService automatically scans the inventory and sends local notifications to the pharmacist if any medicine has fallen below its reorder level. All data is stored in Firebase Firestore and updates instantly across the interface, giving the pharmacist full control and real-time awareness of their inventory status.

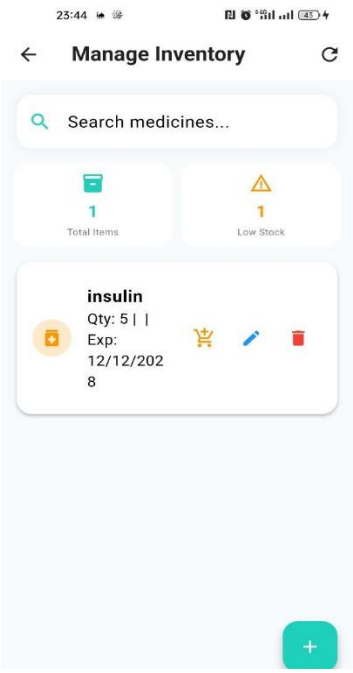


Figure 14:Manage Inventory Screen

CaregiverReportsforthePharmacist

The Caregiver Reports feature provides the pharmacist with a comprehensive, real-time view of adherence summaries generated by the patient's caregiver. The **CaregiverReportsListScreen** fetches all incoming reports from the caregiver reports Firestore collection and displays them as an ordered list, with the most recent reports shown first. Each card presents key metadata at a glance: the patient's name and avatar, the caregiver who created the report, the selected analysis period (weekly, monthly, or yearly) highlighted with a color-coded badge, and the exact creation timestamp. A pop-up menu on every card allows the pharmacist to quickly **share** the report as a PDF file using the system share sheet or **delete** the report entirely after confirmation. Tapping on a card navigates to the **PharmacistReportViewScreen**, where the full PDF is rendered using the PdfPreview widget, enabling the pharmacist to review detailed statistics, medication lists, daily dose statuses, adherence rates, and alert counts. From this screen, the pharmacist can also print the report or share it via the action buttons in the app bar. All data is stored as Base64-encoded PDF documents in Firestore, guaranteeing instant availability and offline access. The feature is fully integrated with the application's notification system: when a caregiver sends a report, an internal notification is delivered to the pharmacist, and tapping it opens the corresponding report directly. Both screens support the application's light and dark themes, ensuring a consistent and accessible experience across the entire dashboard.

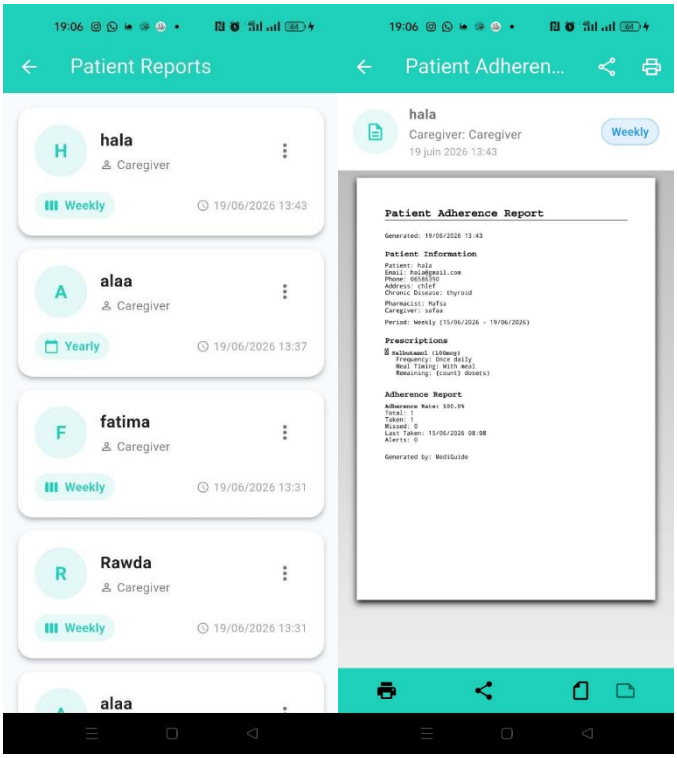


Figure 15:Patient Reports

Message List Screen

The Message List Screen provides a secure, real-time communication channel between the pharmacist, patients, and caregivers. It displays a chronological list of all conversations, each showing the contact's name, last message preview, and a timestamp. The pharmacist can start new conversations, search for specific contacts, and open any chat to exchange messages. Unread messages are visually highlighted with a badge counter for quick identification. Inside a conversation, messages are organized in a familiar chat-bubble layout, and the pharmacist can send text messages that are stored instantly in Firebase Firestore. Both parties receive real-time updates, enabling efficient coordination for prescription clarifications, dosage questions, or general support. This screen is essential for maintaining continuous, documented communication with patients and their caregivers.

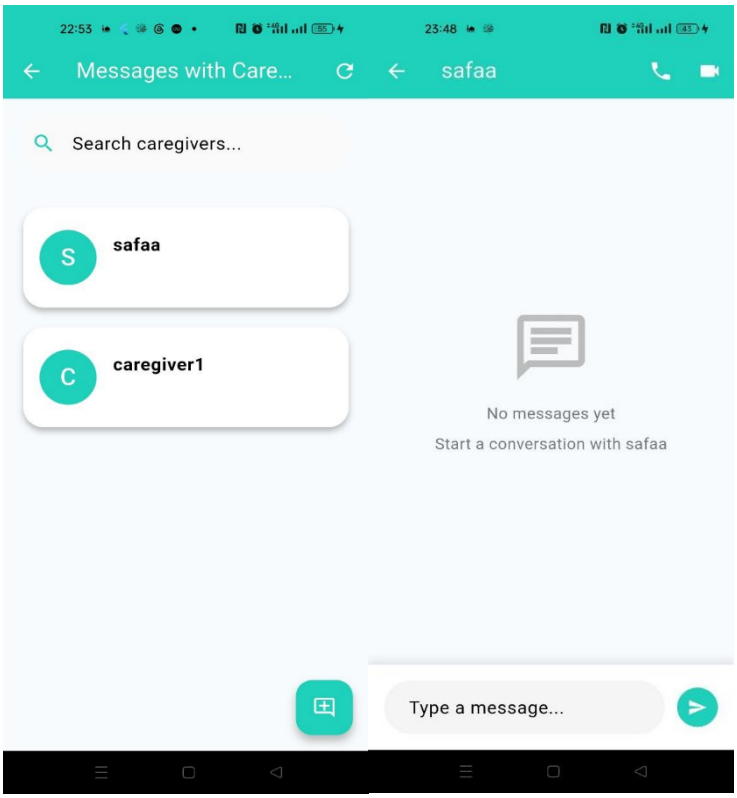


Figure 16:Message List Screen

Statistics Screen

The Statistics Screen offers a comprehensive, real-time analytical dashboard for the pharmacist. It displays key performance metrics such as total patients, total prescriptions, pending and delivered prescriptions, and an overall adherence rate. The data is visualized through animated cards and progress bars, with colour-coded indicators (green for good adherence, orange for moderate, red for low) for instant assessment. A dedicated "Patient Adherence Today" section lists every patient linked to the pharmacy, showing each patient's dose completion progress, a mini progress bar, and their current status (stable, warning, or critical) derived from active alerts. The screen updates automatically using live Firestore streams, eliminating the need for manual refreshes. By presenting individual and aggregate adherence trends, this screen empowers the pharmacist to identify at-risk patients and evaluate the effectiveness of prescribed treatments.

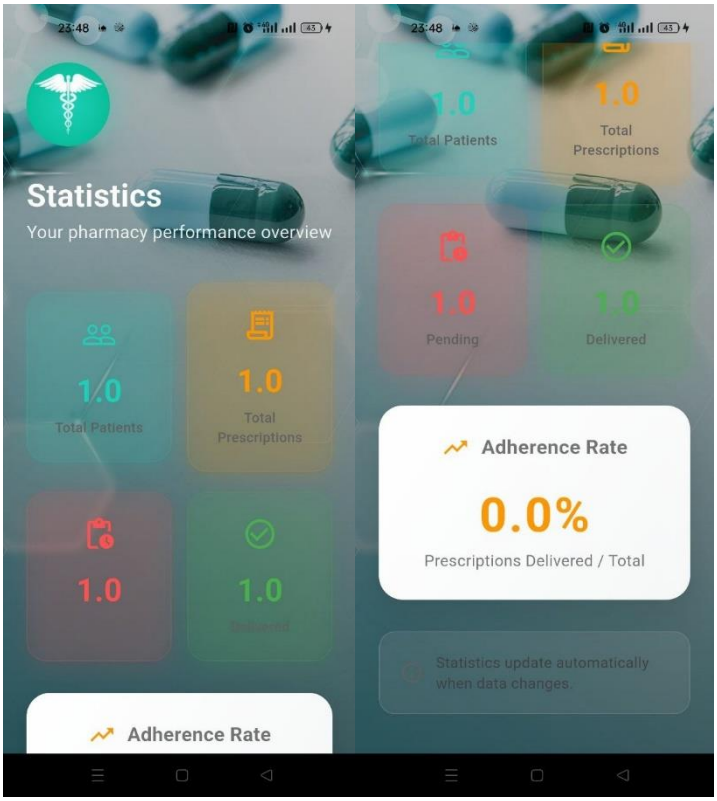


Figure 17:Statistics Screen

Appointments Screen

The Appointments Screen enables the pharmacist to manage patient consultations, medication reviews, and follow-up visits in an organized calendar-style interface. The pharmacist can view all upcoming appointments, schedule new ones, and update or cancel existing entries. Each appointment includes the patient's name, doctor's name, location, date, time, and notes. Appointments are sorted chronologically, and colour-coded status badges (scheduled, completed, cancelled) provide an immediate overview. A floating action button allows the pharmacist to quickly add a new appointment by selecting a patient, entering doctor details, choosing a date and time, and optionally adding notes. The system automatically sends a notification to the patient's device, ensuring they are informed. This screen streamlines the scheduling process and helps the pharmacist maintain a well-organized clinical workflow.

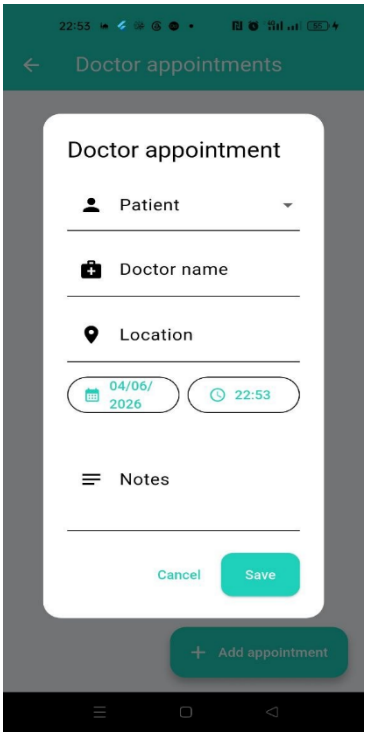


Figure 18:Appointements Screen

Profile Screen

The Profile Screen allows the pharmacist to manage their personal and professional account information. It displays the pharmacist's name, email, role, and pharmacy details (name, phone, address) in an aesthetically designed header with gradient backgrounds and animated elements. A dedicated statistics row presents live counts of linked patients, active prescriptions, and unread stock alerts, all updated in real-time via Firestore streams. The pharmacist can edit their profile information (name, phone, address) through an inline dialog, change their email or password via dedicated screens, and toggle dark mode on or off. Additional options include quick access to inventory management, statistics, and a nearby pharmacies finder. A prominent sign-out button at the bottom provides a secure way to log out. The screen combines essential account settings with live performance indicators, making it a convenient hub for the pharmacist's daily activities.

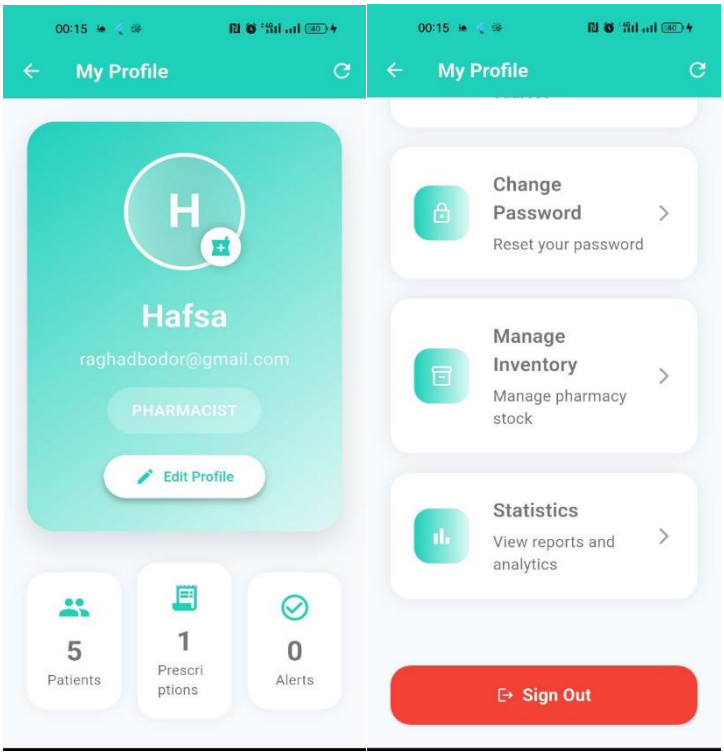


Figure 19:Pharmacist Profile Screen

3.3.7. Patient Dashboard

The Patient Dashboard, also referred to as the Home Screen, is the main and central interface designed specifically for elderly patients in the MediGuide application. It prioritizes

simplicity, large visual elements, high contrast, and intuitive navigation to ensure an accessible and stress-free experience for senior users. The screen provides a personalized, motivating, and comprehensive overview of the patient's daily medication routine at a single glance.

The dashboard is structured as follows:

- **Header Section**: Features a calming teal gradient background with a personalized greeting ("Welcome back [Patient Name]"), a circular profile avatar, and quick access icons for refreshing data, changing language, and viewing notifications (with unread badge).
- **Weekly Streak Card**: Displays the patient's adherence progress over the past seven days with motivational messages such as "Excellent! Almost perfect".
- **Today's Adherence Progress**: A prominent card showing the daily adherence percentage with a clear animated progress bar and the number of doses taken out of the total scheduled.
- **Daily Statistics Row**: Three large cards summarizing **Total Doses**, **Taken**, and **Missed** for the current day.
- **Quick Actions**: Large, colorful cards providing direct access to essential features such as History, Appointments, and Schedule.
- **Today's Medications Section**: The core part of the dashboard. Medications are intelligently grouped by time of day (Morning, Afternoon, Night). Each medication appears in a large, colorful card with the medicine name, dosage, scheduled times, "Take" buttons, and remaining doses with refill options.
- **Floating Action Button**: A prominent teal button for quick access to the full Schedule Screen.

This dashboard serves as the patient's daily companion, combining motivation, clarity, and ease of use to significantly improve medication adherence.

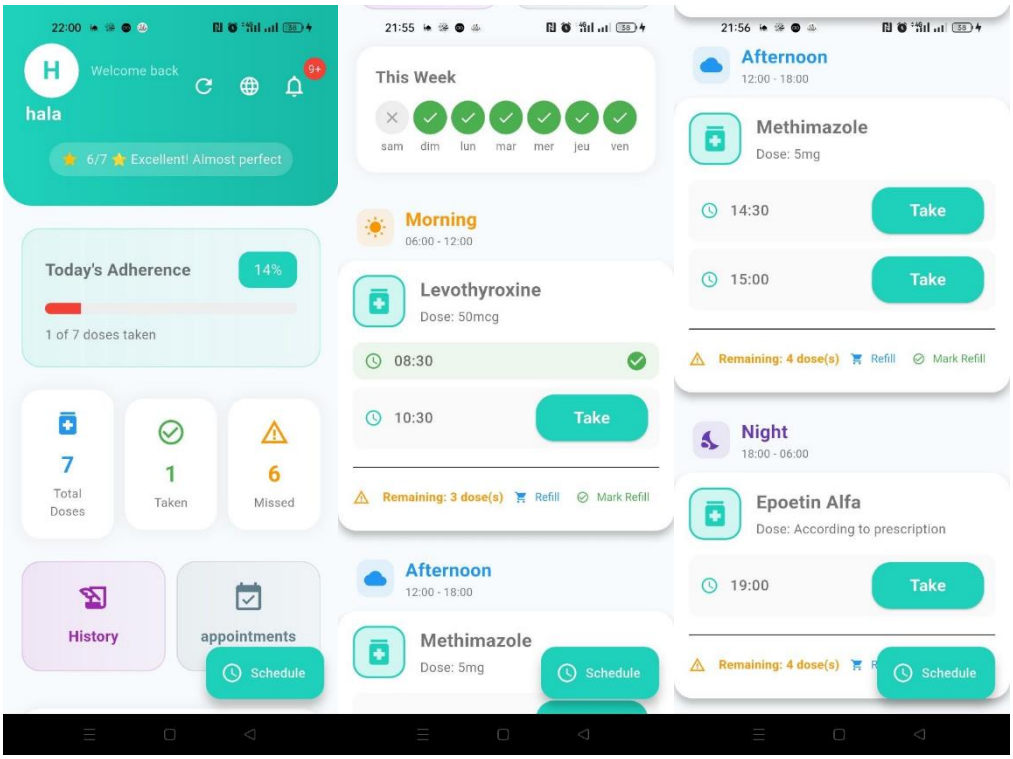


Figure 20:Patient Dashboard

Key Sub-Pages and Their Functions:

Medication Confirmation Screen

The Medication Confirmation Screen appears immediately after the patient taps the "Take" button on any scheduled dose from the Patient Dashboard or Schedule Screen. This screen is specifically designed to be simple, clear, and reassuring for elderly users. It prominently displays the medication name in large, bold text, along with the prescribed dosage, scheduled time, and any special instructions. A large animated hero icon of the medicine is shown at the top with smooth entrance animations and subtle pulsing effects to draw attention. At the center, there is a very large, prominent teal confirmation button labeled "Yes, I took my medication ✓" that occupies most of the screen width, making it easy to tap even for users with limited dexterity. Upon successful confirmation, the screen transitions to a celebratory success state with a green checkmark animation, plays a positive voice confirmation message, and automatically updates the adherence record in the database. The system also notifies the linked pharmacist and caregiver in real time. This screen plays a critical role in ensuring accurate tracking of medication intake, preventing

accidental double dosing, and providing immediate positive reinforcement to encourage consistent adherence.

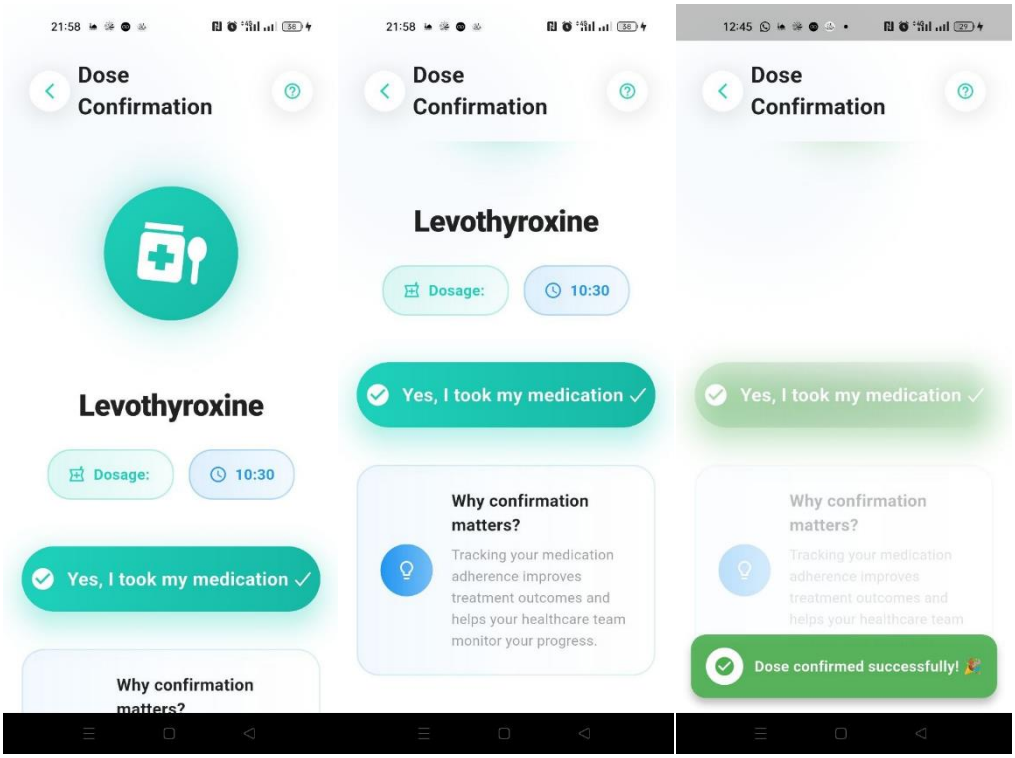


Figure 21:Medication Confirmation Screen

Schedule Screen

The Schedule Screen provides the patient with a complete and organized timeline view of all their medications for the selected day and allows easy navigation to other days. This screen serves as a comprehensive planning tool that complements the main Patient Dashboard by offering a broader perspective on the entire treatment schedule. At the top, the patient can see the selected date with options to change it using a calendar picker or refresh the data. Medications are intelligently grouped into three clear sections: **Morning** (06:00 - 12:00), **Afternoon** (12:00 - 18:00), and **Night** (18:00 - 06:00), each with its own distinctive color and icon for better visual recognition. Each medication card displays the medicine name, dosage, scheduled times,

pharmacist name, meal timing, and any additional notes. Prominent “Take” buttons allow the patient to confirm intake directly from this screen, while completed doses are clearly marked with green checkmarks. This interface helps elderly patients maintain a clear understanding of their daily and weekly medication routine, plan ahead, and ensures they never miss important doses.

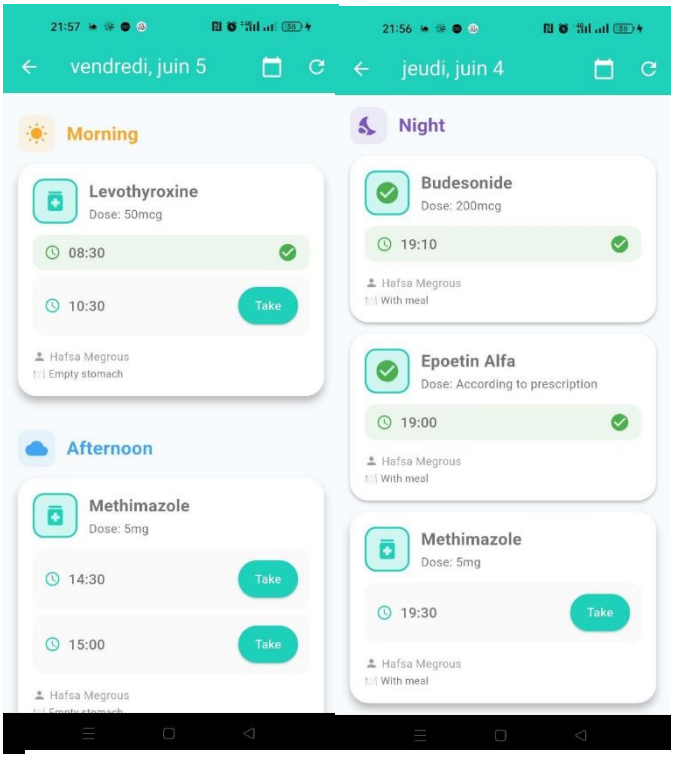


Figure 22:Schedule Screen

History & Medical Information Screen

The History & Medical Information Screen allows patients to review their complete medication history and past adherence records in a clear and organized manner. This screen displays all previous prescriptions in a scrollable list ordered by creation date (newest first). Each prescription is presented as an expandable card (ExpansionTile) showing essential information such as medicine name, dosage, schedule, status, prescribed date, meal timing, duration, and any additional notes from the pharmacist. The interface includes visual indicators for low stock or out-of-stock situations with prominent warning icons and a “Mark Refill” button that enables patients

to easily update the remaining doses. Patients can also view who prescribed the medication and access detailed information by expanding each card. This screen plays a vital role in helping elderly patients and their caregivers track long-term treatment progress, maintain awareness of their medication history, and manage refills proactively, thereby supporting better treatment continuity and health monitoring.

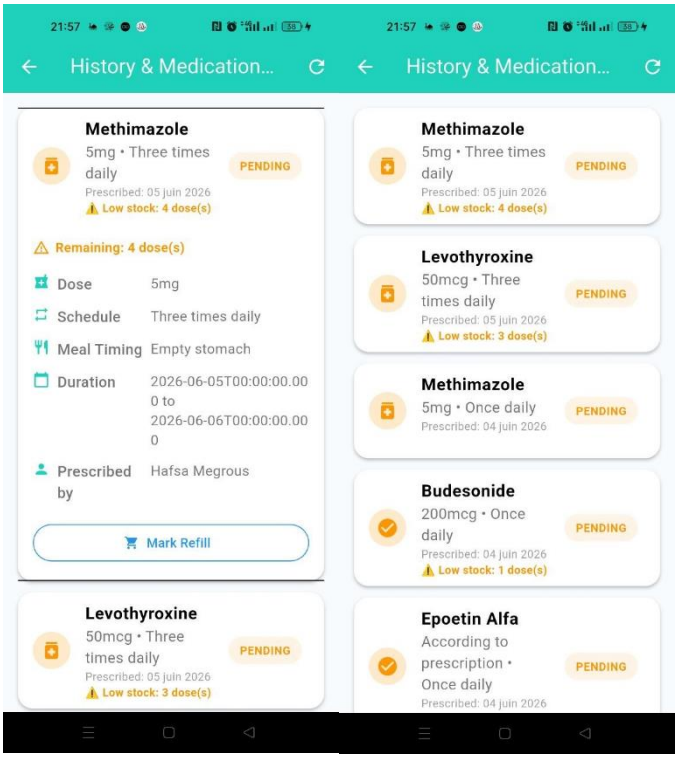


Figure 23:History & Medical Information Screen

Adherence Report Screen

The Adherence Report Screen provides patients with detailed statistical reports and visual insights into their medication compliance over time. This screen is designed to help elderly users and their caregivers better understand treatment effectiveness through clear, animated, and interactive visualizations. At the top, a large animated card prominently displays the overall adherence rate as a percentage with a colorful progress bar. Below it, three statistic cards show **Total Doses**, **Taken**, and **Missed** doses with appropriate icons and colors. The screen includes period selectors (Weekly, Last 7 Days, Monthly) for flexible data viewing, a pie chart illustrating the proportion of taken versus missed doses, and a weekly bar chart showing daily adherence distribution. Additional features include a progress timeline with motivational messages, practical health tips, and export options (PDF generation and sharing). All data is calculated dynamically from the patient's actual schedules stored in Firebase Firestore. This screen plays a crucial role in empowering patients to monitor their long-term progress, identify patterns, and maintain motivation for consistent medication adherence.

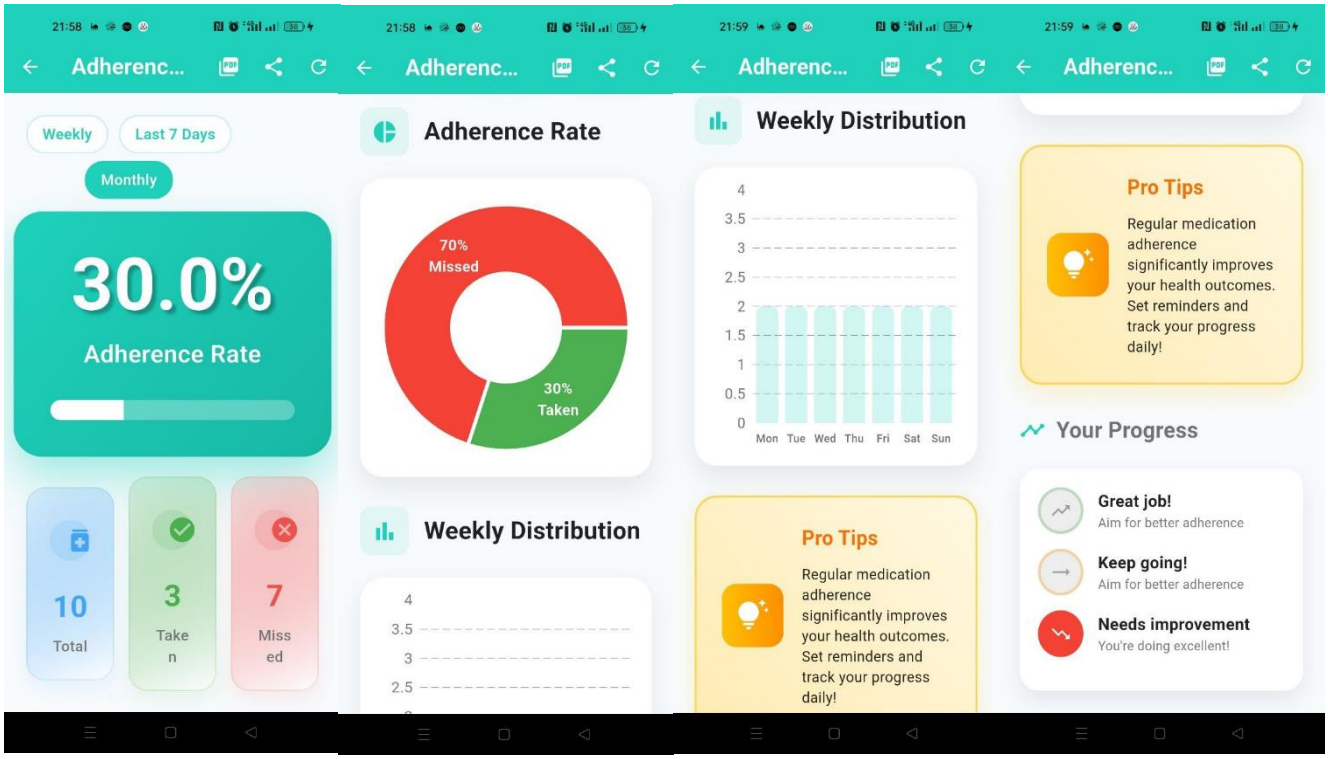


Figure 24:Adherence Report Screen

Doctor Appointments Screen

The Doctor Appointments Screen enables patients to view, manage, and receive reminders for their medical appointments with doctors. This interface displays all upcoming and past appointments in a clean chronological list. Each appointment card shows the doctor's name, date and time, location, notes, and current status (scheduled, completed, or cancelled) with color-coded indicators. Patients can add new appointments using a floating action button that opens a comprehensive form including doctor selection, date and time pickers, location, and additional notes. The screen also allows updating the status of existing appointments. All data is synchronized in real time with Firebase Firestore and notifications are automatically sent to the patient upon creation. This screen helps elderly patients stay organized with their healthcare schedule and ensures better coordination between the patient, pharmacist, and medical professionals.

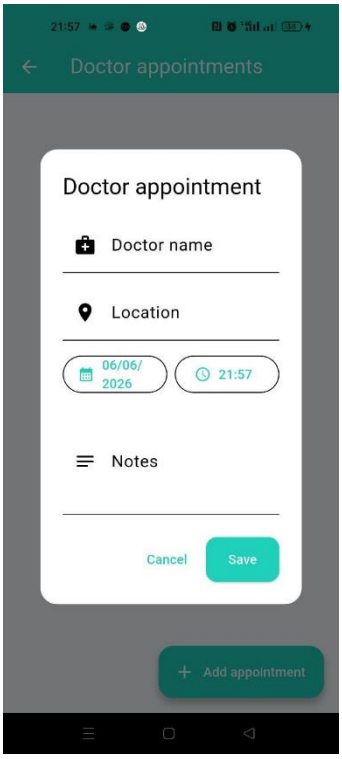


Figure 25:Doctor Appointements Screen

Profile Screen

The Profile Screen allows patients to manage their personal account information simply and securely. It features a beautiful header with the patient's name, profile avatar, role indicator, and quick statistics. The screen includes sections for contact information (email, phone, address), medical details (chronic diseases), and account settings. Patients can edit their profile details, change language preferences, toggle dark mode, and access other important features such as Nearby Pharmacies. A prominent sign-out button is placed at the bottom for security. The interface is designed with large touch targets and clear labels to ensure ease of use for elderly users while maintaining full control over their personal data.

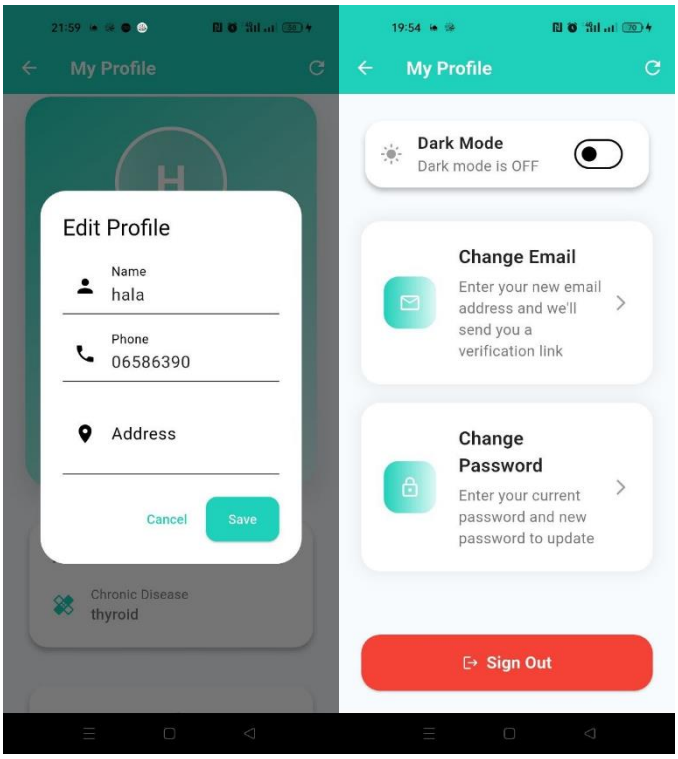


Figure 26:Patient Profile Screen

3.3.8. Caregiver Dashboard

The Caregiver Dashboard is the main interface designed for family members or caregivers responsible for monitoring elderly patients. It provides a real-time, comprehensive overview of the patients under their care, with special emphasis on adherence status, active alerts, and quick access to critical actions. The design uses calming colors, large elements and clear visual indicators to make it easy for caregivers to stay informed without feeling overwhelmed.

The dashboard is structured as follows:

- **Header Section**: Features a personalized greeting, profile avatar, quick access icons for refresh, language, and notifications.
- **Critical Alerts Button**: A prominent orange card highlighting the number of active patient alerts with direct access to the monitoring screen.
- **Monitoring Progress Card**: Shows the percentage of active patients today with a clear progress bar.
- **Statistics Row**: Three summary cards displaying Total Patients, Active Today, and Current Alerts.
- **Quick Actions**: Large cards for Monitoring, Reminders, Messages, and Statistics.
- **Status Filters**: Horizontal chips to filter patients by status (All, Stable, Warning, Critical).
- **Patients List**: Dynamic list of linked patients with status indicators, today's activity, and quick navigation to detailed profiles.

This dashboard plays a vital role in giving caregivers peace of mind, enabling them to respond quickly to missed doses or low adherence situations, and maintaining continuous coordination with the pharmacist and patient.

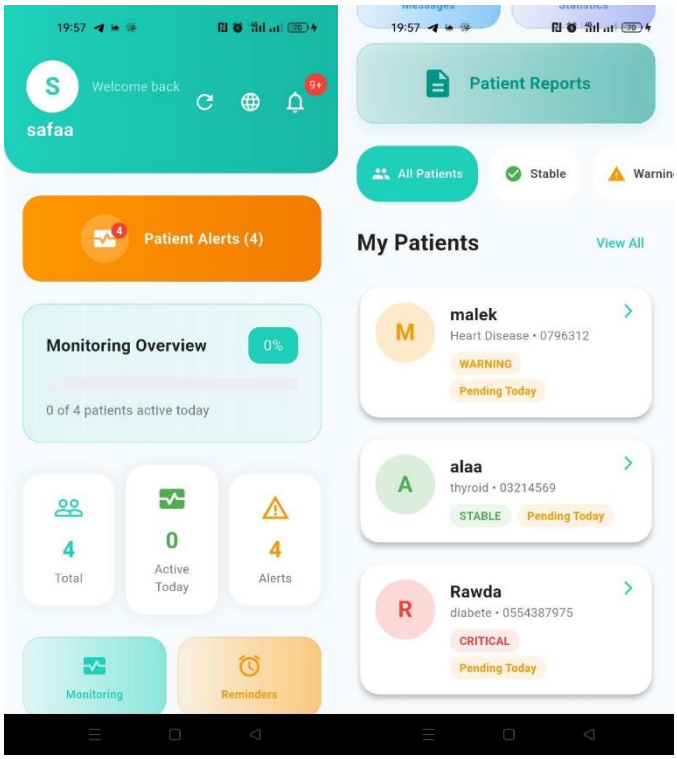


Figure 27:Dashboard caregiver

Key Sub-Pages and Their Functions:

Caregiver Monitoring Screen

The Caregiver Monitoring Screen is one of the most important interfaces in the Caregiver Dashboard. It provides real-time monitoring of all patients linked to the caregiver. The screen displays each patient's name, chronic disease, current health status (Stable, Warning, or Critical) with clear color-coded indicators, and whether they have taken their medication today. Caregivers can quickly identify patients who need immediate attention through prominent alert cards that highlight missed doses or critical situations. Each patient card is interactive, allowing the caregiver to tap and navigate directly to the detailed patient profile. The screen includes a filter bar at the top (All, Active, Critical, Warning, Medication) to help caregivers focus on specific types of alerts. All data is updated in real time through Firebase Firestore streams, and caregivers can acknowledge or dismiss alerts directly from this interface. This screen plays a vital role in enabling caregivers to respond promptly to potential health risks, maintain continuous oversight of elderly patients, and ensure better coordination with the pharmacist and medical team.

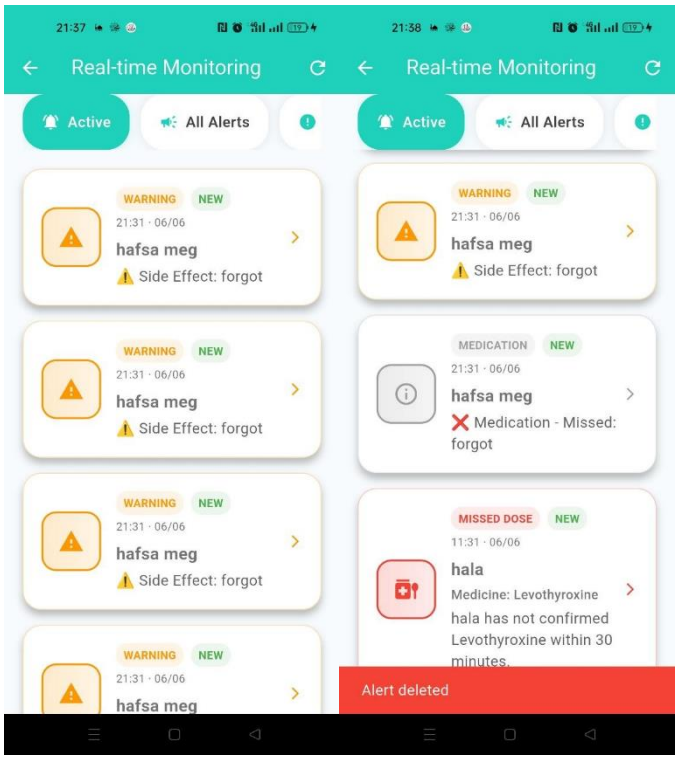


Figure 28:Caregiver Monitoring Screen

Medication Reminders Screen

The Medication Reminders Screen allows caregivers to view and manage all upcoming medication reminders for the patients under their responsibility. This screen provides a clear, organized timeline of scheduled doses grouped by time of day, displaying each reminder with the patient's name, medicine name, dosage, and scheduled time. Caregivers can easily see the current status of each dose (Pending or Taken) with color-coded indicators. The interface includes a filter bar at the top (All, Pending, Taken) to help focus on specific reminders. Caregivers can manually confirm a dose directly from this screen, which updates the adherence record in real time and notifies the pharmacist if necessary. Additional options allow adjusting reminder settings or viewing detailed patient profiles. This screen is essential for caregivers to proactively support elderly patients, ensure timely medication intake, and maintain continuous coordination with the treatment team

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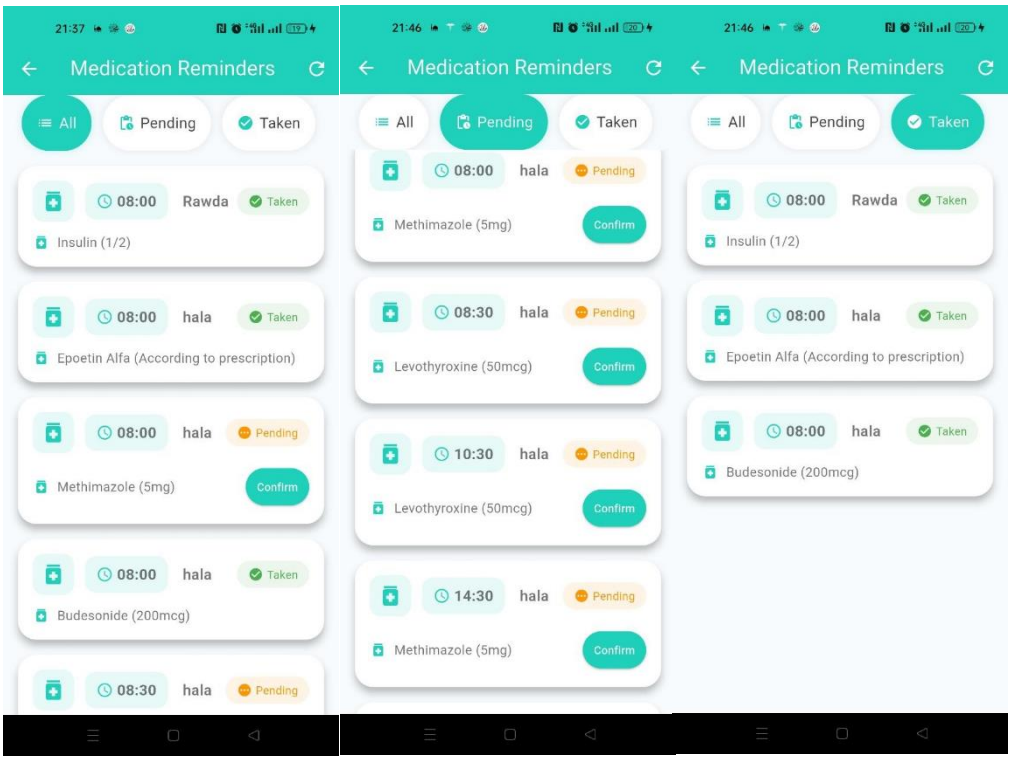


Figure 29:Medication Reminder Screen

CaregiverReportGenerationScreen

The Caregiver Report Generation screen allows the caregiver to create comprehensive adherence reports for any linked patient and share them directly with the pharmacist. Upon entering the screen, the caregiver selects a patient from a searchable dropdown list that displays all assigned individuals. Once a patient is chosen, a summary card appears showing the patient's name, chronic disease, and a real-time preview of their adherence statistics including the adherence rate, total doses, taken doses, and missed doses calculated for the selected period: weekly, monthly, or yearly. The period is chosen via three styled ChoiceChip buttons that instantly refresh the preview data.

Below the preview, two action buttons are provided: **Generate & Share Report** and **Send to Pharmacist**. The former generates a PDF report using the pdf package with an embedded Courier font and opens the system share sheet, allowing the caregiver to send the document via any installed application. The latter performs a complete workflow: it fetches all relevant patient data (personal details, current prescriptions, daily schedules, adherence records, and alerts), builds the PDF, encodes it in Base64, saves it to the caregiver_reports Firestore collection, and then creates an internal notification of type caregiver_report targeted at the patient's linked pharmacist. The notification contains the report ID, patient name, and caregiver name, enabling the pharmacist to open the report directly from the notifications list. The report itself includes full patient information (name, email, phone, address, chronic disease), the name of the caregiver and pharmacist, the selected analysis period, a detailed list of active medications with today's scheduled doses and their taken/missed status, adherence statistics (rate, total, taken, missed), the date and time of the last taken dose, and the number of active patient alerts. All data is retrieved from Firestore, prioritizing the adherence collection and falling back to the schedules array within prescriptions when necessary, ensuring accurate and complete information even for newly created treatment plans. The interface is fully responsive, supporting both light and dark themes, and all labels and messages are localized via easy_localization for Arabic, English, and French, providing a seamless experience for caregivers in Algeria.

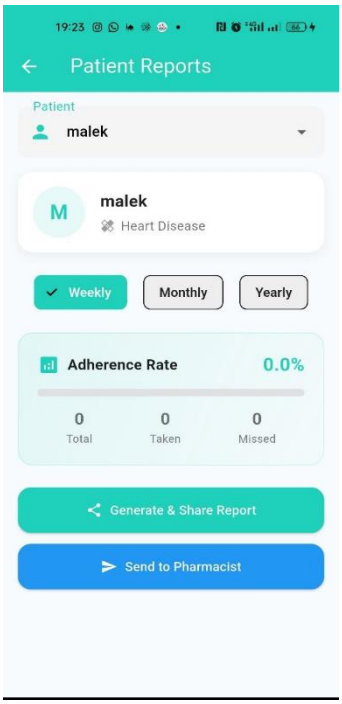


Figure 30:caregiver_report_screen

Caregiver Statistics Screen

The Caregiver Statistics Screen offers caregivers detailed analytical reports about the medication adherence of all patients under their responsibility. This screen is designed to provide clear, visual, and actionable insights to help caregivers evaluate the overall effectiveness of treatment plans. It displays key performance indicators, including the total number of patients, distribution of patient status (Stable, Warning, Critical) with color-coded cards, and the weekly average compliance rate. A prominent line chart illustrates daily adherence trends over the past seven days, while individual patient performance can be reviewed through integrated status indicators. The interface uses smooth animations and intuitive visuals to make complex data easy to understand, even for non-technical users. Caregivers can quickly identify patients who may need additional support or intervention. This screen plays a crucial role in enabling data-driven decisions, improving coordination with pharmacists, and ensuring better long-term health outcomes for elderly patients.

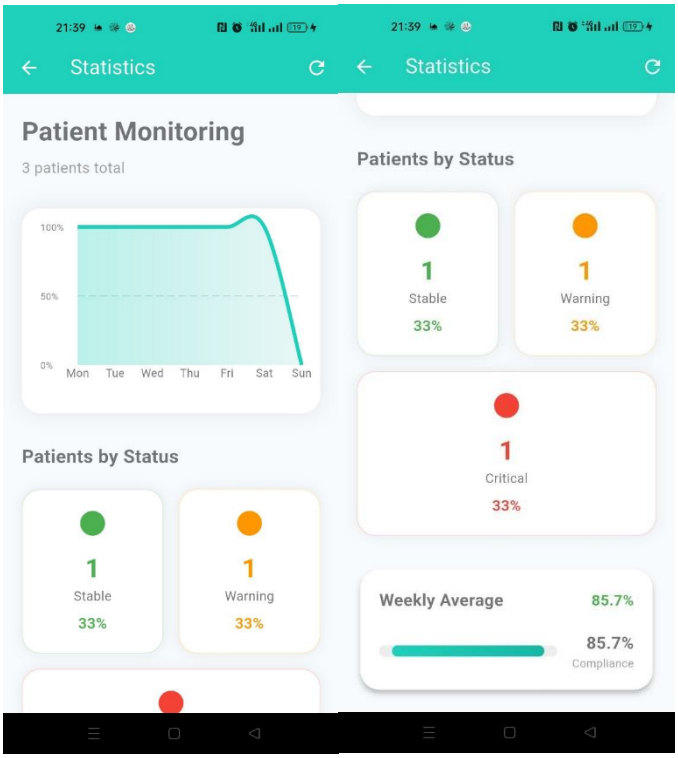


Figure 31:Caregiver Statistics Screen

Caregiver Patient Details Screen

The Caregiver Patient Details Screen provides a complete and comprehensive profile of a selected patient under the caregiver's responsibility. This screen acts as a centralized information hub, giving caregivers quick access to all essential data related to the patient's health and treatment. It displays personal information (full name, phone number, and chronic diseases), a real-time status indicator (Stable, Warning, or Critical) with animated visual feedback, current active prescriptions with dosages, schedules, and confirmation buttons, adherence history, recent alerts and activities, and communication logs. Caregivers can manually confirm medication intake, mark refills when stock is low, record important events such as side effects, doctor visits, or general notes, and initiate direct messaging with the patient or pharmacist. All sections are updated in real time through Firebase Firestore streams. This interface plays a vital role in enabling caregivers to maintain a deep, up-to-date understanding of the patient's condition, respond promptly to any issues, and ensure effective coordination with the pharmacist and the broader healthcare team.

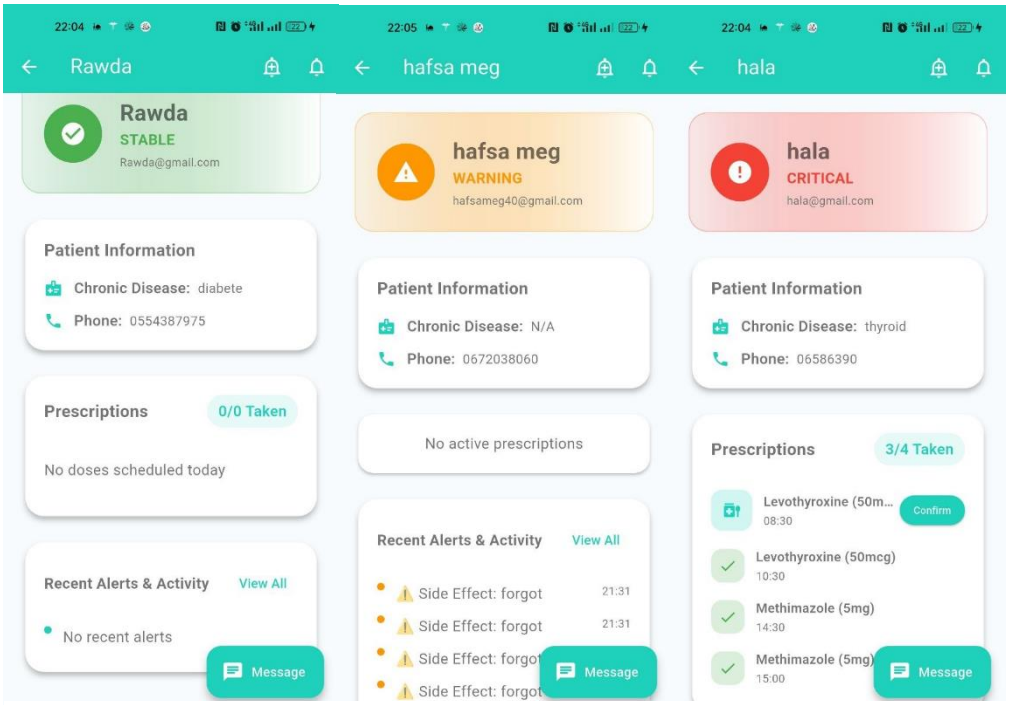


Figure 32:Caregiver Patient Details Screen

Caregiver Messages Screen

The Caregiver Messages Screen facilitates secure and real-time communication between the caregiver, the patient, and the linked pharmacist. This screen displays a chronological list of all conversations, showing each contact's name, the preview of the last message, the timestamp, and a badge indicator for unread messages. Caregivers can start new conversations with pharmacists or open existing chats to exchange important updates regarding medication schedules, side effects, adherence issues, or general health concerns. The chat interface follows a familiar bubble layout with timestamps and read status indicators. All messages are stored securely in Firebase Firestore and synchronized in real time across all parties. This screen is essential for maintaining continuous, documented, and efficient coordination among the care team, enabling quick responses to patient needs and strengthening the collaborative aspect of medication management.

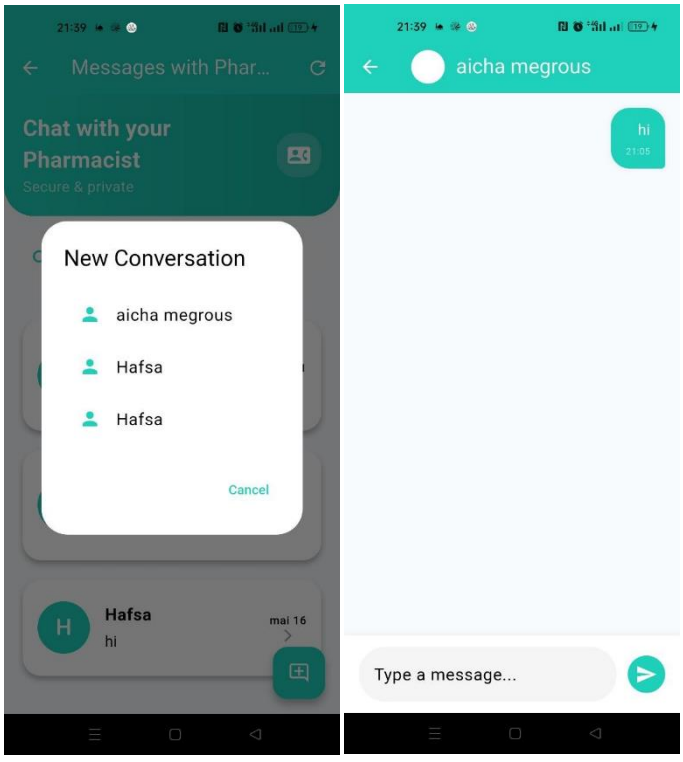


Figure 33:Caregiver Messages Screen

Profile Screen

The Profile Screen allows the caregiver to manage their personal and professional account information in a simple and secure environment. It features an attractive header with the caregiver's name, profile avatar, role indicator, and quick statistics such as the number of linked patients. The screen includes sections for updating contact details (name, phone, address), changing language preferences, toggling dark mode, and accessing other important features such as Nearby Pharmacies. Caregivers can also change their email or password through dedicated screens. A prominent sign-out button is provided at the bottom for security. The interface is designed with large, clear elements and intuitive navigation to ensure ease of use for all caregivers, while giving them full control over their account and quick access to essential tools.

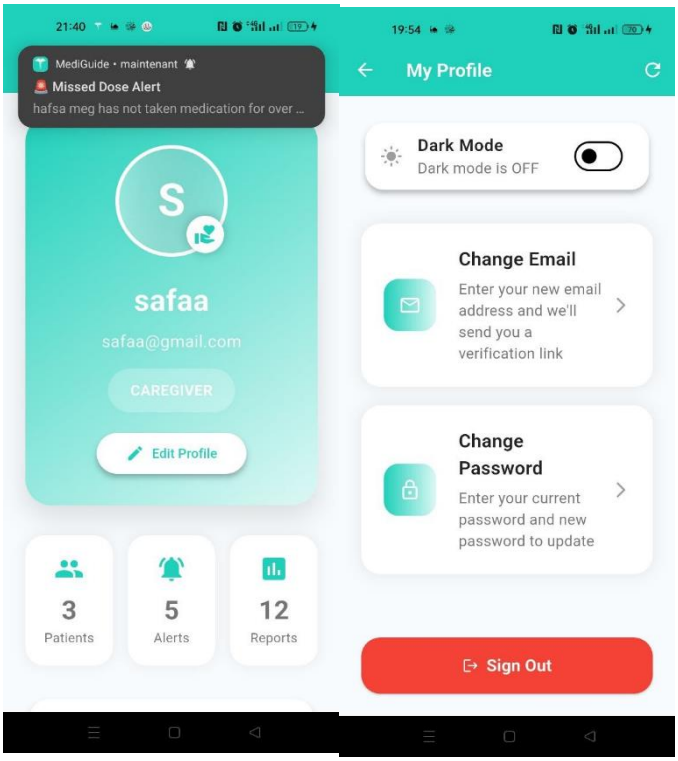


Figure 34:Caregiver Profile Screen

3.3.9. Shared Interfaces (Common Screens)

In addition to the role-specific dashboards, MediGuide includes several shared interfaces accessible to all user types (Patient, Pharmacist, and Caregiver). These screens ensure consistency, improve user experience, and facilitate seamless communication and data access across the care team.

Notifications Screen

The Notifications Screen serves as a centralized and well-organized inbox for all important alerts and updates across the MediGuide application. This shared interface is accessible to patients, pharmacists, and caregivers alike. It displays a chronological list of notifications covering medication reminders, missed doses, low stock alerts, new prescriptions, adherence reports, dose confirmations, and general system messages. Each notification card clearly shows a title, descriptive body, timestamp, and priority level with appropriate color coding (red for critical alerts). Unread notifications are visually highlighted with red badges for quick identification. Users can mark individual notifications as read, delete them, or interact directly with them (for example, navigating to a specific prescription or patient profile). The screen supports real-time synchronization through Firebase Firestore streams and includes options to mark all notifications

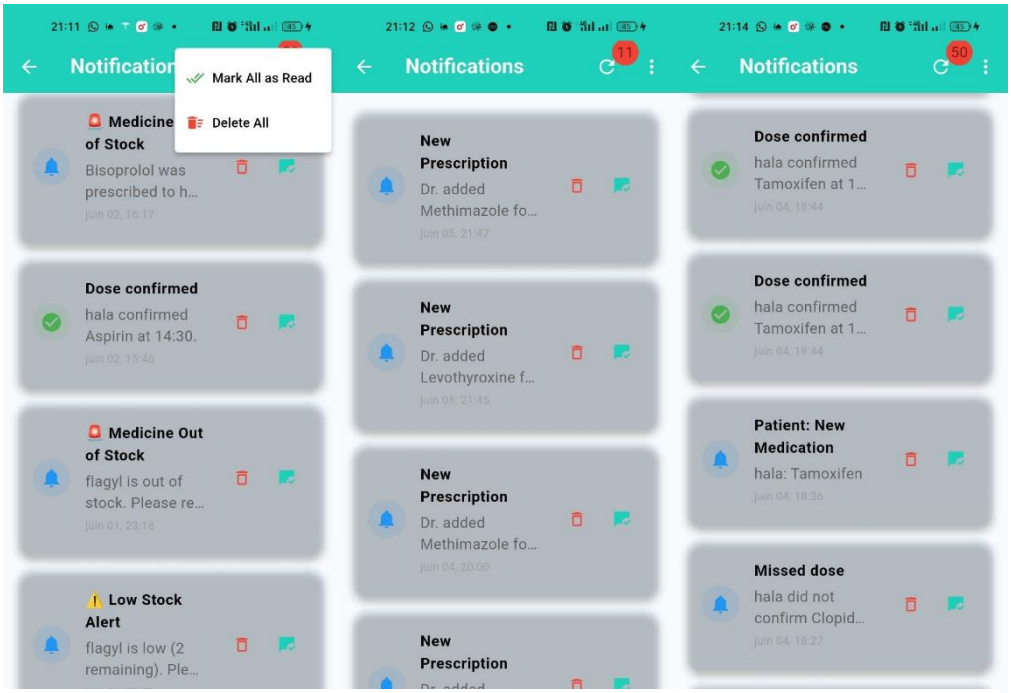


Figure 35:Notifications Screen

as read or delete them in batches. This shared screen plays a crucial role in keeping all stakeholders informed on time, facilitating proactive management of the patient's treatment, improving coordination between the care team, and ensuring better overall adherence and safety.

Change Password Screen

The Change Password Screen allows users, whether patients, pharmacists, or caregivers, to update their account password securely. This shared interface is designed with simplicity and clarity in mind, featuring large, well-spaced input fields for the current password, the new password, and password confirmation. Real-time validation messages guide the user by indicating minimum length requirements and whether the passwords match. A prominent teal "Update Password" button initiates the process through Firebase Authentication. Upon successful completion, the user receives clear positive feedback, while any errors (such as incorrect current password or weak new password) are displayed with helpful explanations. The screen includes smooth animations and large touch targets to ensure accessibility for elderly patients. This interface significantly enhances account security while giving users intuitive, reassuring control over their credentials.

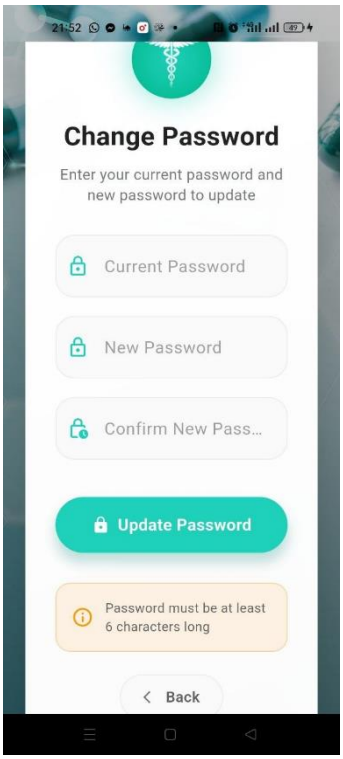


Figure 36:Change Password Screen

Change Email Screen

The Change Email Screen enables users (patients, pharmacists, or caregivers) to update their registered email address securely. This shared interface follows a clean and user-friendly design with large input fields for the current password (for security verification), the new email address, and a confirmation field. The screen performs real-time validation to ensure the email format is correct and the fields are properly filled. Upon submission, Firebase Authentication sends a verification link to the new email address. Users receive clear instructional messages and status feedback throughout the process, including success confirmation and error handling (such as incorrect password or email already in use). The interface includes smooth animations and prominent buttons to ensure accessibility for elderly patients. This screen is essential for maintaining accurate contact information, supporting account recovery, and keeping user data up to date across the MediGuide platform.

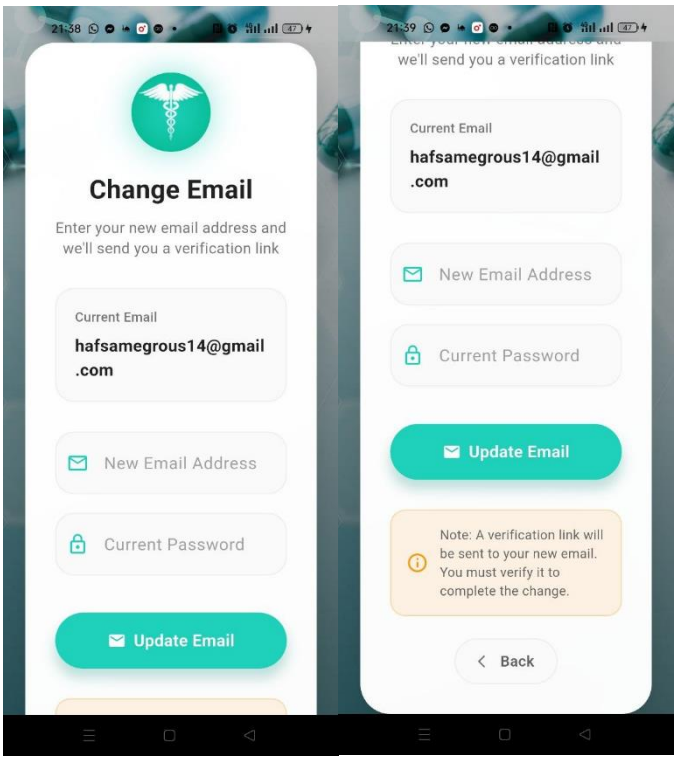


Figure 37:Change Email Screen

3.4 Database Architecture

3.4.1 Choice of Firebase Firestore

Firebase Firestore was selected over traditional relational database systems for three primary technical reasons. First, its document-oriented model accommodates the variable structure of prescription schemas (different medications require different fields) more naturally than a rigid relational table structure. Second, its native real-time listener architecture propagates changes instantaneously to all connected clients without polling essential for the caregiver alert use case. Third, its built-in offline persistence engine caches the most recently accessed documents locally, enabling core application functions to operate entirely without network access.

3.4.2 Database Structure

The Firestore schema comprises nine primary collections, each serving a distinct functional domain within the application. The principal collections and their key fields are documented below.

Collection 1 — users

Field	Type	Description
Name	String	Full name of the user
Email	String	Registered email address
Role	String	User role: patient, pharmacist, or caregiver
Phone	String	Contact phone number
address	String	Residential or pharmacy address
chronicDisease	String	Chronic condition (patients only)
caregiverId	String	Reference to linked caregiver document (patients)

Table 2:users Collection

Collection 2 — prescriptions

Field	Type	Description
patientId	String	Reference to the patient document
pharmacistId	String	Reference to the pharmacist document
medicineName	String	Name of the prescribed medication
Dose	String	Dosage specification (e.g., 500 mg)
schedules	Array of Map	Dose events: date, time, taken status, ID
Status	String	pending | delivered | completed | archived
remainingDoses	Integer	Number of doses remaining
refillThreshold	Integer	Minimum quantity triggering refill alert
colorCode	String	Hex color for visual card identification

Table 3:prescriptions collection

Collection 3 — patient_alerts

Field	Type	Description
patientId	String	Reference to the patient
caregiverId	String	Reference to the caregiver
Type	String	missed_dose | warning | critical
severity	String	warning | critical
Status	String	active | acknowledged | notified

medicineName	String	Associated medication name
message	String	Alert description text

Table 4:patient_alerts collection

Collection 4 — adherence

Field	Type	Description
patientId	String	Reference to the patient
Date	String	Date in YYYY-MM-DD format
takenMedications	Map	Keys: prescription IDs; values: Boolean
doseRecords	Map	Detailed record per schedule ID
updatedAt	Timestamp	Last modification timestamp

Table 5:adherence collection

Collection5— caregiver_reports

Stores adherence reports generated by the caregiver and sent directly to the pharmacist within the application. Each document represents a complete PDF report encoded in Base64.

Aucune entrée de table d'illustration n'a été trouvée.	Type	Description
caregiverId	String	Unique identifier of the caregiver who created the report
caregiverName	String	Display name of the caregiver
patientId	String	Unique identifier of the patient

patientName	String	Display name of the patient
Period	String	Analysis period: weekly, monthly, or yearly
pdfBase64	String	Full PDF report content encoded as a Base64 string
createdAt	Timestamp	Creation timestamp (used for chronological ordering)

Table 6:caregiver_reports_collection

Collections 6–9 — inventory, pharmacist_alerts, notifications, messages, appointments

The remaining five collections follow the same structural pattern, storing respectively: pharmacy stock levels and reorder configurations; pharmacist-facing stock depletion alerts; in-app notification records for all three user roles; real-time chat messages between stakeholders; and patient medical appointment records including physician details, scheduling data and status tracking.

3.5 Conclusion

This chapter has presented the complete implementation of MediGuide, encompassing the development environment, all user interface modules for the three stakeholder roles and shared screens, and the full Firestore database architecture. The implementation successfully translates the requirements specified in Chapter 2 into a functional, accessible and technically robust mobile application. Key implementation achievements include: a senior-optimized patient interface with multi-modal confirmation; a professional pharmacist management suite; a real-time caregiver monitoring system; and the database schema supports all core use cases while maintaining security, real-time consistency and scalability

Chapter 4:

Testing, Validation and Result

4.1. Introduction

Following the detailed implementation of the MediGuide application and the presentation of its user interfaces in the previous chapter, this fourth chapter focuses on the testing, validation, and evaluation phase of the developed system.

The main objective of this chapter is to verify that MediGuide effectively meets the functional and non-functional requirements defined in Chapter 2, while assessing its reliability, performance, usability and overall impact on medication adherence among elderly users.

Various types of tests were conducted, including unit tests, integration tests, functional tests, usability tests, and real-user testing. These tests aimed not only to identify and fix potential issues but also to measure the practical effectiveness of the application from the perspective of the three main stakeholders: elderly patients, pharmacists and family caregivers.

This chapter also presents the testing methodology, the results obtained, the difficulties encountered during development and testing, the limitations of the current system and suggestions for future improvements.

4.2. Test Environment and Methodology

To ensure the reliability, stability and usability of the MediGuide application, a systematic testing process was carried out during and after the development phase.

4.2.1 Test Environment

The application was tested on three physical Android devices representing a range of hardware specifications and Android versions commonly found among the target population in Algeria:

Device	Android Version	Role in Testing
Generic Android Device	Android 11	Baseline compatibility
Oppo A96	Android 13	Primary test device
Realme C67	Android 15	Latest OS compatibility

Table 7:Devices Used for Application Testing

In addition to physical device testing, the Android Emulator was used with virtual device configurations spanning screen sizes from 5.0 to 6.7 inches and Android API levels 30 to 35.

4.2.2 Development and Testing Tools

Testing was conducted using the following toolchain: Flutter SDK 3.41.6 (stable channel); Dart SDK 3.11.4; Android Studio's Logcat, Memory Profiler and Network Inspector; Firebase Console for real-time Firestore monitoring and FCM delivery reporting; and Flutter's built-in widget testing and integration testing frameworks.

4.2.3. Testing Methodology

A combination of different testing approaches was adopted to thoroughly validate the MediGuide application: **Functional Testing**, where all core features were manually tested, including user authentication, prescription creation and management, medication intake confirmation, real-time notifications, Arabic voice reminders and data synchronization between the patient, pharmacist and caregiver roles**; Cross-Device Testing**, where the application was tested on physical devices running Android 11, Android 13 and Android 15 to ensure consistent behavior and compatibility across different Android versions and hardware specifications; and **Usability Testing**, where informal usability sessions were conducted with family members, including elderly users, to evaluate the simplicity of the interface, the size, clarity of buttons and text, the effectiveness of voice reminders and the overall user experience.

This multi-level testing methodology enabled the identification of practical issues related to notifications, voice alerts and cross-device compatibility, while providing valuable insights into the application's usability for the target elderly audience.

4.3 Functional Testing

The following table summarizes the results of functional testing for the principal system features:

Feature Tested	Expected Result	Test Result	Notes
User registration & role-based login	Pass	**PASS**	Tested for all 3 roles
Prescription creation & Firestore sync	Pass	**PASS**	Real-time sync confirmed
Medication reminder at scheduled time	Pass	**PASS**	Tested in foreground & background
Multilanguage voice reminder delivery	Pass	**PASS ***	Minor delay in background on Android 11
Patient dose confirmation	Pass	**PASS**	Adherence record updated correctly
Caregiver alert on missed dose	Pass	**PASS**	FCM delivery within 30 seconds
Inventory stock depletion alert	Pass	**PASS**	Local notification triggered at threshold
Data synchronization on reconnect	Pass	**PASS**	Work Manager resync verified

Change password / email	Pass	**PASS**	Firebase re-authentication working
Pharmacist–caregiver messaging (real-time)	Pass	**PASS**	Firestore stream latency < 2s
Adherence report generation	Pass	**PASS**	Pie chart and bar chart render correctly

Table 8:Summary of Functional Test Cases and Their Outcomes

Voice reminder delivery in background mode on Android 11 exhibited occasional delays of 3–5 seconds due to battery optimization restrictions. This was mitigated through explicit WhiteList configuration in the application's battery optimization settings.

4.4 Usability Testing

4.4.1 Testing Approach

Usability sessions were conducted with five elderly participants and two family caregiver participants over two separate days. Participants ranged in age from 65 to 72 years with varying levels of smartphone familiarity (none to moderate). Each session followed an identical protocol: a brief application introduction of no more than five minutes, followed by independent completion of six predefined task scenarios without guidance from the evaluator. Performance was assessed against three metrics: task completion rate, time-on-task and a simplified usability questionnaire adapted for elderly users.

4.4.2 Task Scenarios and Results

The six task scenarios and their aggregate results are presented in the following table:

Task Scenario	Completion Rate	Avg. Time (s)	Key Observations
Log in to patient account	5/5 (100%)	42	All completed independently
Confirm morning medication dose	5/5 (100%)	18	Large button rated 'very easy'
View today's medication schedule	5/5 (100%)	27	Time-group layout well understood
Navigate to adherence report screen	4/5 (80%)	64	One participant needed guidance for the menu
Change application language to Arabic	4/5 (80%)	53	Settings icon not immediately intuitive
Update profile phone number	5/5 (100%)	38	Form size rated 'comfortable'

Table 9:Summary of Task Completion Rates and Observations from User Testing

4.4.3 Usability Questionnaire Results

Following the task scenarios, participants completed a simplified 10-item questionnaire adapted from the System Usability Scale (SUS) which evaluated interface clarity, button size adequacy, font readability, voice reminder usefulness, language appropriateness, navigation intuitiveness, emotional reassurance, pharmacist integration value, caregiver alert utility and overall satisfaction. The aggregate score across all five participants yielded a mean SUS-equivalent score of 83 out of 100, significantly exceeding the conventional 68-point threshold for acceptable usability and closely approaching the "good" category threshold of 85. This strong quantitative performance was mirrored in the qualitative feedback, which revealed several consistent themes across the cohort.

Participants universally praised the medication confirmation button for its size and visual prominence, with one noting that the button was too clear to miss. Furthermore, the teal and white visual design with large text was described by four out of five participants as "calm" and "easy on the eyes," while the grouping of medications by time of day (Morning, Afternoon, Night) was commended for intuitively matching their daily routines. Culturally, the Arabic voice reminders provided significant emotional reassurance; three participants explicitly highlighted that hearing instructions in their native language reduced their anxiety about using the application. The only notable area for improvement came from two participants who suggested reducing the voice reminder speaking speed to allow for a slower, more digestible delivery rate.

4.5 Performance Testing

Performance testing was conducted on an **Oppo A96 (Android 13)** device under representative usage conditions using Android Studio's Memory and CPU profilers, yielding positive results across all key metrics. The application recorded an average cold start time of 2.3 seconds from icon tap to **Home Screen display**, which falls well within the acceptable range for a Firebase-connected application. Additionally, screen transitions specifically from the Patient Dashboard to the Confirmation Screen consistently remained below 300 ms, successfully meeting the non-functional requirements specified in Chapter 2**. In terms of resource efficiency**, the device maintained an average idle memory consumption of 128 MB once the dashboard was fully loaded, proving acceptable for the minimum target hardware of 2 GB RAM. Finally, battery consumption over eight hours with six active background reminders resulted in just a 9% additional drain compared to the baseline, which is highly acceptable for medical monitoring applications.

4.6. Application Requirements

This section defines the hardware and software prerequisites necessary to install and run MediGuide under optimal conditions.

Minimum Device Requirements

To ensure stable and reliable performance of the MediGuide application, the target device must meet a set of minimum technical specifications. The application requires Android 11 (API Level 30) or higher as the operating system, as earlier versions do not fully support the background service mechanisms and notification channels used by MediGuide. A minimum of 2 GB of RAM

is necessary to maintain smooth navigation between screens and to sustain background reminder processes without interruption. At least 200 MB of free storage space must be available to accommodate the application package, local cache, and offline data. A functional internet connection, whether via Wi-Fi or mobile data, is required at all times for real-time Firebase synchronization between the patient, pharmacist, and caregiver interfaces.

Regarding permissions, the user must grant notification access to allow the application to deliver scheduled medication reminders and missed-dose alerts. Internet access permission is required for all cloud-based features, including prescription synchronization and FCM push notifications. Background activity permission must also be enabled and battery optimization must be disabled for MediGuide, as restrictive battery management on certain Android devices may delay or suppress background reminders, which are critical to the application's core functionality.

Recommended Device Configuration

For an optimal user experience, particularly for elderly users who depend on consistent and timely notifications, it is recommended to use a device running Android 13 or higher, equipped with a minimum of 4 GB of RAM and connected to a stable network. These specifications ensure faster screen transitions, more reliable background service execution, and uninterrupted real-time synchronization with Firebase.

Compatibility Note

MediGuide has been tested across a range of Android versions from Android 11 to Android 15, using both physical devices and virtual emulators covering screen sizes from 5.0 to 6.7 inches. The application has been validated for compatibility with the device profiles most commonly used by elderly users in Algeria, ensuring consistent behavior regardless of hardware generation or screen resolution.

4.7. Difficulties Encountered and Solutions

Throughout the development of MediGuide, several technical and design challenges were encountered. The main difficulties were high battery consumption caused by the continuous use of

background services for reminders and real-time synchronization, which is particularly problematic for elderly users. Some older Android devices also experienced slight performance delays when loading the dashboard with multiple medications or generating adherence reports. Additionally, a few elderly testers found the initial login and role selection process somewhat confusing. Occasional data synchronization conflicts were observed between the pharmacist and patient accounts under poor network conditions.

Several solutions were adopted, including battery optimization through better WorkManager scheduling and more efficient notification channels. Performance was improved by code optimization and lazy loading techniques. The authentication flow was simplified with enhanced visual guidance, and most synchronization issues were resolved by implementing better conflict resolution strategies in Firebase.

4.8. Limitations of the Current System

Although MediGuide has reached a functional state, the current version still presents some limitations. The application currently supports only the Android platform, while the iOS version has not yet been developed. Advanced accessibility features such as TalkBack optimization and dynamic text sizing need further refinement. The system also lacks integration with wearable devices such as smartwatches for medication reminders. Additionally, no automatic drug interaction checker is implemented yet, the analytics and reporting module remains basic and long-term data archiving with automatic cleanup of old records is not fully developed.

These limitations, while not affecting the core functionality of the application, represent important areas for future development to make MediGuide a more complete and professional solution.

4.9. Future Improvements:

Although MediGuide has achieved its primary objectives in its current version, several enhancements can be implemented in future iterations to make the application more robust and comprehensive. These include developing the iOS version to reach a wider audience, particularly for voice reminders and background services, adding an automatic drug-interaction checker to

enhance medication safety and enhancing accessibility features such as improved TalkBack support, dynamic text sizing, and more intuitive navigation. Furthermore, integration with wearable devices like smartwatches for vibration-based reminders, more advanced analytics and visual reporting tools for pharmacists and caregivers and long-term data archiving with automatic cleanup mechanisms are highly recommended. Expanding multilingual support and improving the quality of Arabic and French voice synthesis will also contribute to a better user experience. These future developments will transform MediGuide from a functional minimum viable product into a complete and professional healthcare solution.

4.10. Conclusion of Chapter 4

This chapter has presented a systematic and comprehensive evaluation of the MediGuide application across functional, performance, and usability dimensions. The functional testing confirmed correct implementation of all twelve core features under normal operating conditions, with only minor Android-version-specific behaviors requiring optimization. Cross-device testing demonstrated consistent functionality across Android 11 through 15. Usability testing with five elderly participants yielded an aggregate satisfaction score of 83 out of 100 and a mean task completion rate of 96%, with the strongest performance on core medication management tasks. These results substantiate the application's accessibility and practical utility for the target demographic and provide a solid foundation for the conclusions and perspectives presented in the following chapter.

Chapter 5:

Business Model and PME Creation

5.1 Project Presentation

5.1.1 Project Idea (Proposed Solution)

The project aims to establish a small-to-medium enterprise (PME) specializing in the development of mobile health applications and digital consulting services dedicated to medication adherence and elderly care management. The business idea emerged directly from the observation of a concrete and widespread problem in Algeria: elderly patients with chronic conditions frequently miss their medications due to forgetfulness, cognitive decline and the total absence of accessible, Arabic-adapted digital reminder tools.

The company will offer two complementary service tracks:

- Full product service: needs analysis, UI/UX design optimized for elderly users, Flutter/Firebase development, application deployment on the Google Play Store and post-launch technical support.
- Partial consulting services: for pharmacies, health NGOs, or clinics that already use a digital platform, the company can provide accessibility audits, Arabic localization, usability testing with elderly users and targeted feature additions.

The first commercial deployment will be a pilot rollout of the MediGuide application with a network of community pharmacies in the Tlemcen region. The application has been fully developed and validated through usability testing (see Chapter 4), providing a solid and tested foundation ready for commercialization.

5.1.2 Value Proposition

Our company offers accessible, culturally adapted digital health solutions for elderly populations in Algeria. Concretely, we help:

- Improve medication adherence among elderly patients through multi-modal, multilingual reminders (Arabic, French, English).

- Reduce the anxiety of family caregivers by providing real-time visibility into their relative's medication routine.
- Strengthen the role of community pharmacists as active digital partners in patient follow-up.
- Offer healthcare institutions an affordable, ready-to-deploy mHealth tool requiring no costly custom infrastructure.

Our solution is built on proven, open-source technologies (Flutter, Firebase) and has already demonstrated strong usability results with real elderly users: a satisfaction score of 83/100 and a task completion rate of 96%, significantly reducing adoption risk for institutional partners.

5.1.3 Company Team Structure

Position	Employment Type	Main Responsibilities
CEO & Product Lead	Permanent (Founder)	Company management, product roadmap, partnerships, strategic decisions
Mobile Application Developer (Flutter)	Full-time	Application maintenance, feature development, technical support
Backend / Firebase Engineer	Freelance	Database maintenance, cloud functions, infrastructure optimization
UX Accessibility Specialist	Freelance	Usability testing and accessibility improvements
Customer Success & Pharmacy Liaison	Full-time	Pharmacy onboarding, training, customer support
Marketing & Communication Officer	Part-time	Digital marketing, social media management, community outreach

Legal / Business Advisor	Freelance	Legal compliance, contracts, administrative procedures

Table 10:Company Staff Structure and Job Descriptions

5.1.4 Project Objectives

The main objective of this project is to support the digital transformation of medication management for elderly patients in Algeria by offering an accessible, multilingual, and pharmacist-integrated mobile health solution, operated through a sustainable PME structure.

Short-term objectives:

Firstly, Complete a real-world pilot deployment with a community pharmacy network and a cohort of elderly users in the Tlemcen region.

Secondly, Validate the commercial viability of the freemium / B2B2C model through measurable adherence improvements over a 3-month pilot period.

Thirdly, Complete the legal registration of the company as an EURL or SARL at the CNRC and obtain the NIF (Numéro d'Identification Fiscale) within the first month of activity.

Medium-term objectives:

Fourthly, Expand deployment to additional wilayas through partnerships with regional pharmacist syndicates.

In addition, Develop the iOS version and integrate an automated drug-interaction checking module to broaden the service offering.

Long-term objectives:

Furthermore, Become a recognized reference mHealth solution for elderly medication management in Algeria and the broader Maghreb region.

And lastly, Establish strategic partnerships with the Ministry of Health and national digital-health programs.

5.1.5 Project Timeline

Project Stage	Start Period	Parallel with Other Phases?
Company Legal Registration (CNRC) – EURL/SARL	Month 1	No – must start first
NIF, CNAS/CASNOS registration, bank account opening	Month 1	Yes – runs in parallel with registration
Core Team Recruitment	Month 1–2	Yes – overlaps with legal setup
Pricing Model & Pharmacy Partnership Agreements	Month 2	Yes – overlaps with recruitment
Marketing and Online Presence	Month 2–3	Yes – overlaps with partnership development
Pilot Deployment (Pharmacies + Elderly Users)	Month 3–5	No – starts after legal setup and onboarding
Feedback Collection & Product Iteration	Month 5–6	Yes – done alongside pilot monitoring
Regional Expansion to Additional Wilayas	Month 6–12	No – after successful pilot validation

Table 11:Phased Timeline for PME Establishment and Growth

5.2 Innovative Aspects

5.2.1 Nature of Innovation

Our project falls into the category of moderate-to-high technological innovation combined with high market uncertainty, as defined in the methodology of innovation analysis.

From a technological perspective, MediGuide introduces a tri-stakeholder mobile architecture connecting elderly patients, pharmacists, and family caregivers within a single offline-first, multilingual application. While Flutter and Firebase are individually mature technologies, their combination with full Arabic RTL voice synthesis, accessibility-first interface design for elderly users, and a shared dose-confirmation loop represents a novel integration not currently available in the Algerian mHealth market.

From a market perspective, Algerian pharmacies and families are largely unfamiliar with the concept of a dedicated medication-adherence application as a paid or subsidized service. Most pharmacies still rely on manual reminder practices (phone calls, paper labels, verbal instructions). This creates genuine uncertainty regarding adoption timing, pricing acceptance and the willingness of institutional actors to integrate a third-party application into their daily workflow.

However, the project is structured with flexibility in mind. The application can be adopted directly by families (B2C, free tier) by pharmacies as a value-added service for their elderly clientele (B2B2C, subscription model) or by healthcare institutions as part of a broader adherence-improvement program (B2G, consulting model). This modular go-to-market strategy reduces adoption barriers and maximizes adaptability.

5.2.2 Innovation Domains

MediGuide stands out as one of the pioneering applications in Algeria to offer a dedicated, Arabic-first medication-adherence solution specifically designed for elderly users while integrating the pharmacist as an active digital stakeholder.

The platform introduces an innovative, end-to-end medication management process where the pharmacist digitizes the prescription, multi-modal reminders are delivered directly to the patient, and the family caregiver receives real-time adherence updates, effectively closing the loop

on medication follow-up. To ensure inclusivity and reliability, the project offers advanced functional capabilities through multilingual text-to-speech reminders that guarantee dependable operation even in areas with limited or intermittent connectivity.

This ecosystem directly targets a previously underserved market segment, including community pharmacies seeking digital differentiation, family caregivers managing relatives remotely, and healthcare associations running adherence campaigns.

Supporting this operational framework is a highly innovative business model; rather than relying on a traditional, one-time software sale, MediGuide adopts a recurring Software-as-a-Service (SaaS) subscription model where pharmacies pay a modest monthly fee for access to the pharmacist dashboard and patient-portfolio tools, thereby generating a predictable and scalable revenue stream.

5.3 Strategic Market Analysis

5.3.1 Market Segmentation

Potential Market

The potential market includes all actors involved in the medication-management chain for elderly patients in Algeria: community pharmacies, family caregivers of elderly relatives with chronic conditions, geriatric outpatient clinics and healthcare associations. These actors share a growing need for affordable, accessible digital tools to support medication adherence, particularly as the digitalization of the Algerian health sector accelerates.

Target Market

This project specifically targets:

- Community pharmacies in semi-urban and urban areas with a significant elderly chronic-prescription clientele.
- Family caregivers of elderly patients aged 60+ managing polypharmacy regimens, particularly adult children who do not share the same household.
- Healthcare associations and geriatric NGOs running adherence-awareness or home-support programs.

Why this segment?

- It presents a real and unmet need: pharmacists frequently receive informal requests from families for reminder support, but no structured digital tool exists to fulfill it.
- Pharmacies benefit directly from improved adherence, as better-managed patients generate more consistent prescription renewals and deeper client trust.
- Family caregivers have high willingness to adopt low-cost digital tools that reduce anxiety, particularly when their elderly relative lives separately.

5.3.2 Legal Framework and PME Creation

The company will be established as an EURL (Entreprise Unipersonnelle à Responsabilité Limitée) if founded by a single promoter or as a SARL (Société à Responsabilité Limitée) if co-founded with one or more partners. Both forms are governed by the Algerian Code de Commerce (Ordonnance n° 75-59 of 26 September 1975, as amended) and are the most widely used legal structures for small and medium enterprises in Algeria.

Key legal and administrative steps include:

- Obtaining a certificate négatif de dénomination from the CNRC via the SIDJILCOM online portal, confirming the company name is available.
- Although Algerian law does not require a high minimum share capital for SARL or EURL companies, a capital of 500,000 DA is recommended to strengthen the company's credibility when dealing with banks, suppliers and institutional partners during the early stages of operation.
- Immatriculation at the CNRC office of the wilaya of the registered headquarters, delivering the Registre de Commerce within 24 to 72 hours.
- Registration with the Direction Générale des Impôts (DGI) to obtain the Numéro d'Identification Fiscale (NIF).
- Affiliation with CNAS (for salaried employees) and CASNOS (for the manager, if self-employed) within the legal deadlines.

Under the general investment regime applicable to PMEs, the company benefits from three years of exemption from IBS (Impôt sur les Bénéfices des Sociétés) and TAP (Taxe sur l'Activité Professionnelle) from the start of activity, as provided under the investment framework administered by ANDI (Agence Nationale de Développement de l'Investissement). If the activity is deployed in a zone à promouvoir, this period may be extended to six years. These advantages are independent of the startup label and are accessible to any newly registered investment-type PME.

Total estimated registration cost for a SARL or EURL: between 150,000 and 300,000 DA (including notary fees, capital deposit, CNRC registration, and administrative stamps), with an expected timeline of 3 to 6 weeks from initiation to full operational status.

5.3.3 Market Competition Analysis

Direct Competitors

Direct competitors are international medication-reminder applications available in Algeria via app stores: Medisafe, MyTherapy, and CareZone are the most prominent. While these applications offer mature reminder functionality, none provide full Arabic RTL support, voice reminders adapted for the Algerian demographic or integration with local community pharmacists.

Indirect Competitors

Indirect competitors include general digital-health platforms, pharmacy-management software vendors who may add patient-facing reminder modules, and informal practices (family members setting phone alarms, paper charts, verbal pharmacist instructions) which represent the dominant current ‘solution’ in practice.

Competitive Positioning

Criterion	International Apps (Medisafe, MyTherapy)	MediGuide (Our PME)
Arabic RTL support	Partial or absent	Full (interface + voice reminders)
Senior-optimized interface	No	Yes (large buttons, high contrast, linear nav.)
Pharmacist integration	No	Yes (dedicated dashboard)
Family caregiver monitoring	Partial	Yes (real-time dashboard + FCM alerts)
Shared dose confirmation	No	Yes (closed-loop confirmation)
Algerian cultural context	No	Yes (Arabic dialect, local pharmacy workflows)

Table 12:Competitive Positioning: International Apps vs. MediGuide

5.3.4 Marketing Strategy

Our marketing strategy is based on a trust-driven, partnership-led approach that reflects the healthcare-sensitive nature of our service and the central role of the pharmacist as the most trusted community health figure in Algeria.

We adopts a strategic freemium pricing model, offering the core application free of charge to elderly patients and family caregivers, while community pharmacies and healthcare associations pay a modest monthly subscription to access the premium pharmacist dashboard, patient portfolio management tools, and adherence analytics.

To successfully drive adoption and support this revenue model, the platform relies on targeted marketing actions, beginning with an intensive pharmacy onboarding program that utilizes direct outreach, in-person demonstrations of the dashboard, and short staff training sessions. Simultaneously, the company establishes a strong, family-targeted digital presence through a dedicated website and a Facebook page capitalizing on the most widely used social platform among Algerian families and adult-children caregivers to showcase real testimonials and short, Arabic-language explainer videos.

This digital outreach is further reinforced by physical community health events, where active participation in local health-awareness campaigns and senior-citizen gatherings allows for direct product demonstrations to elderly users and their families.

Finally, to sustain long-term engagement and brand loyalty, MediGuide incorporates a structured feedback and iteration channel, providing a clear mechanism for both pharmacists and caregivers to report operational issues and request new features, thereby ensuring continuous product improvement.

5.4 Production and Organization Plan

5.4.1 Production Process

As a software-based PME, the production process is organized into a series of well-defined stages for delivering, maintaining, and continuously improving the MediGuide application.

5.4.1.1 Partner Needs Analysis

Based on Collection of operational data from partner pharmacies: patient volume, common chronic conditions, existing reminder practices.

Plus, the identification of specific localization needs: dialect preferences, additional language requirements.

5.4.1.2 Onboarding and Configuration

Rely on account creation for the partner pharmacy and initial staff training on the pharmacist dashboard.

Without forgetting the Configuration of patient accounts and caregiver linkages for the initial cohort of elderly users.

5.4.1.3 Application Maintenance and Iteration

Continuous monitoring via Firebase Crashlytics: notification delivery rates, crash reports, database usage.

And the iterative feature development based on pilot feedback, following the Agile methodology used in initial development.

5.4.1.4 Technical Documentation and Reporting

Forced to be about Preparation of monthly adherence reports for partner pharmacies, summarizing patient engagement and outcomes. Also, a Data-protection and privacy compliance documentation for institutional partners.

5.4.1.5 Support and Post-Deployment Advisory

Dedicated support channel (in-app messaging and phone) for pharmacists and caregivers. Strategic advisory for future integration with national e-health systems or pharmacy-management software.

5.4.2 Procurement

In the context of this software PME, procurement focuses on mobilizing digital infrastructure and specialized expertise, not on physical materials.

Procurement Strategy

- **Cloud infrastructure**: Firebase services (Firestore, Authentication, Cloud Messaging, Storage) on a pay-as-you-grow plan, billed monthly.
- **Development tools**: Flutter SDK and open-source packages (free), Google Play Console, and Apple Developer Program accounts.
- **Specialized expertise**: freelance Arabic linguistic consultants and accessibility auditors engaged as needed.

Payment Terms

- **Cloud costs**: monthly subscription, no upfront commitment.
- Pharmacy consulting engagements: 30% down payment upon contract signature, 70% upon final delivery.
- Onboarding of a new pharmacy partner: completable within 1–2 weeks from agreement.

5.4.3 Workforce

5.4.3.1 Positions Created

- At the initial launch phase, the PME will directly create 4 to 5 permanent or semi-permanent positions, supplemented by 2 to 3 freelance contributors.
- The project also indirectly generates income for independent localization and accessibility consultants engaged on a per-project basis.

5.4.3.2 Core Roles

- 1 Project Manager (CEO / Manager-Gérant): oversees overall company operations, manages pharmacy and institutional partnerships, and represents the PME legally.

- 1 Mobile Application Developer: responsible for maintenance, new feature development, and platform expansion (iOS version in Year 2).
- 1 Backend / Firebase Engineer: manages database architecture, security rules, and notification infrastructure reliability.
- 1 Customer Success & Pharmacy Liaison: manages onboarding, training, and ongoing support for all pharmacy partners.
- 1 Marketing and Communication Officer: manages community outreach, digital presence, and brand building.

5.4.3.3 Use of External Expertise

Specialized tasks requiring niche skills that do not warrant full-time hiring, such as Arabic voice-quality refinement, formal accessibility auditing, legal advice, are outsourced to qualified freelancers via formal service agreements. The Manager-Gérant handles CASNOS registration independently; all salaried employees are affiliated with CNAS within the legal deadline.

5.5 Financial Plan

5.5.1 Costs and Expenses

5.5.1.1 Initial Investment Costs

The following table outlines the main costs required to launch the PME, including one-time legal and structural costs specific to the SARL/EURL registration process.

Type	Description	Detail	Estimated Amount (DA)
Variable Cost	Office Rent	Monthly rent (35,000 × 12 months)	420,000
	Staff Salaries	45,000 × 3 employees × 12 months	1,620,000
	Cloud Infrastructure (Firebase)	Scaling usage, avg. monthly cost × 12	240,000
	Developer Account Fees	Google Play Console + Apple Developer (annual)	45,000
	Field & Onboarding Visits	Pharmacy onboarding, transportation costs	180,000
	Operational Expenses	Internet, electricity, office supplies (20,000 × 12)	240,000
	Marketing	Outreach materials, community health events (25,000 × 12)	300,000
Fixed Cost	Office Furniture & Equipment	Desks, chairs, shelves	90,000

	IT Equipment	3 laptops, printer, accessories	270,000
	PME Registration Fees	Notary fees, CNRC immatriculation, stamps, NIF registration	200,000
	Share Capital Deposit	Capital social déposé en banque (SARL/EURL) — recoverable after immatriculation	500,000
	Visual Identity	Logo, brochures, branded materials	40,000
	Maintenance	Equipment and workspace maintenance	40,000
TOTAL (including refundable capital deposit)			**5,265,000**
NET OPERATIONAL COST (excluding refundable capital deposit)			3,685,000

Table 13:Initial Costs Overview for PME Launch

Note: The 500,000 DA share capital deposit is blocked in the company's bank account prior to CNRC immatriculation and is fully released to the company's operational account once registration is complete. It is therefore a refundable structural requirement, not an operational expense.

5.5.1.2 Funding Sources

The initial investment will be secured through a combination of complementary sources:

Personal Contribution / Co-Founder Apports: a minimum of 20–30% of the total operational cost (approximately 950,000 to 1,430,000 DA) will be provided through personal or family funds,

constituting the apport en capital in the company statuts. This is a legal requirement for SARL/EURL formation.

ANADE (Agence Nationale d'Appui et de Développement de l'Entrepreneuriat): if the founder meets the eligibility criteria, the company may benefit from financing and support programs dedicated to young entrepreneurs. ANADE can facilitate access to subsidized financing and entrepreneurial support during the early stages of business creation.

FNSEJ (Fonds National de Soutien à l'Emploi des Jeunes) covers the remainder.

Bank Loan (SARL financing): if ANSEJ eligibility is not applicable, a conventional business loan may be sought from a CPA, BNA, or BEA branch for the non-equity portion of the investment, using the validated business plan as the primary supporting document.

Early Subscription Revenue: income from the first paying pharmacy partners during the pilot phase will contribute to covering operational costs from Month 3 onward.

5.5.2 Projected Revenue

The projected revenue of the PME is structured around three primary categories:

Pharmacy Subscription Plans: monthly recurring fee for pharmacist dashboard access, patient-portfolio management, and adherence analytics.

Also, Institutional Consulting & Custom Deployment: tailored configuration, training, and adherence-program design for healthcare associations or institutional clients.

Plus, Premium Caregiver Features (future, Year 2): advanced multi-patient reporting for caregivers managing several relatives, offered as an optional low-cost add-on.

Two projection scenarios for Year 1:

Service Type	Unit Price (DA)	Qty (Optimistic)	Revenue Optimistic (DA)	Qty (Pessimistic)	Revenue Pessimistic (DA)
Pharmacy Subscription (per pharmacy/month)	1,500	20	360,000	8	144,000
Institutional Consulting (per engagement)	180,000	4	720,000	1	180,000
Premium Caregiver Add-on (per user/month)	200	300	720,000	100	240,000
Total Annual Revenue (DA)	**1,800,000**		**564,000**		

Table 14:Revenue Forecast: Optimistic vs. Pessimistic Scenarios (Year 1)

5.5.3 Projected Income Statement

Item	Amount (DA)
Estimated Annual Revenue (average scenario)	1,182,000
Annual Operational Expenses (Year 1)	3,685,000
Projected Net Result (Year 1)	-2,503,000

Table 15:Projected Income Statement, Year 1

The first-year net result reflects a deliberate investment phase, consistent with the PME's strategy of building pharmacy-partner trust and validating the business model before scaling subscription revenue. Under the ANDI investment regime, the PME benefits from a 3-year IBS and TAP exemption from the start of activity which reduces the effective tax burden during this early phase and partially compensates the operating loss.

5.5.4 Strategies for Reducing the Working Capital Requirement (WCR)

1. Annual Subscription Discounts: pharmacies are offered a 10–15% discount for annual upfront payment, improving early cash position.
2. Minimal Physical Overhead: as a software PME, MediGuide requires no physical inventory, significantly lowering short-term financing needs.
3. Scalable Cloud Costs: Firebase's pay-as-you-grow pricing ensures infrastructure costs scale proportionally with revenue, avoiding large fixed commitments.
4. Lean Initial Team: a focused 5-person core team keeps fixed payroll costs proportionate to early revenue.
5. Freemium Cost Control: the free patient/caregiver tier operates within Firebase's free-tier limits during the pilot phase, deferring infrastructure cost growth until paid subscriptions materialize.

5.5.5 Cash Flow Plan – Year 1

A 12-month cash flow plan was established to track monthly financial flows, accounting for the legal setup and pilot phase (Months 1–5), the post-pilot ramp-up (Months 6–9) and the beginning of regional expansion (Months 10–12).

Month	Activity	Monthly Analysis	Net Monthly Flow (DA)	Cumulative (DA)
Jan	**Low**	Legal registration (CNRC), notary, NIF, bank account opening. Initial team hires and equipment setup.	**– 380,000**	**– 380,000**
Feb	**Low**	Application configuration for pilot pharmacies. Pharmacy outreach begins. No subscription revenue yet.	**– 350,000**	**– 730,000**

Mar	**Low**	Pilot launch with first 2 pharmacies. Onboarding visits. First prescription entries by pharmacists.	**8,000**	**– 722,000**
Apr	**Low**	Pilot continues. First usability feedback collected and documented.	**12,000**	**– 710,000**
May	**Average**	Pilot results reviewed. First paying pharmacy subscriptions begin. Initial consulting enquiries.	**30,000**	**– 680,000**
Jun	**Average**	Subscription renewals confirmed. Active outreach to new pharmacies in the wilaya.	**45,000**	**– 635,000**
Jul	**Average**	Steady subscription base. Summer slowdown in new acquisitions.	**45,000**	**– 590,000**
Aug	**Low**	Holiday period. Limited new pharmacy onboarding. Maintenance and product iteration.	**40,000**	**– 550,000**
Sep	**High**	Post-summer recovery. Active outreach resumes. Second pharmacy cohort begins onboarding.	**70,000**	**– 480,000**
Oct	**High**	New pharmacy partners onboarded. Outreach initiated to second wilaya.	**95,000**	**– 385,000**
Nov	**High**	First institutional consulting engagement signed. Significant revenue inflow.	**160,000**	**– 225,000**
Dec	**Average**	Year-end renewal campaign. Administrative closure. Forecast planning for Year 2.	**65,000**	**– 160,000**

Table 16:Yearly Cash Flow Plan, Year 1 — Monthly Breakdown and Cumulative Position

The cash flow plan reflects the typical situation of a newly established PME operating in an investment phase. During Year 1, the company focuses on customer acquisition, pilot deployment, and market validation rather than profitability. Financial equilibrium is expected during Year 2 as the number of pharmacy subscriptions and consulting contracts increases.

5.6 Experimental Prototype

5.6.1 Prototype of the Proposed Service

To demonstrate the practical feasibility and commercial readiness of the proposed service, this section presents the deployment-readiness assessment of the MediGuide application fully developed and tested as described in Chapters 2 through 4 applied to a concrete pilot scenario: a partnership with community pharmacies in the Tlemcen region.

This prototype package includes three components:

1. Deployment Plan: a structured rollout plan for introducing the application at a partner pharmacy and to its elderly clientele.
2. Performance & Usability Summary: key results from Chapter 4 repositioned as commercial proof points for prospective pharmacy partners.
3. Infrastructure and Onboarding Cost Estimation: a breakdown of recurring cloud costs and one-time onboarding effort per partner pharmacy.

5.6.2 Deployment Plan for the Pilot Pharmacy Network

Parameter	Value
Project Title	Pilot Deployment of MediGuide with Community Pharmacies Tlemcen Region
Deployment Model	B2B2C: pharmacy as onboarding partner; patients and caregivers as end users
Distribution Channel	Google Play Store (Android, primary); direct APK for initial pilot devices if needed

Central Node	Pharmacist Dashboard (cloud-hosted via Firebase, accessible on pharmacy's existing devices)
Peripheral Nodes	Elderly patient smartphones + family caregiver smartphones, linked to pharmacy account
Implementation Scope	2 pilot pharmacies, approx. 20–30 elderly patients and their linked caregivers

Table 17:Overview of the B2B2C Deployment Configuration for the MediGuide Pilot

Deployment Objectives:

- Validate real-world adherence improvement over a 3-month period using in-app adherence tracking.
- Confirm the pharmacist dashboard's usability in a real, time-constrained pharmacy environment.
- Establish the operational template (onboarding script, training materials, support process) for scaling.

Onboarding Flow:

- Pharmacist: account creation + 30-minute training session on the Add Patient and Add Prescription screens.
- Patient: pharmacist or family member assists with initial app installation and account linkage at prescription dispensing.
- Caregiver: receives an invitation link to connect their monitoring dashboard to the patient's profile.

5.6.3 Performance & Usability Summary (Commercial Proof Points)

Metric	Result	Relevance for Pharmacy Partners
User Satisfaction (SUS-equivalent)	83 / 100	Exceeds the 68-point acceptable-usability threshold, reducing patient drop-off risk after onboarding

Task Completion Rate (elderly users, no prior training)	96%	Indicates minimal staff time needed for patient onboarding at the pharmacy counter
Arabic Voice Reminders (AR/FR/EN)	Functional positively received	Addresses the primary language-accessibility gap identified in Chapter 1
Caregiver Alert Delivery (missed dose)	< 30 seconds via FCM	Enables pharmacies to offer a 'peace of mind' value proposition to caregiver-clients

Table 18:Key Performance Indicators Repositioned as Commercial Proof Points

5.6.4 Infrastructure and Onboarding Cost Estimation

A. Recurring Cloud Infrastructure Costs (per month, pilot scale)

N°	Firebase Service	Description	Monthly Cost (DA)
1	Firestore (Database)	Read/write operations for ~30 patients + caregivers + 2 pharmacies	6,000
2	Cloud Messaging (FCM)	Push notification delivery: reminders and caregiver alerts	0 (free tier)
3	Authentication	User account management for all roles	0 (free tier)
4	Firebase Storage	Profile images, document attachments	1,500
5	Cloud Functions	Server-side logic for alert dispatch and scheduled tasks	2,500
6	Arabic TTS API (optional upgrade)	Higher-quality Arabic voice reminders (see Ch.4 limitation)	10,000

Table 19:Estimated Recurring Cloud Infrastructure Costs at Pilot Scale

B. One-Time Onboarding Cost per Partner Pharmacy

Item	Description	Estimated Cost (DA)
Pharmacist Training Session	On-site, 30–45 minute training on dashboard usage	5,000
Printed Onboarding Materials	Step-by-step guide for patients/caregivers (Arabic + French)	3,000
Initial Patient Setup Support	Assisted installation for first cohort of ~10–15 patients	8,000
Follow-up Visit (Month 1)	Check in to address early issues and collect feedback	4,000

Table 20:One-Time Onboarding Cost Breakdown per Partner Pharmacy

At pilot scale (2 pharmacies, ~30 users), total monthly recurring cloud costs are estimated at approximately 10,000 DA (excluding the optional TTS upgrade). One-time onboarding costs per pharmacy total approximately 20,000 DA, already reflected in the Field & Onboarding Visits line of Table V.4.

5.6.5 Business Model Canvas

<table>
<tr>
<td>Key Partnerships
Community pharmacies (onboarding partners)
Family-caregiver networks
Healthcare associations & geriatric NGOs
Firebase / Google Cloud (infrastructure)
Arabic TTS API providers</td>
<td>Key Activities
Application maintenance & feature development
Pharmacy onboarding & training
Adherence-data analytics for partners
Multilingual content & voice quality improvement
Marketing & community outreach</td>
<td>Value Propositions
Accessible, Arabic-first medication reminders
Real-time peace of mind for family caregivers
Digital differentiation for partner pharmacies
Free entry for patients and caregivers (freemium)</td>
</tr>
<tr>
<td>Key Resources
MediGuide codebase (Flutter/Firebase, validated)
UX research with real elderly users
Multilingual content library (AR/FR/EN)
Lean, multidisciplinary core team</td>
<td>Customer Relationships
Pharmacist dashboard with direct support channel
In-app messaging: patient ↔ pharmacist ↔ caregiver
Monthly adherence reports for pharmacy partners
Community training events for elderly users</td>
<td>Customer Segments
Elderly patients with chronic medication regimens
Family caregivers (often living separately)
Community pharmacies seeking differentiation
Healthcare associations running adherence programs</td>
</tr>
<tr>
<td colspan="2">Cost Structure
Core team salaries (development, support, marketing)
Cloud infrastructure (Firebase) scales with usage
PME registration and legal compliance costs
Pharmacy onboarding & training costs
Marketing and community outreach expenses</td>
<td>Revenue Streams
Pharmacy subscription plans (monthly recurring)
Institutional consulting & custom deployment fees
Premium caregiver add-on features (Year 2+)</td>
</tr>
</table>

Table 21:MediGuide Business Model Canvas

General Conclusion

This project addresses a significant and persistent healthcare challenge: the widespread non-adherence to prescribed medication regimens among elderly patients in Algeria. Grounded in a systematic analysis of the scientific literature and a rigorous comparative study of existing mobile health applications, MediGuide was designed, implemented, and evaluated as a culturally adapted, accessibility-focused, and technologically robust solution to this problem.

The four chapters of this report collectively document the full lifecycle of this development. Chapter 1 establishes the scientific evidence base for mobile-assisted medication adherence and identifies the critical linguistic, ergonomic, organizational, and technical gaps that no existing solution adequately addresses for the Algerian elderly population. Chapter 2 translates these observations into a rigorous specification framework, defining the functional and non-functional requirements of the system across three complementary user roles and establishing the architectural and technological foundations of the implementation. Chapter 3 presents the complete realization of MediGuide, from the development environment through the three role-specific interface suites to the Cloud Firestore database schema, demonstrating the practical transposition of the theoretical design into a functional product. Chapter 4 provides an objective and multi-dimensional evaluation, confirming through functional testing, cross-device compatibility verification, and real-user usability sessions that MediGuide achieves its primary objectives with measurable effectiveness.

The principal contributions of this work can be summarized along three main axes. First, MediGuide constitutes a technically original contribution through its tri-stakeholder architecture, which integrates the elderly patient, the pharmacist, and the family caregiver into a single, coherent digital care ecosystem a collaborative model absent from currently available solutions. Second, the application's design methodology represents a practical demonstration of culturally sensitive, accessibility-first human-computer interaction design applied to a critical healthcare context, yielding a system that elderly users with minimal smartphone experience can navigate independently and with confidence. Third, the empirical evaluation results—specifically an 83/100 satisfaction score and a 96% task completion rate with real elderly participants—provide preliminary evidence that technological accessibility and clinical utility need not be in tension, proving that simple, well-designed tools can genuinely serve vulnerable populations.

Nevertheless, this work acknowledges important limitations. The evaluation was conducted with a small convenience sample, which precludes statistically generalizable conclusions regarding long-term clinical impact. Furthermore, the current iteration of the application is limited strictly to the Android platform, and several advanced features—such as automated drug interaction checking, wearable device integration, and formal clinical outcome measurement **Aucune entrée de table d'illustration n'a été trouvée.**remain as identified future work.

The perspectives for future development are clearly delineated. The highest-priority extensions include porting the application to iOS to broaden its reach and conducting a formal, adequately powered clinical pilot study with a randomized design to generate rigorous evidence of its impact on medication adherence and downstream health outcomes. Additionally, future iterations will focus on integrating an automated pharmacological interaction validation engine and implementing high-quality, dedicated Arabic text-to-speech capabilities to further improve the voice reminder experience.

In conclusion, MediGuide represents a meaningful first step toward a genuinely inclusive and effective digital medication management ecosystem for elderly Algerians. It demonstrates that thoughtful, user-centered design, informed by evidence and grounded in cultural reality, can produce tools that are simultaneously technically sound, accessible to vulnerable populations, and practically impactful. The work presented here provides both a functional prototype and a methodological foundation for the continued development of this solution toward clinical deployment.

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