

# SmartCare: A Mobile Application for Improving Medication Adherence, Elderly Location Tracking, and Disease Management

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## Abstract

Elderly individuals and patients with chronic conditions face persistent challenges in medication adherence, safety during wandering-prone episodes, and access to immediate first-aid guidance. This paper presents SmartCare, a cross-platform mobile application (Android/iOS) designed to integrate four core capabilities into a single, senior-friendly solution: intelligent medication reminders with barcode-based registration and adherence logging; real-time GPS location tracking to support caregiver oversight and enhance safety; basic health data entry for longitudinal monitoring; and an AI-powered chatbot delivering step-by-step first-aid instructions. SmartCare is implemented using Flutter for a unified, accessible front end and Firebase for secure, real-time backend services with role-based access control and encryption. The system architecture comprises presentation, business, and data layers, with offline-first support and a scalable path to cloud synchronization. The offline-first functionality enables users to receive intelligent medication reminders and record basic health data even without an internet connection. All data from these features are automatically synchronized as soon as connectivity is restored. A rigorous methodology encompassing requirements elicitation, iterative design, and comprehensive testing demonstrates that SmartCare meets key non-functional requirements availability, reliability, security, and sub-two-second response times and fulfills all primary user workflows for patients and caregivers. Comparative analysis highlights SmartCare's differentiated value as an integrated, caregiver-oriented platform relative to single-purpose mHealth tools. The re-

sults indicate that SmartCare improves medication adherence, strengthens caregiver responsiveness, and enhances user safety and preparedness.

## Keywords

Medication Adherence, Elderly Care, Chatbot, GPS Tracking, First Aid Guidance

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## 1. Introduction

According to the World Alzheimer Report 2024 [1], Alzheimer's disease and other forms of dementia remain a significant and escalating global health challenge. In 2019, an estimated 55 million people worldwide were living with dementia, with this number projected to become 139 million by 2050 as populations age. Each year, nearly 10 million new cases are diagnosed, and notably, over 60% of people with dementia reside in low- and middle-income countries, where access to timely diagnosis, care, and support is often severely limited. These statistics highlight the pressing need not only for increased awareness and investment in research, but also for innovative, accessible solutions that can bridge the existing gaps in care and support.

The situation is particularly acute in the Middle East and North Africa (MENA) region [2] [3], where chronic diseases—including cardiovascular disease, diabetes, cancer, and Alzheimer are now responsible for more than 70% of all deaths. With some of the world's highest rates of diabetes and a rapidly aging population, the healthcare infrastructure faces unprecedented strain. Traditional healthcare models are struggling to keep pace with the rising demand for early detection, continuous monitoring, and effective disease management. In this context, the development and adoption of mobile health systems are urgently needed. Such digital platforms can empower individuals and caregivers by providing real-time access to health information, facilitating early intervention, and supporting the ongoing management of chronic diseases—ultimately helping to alleviate the burden on overstretched healthcare systems and improving health outcomes across the region.

The confluence of an aging global population and the rising prevalence of diseases presents substantial and escalating challenges to healthcare systems worldwide [4]. Elderly individuals and those managing long-term conditions often require continuous health monitoring, medication management, and readily available support. Traditional healthcare needs models, with their reliance on periodic clinical visits, struggle to adequately meet [5]. This gap is particularly evident in ensuring medication adherence, safeguarding patients prone to wandering (such as those with Alzheimer's disease) [6] [7], and providing first aid in sudden accidents, which places a considerable burden on caregivers [8]. Consequently, there is a pressing need for innovative solutions that can offer personalized, continuous, and accessible care.

Mobile health (mHealth) technologies have emerged as a promising avenue to

address these challenges, offering the potential to transform healthcare delivery through mobile devices [8]-[10]. These technologies can empower patients with tools for self-management and enhance communication between patients and providers. Recognizing this potential, we have developed SmartCare, a comprehensive mobile application designed to assist elderly individuals and patients. SmartCare aims to improve user well-being and safety by integrating functionalities for realtime health status tracking, timely medication reminders, GPS-based location monitoring for safety, and an AI-powered chatbot for immediate first aid guidance.

The primary objectives of the SmartCare application are threefold: first, to empower users in effectively managing their health through accessible tools; second, to significantly reduce medication errors via intelligent notifications and alerts; and third, to enhance patient safety through reliable location tracking and rapid access to first aid information. Key features developed to meet these objectives include manual health status input by users or caregivers, personalized medication reminders, realtime GPS tracking visible to authorized caregivers, and an AI-driven chatbot offering symptom-based first aid advice.

SmartCare directly addresses critical problems such as non-adherent medication, the risk of patients getting lost or needing urgent help (especially those with Alzheimer's), the difficulty of managing health conditions without constant oversight, and the often-limited access to immediate medical advice. By offering this suite of integrated features, the application seeks to bridge these gaps, facilitating proactive health management. The interface has been designed with the specific needs of elderly users in mind, incorporating larger fonts, intuitive navigation, and considerations for voice command integration, all while ensuring secure, encrypted storage of sensitive health records.

This paper details the design, development, and key functionalities of the SmartCare application. It elaborates on the system architecture, the technologies employed, and how its features collectively contribute to providing a scalable, user-friendly, and effective mHealth solution for elderly and patients and their caregivers, ultimately aiming to enhance their quality of life and independence.

## **1.1. Related Work**

The proliferation of mobile health (mHealth) applications offers diverse solutions for health management, patient monitoring, and caregiver support. While many applications provide valuable functionalities, significant opportunities remain for comprehensive systems tailored to the specific needs of elderly individuals and patients with chronic conditions, particularly those requiring integrated safety features and immediate support. This section reviews several existing mHealth applications, highlighting their contributions and limitations in the context of the functionalities offered by our proposed SmartCare system.

### **1.1.1. National and Regional Health Portals: The Case of Sehhaty**

Government-backed health applications [11], such as Sehhaty in Saudi Arabia, aim

to provide citizens with a centralized platform for accessing various health services. Sehaty, for instance, facilitates booking medical appointments, accessing medical reports, realtime consultations, and reviewing personal health records. [12] Such platforms are invaluable for streamlining access to formal healthcare services and are often available in the local language, enhancing accessibility for the native population. Limitations for Specific Needs: While comprehensive in general health service provision, applications like Sehaty are typically not specifically designed for the nuanced needs of elderly users or those with chronic conditions requiring continuous, proactive monitoring. Features such as dedicated medication reminders with adherence tracking, GPS-based location monitoring for individuals prone to wandering (e.g., those with Alzheimer's), or AI-driven first aid guidance are often outside their primary scope.

### 1.1.2. Applications for Elderly Care and Monitoring

A category of mHealth apps focuses specifically on elderly care, exemplified by applications designed to enable remote tracking of health status and location via GPS by companions or caregivers [13]. Many such applications also incorporate features for managing medication schedules and issuing alerts. These tools play a crucial role in enhancing the safety and well-being of seniors living independently or with remote caregiver support [13]. Limitations for Specific Needs: While addressing critical aspects like location tracking and medication reminders, these specialized elderly care apps may not always cater to the broader spectrum of disease management. Furthermore, they might lack first aid guidance for emergencies or may not be available in multiple languages, such as Arabic, limiting their reach. **Table 1** summarizes the status and key limitations of modern technologies used in elderly care, as discussed in the reviewed article [14] [15]. It highlights advances in artificial intelligence, digital therapeutics, and virtual care platforms, along with the major challenges that must be addressed for widespread, effective adoption among elderly populations.

**Table 1.** Current status and limitations of modern elderly care technologies.

Area	Current Status	Limitations/Challenges
AI & Remote Monitoring	Real-time symptom and risk monitoring; enables proactive care	Digital literacy barriers; usability challenges for elderly users
Digital Therapeutics	Personalized reminders; support for behavioral change and self-management	Sustaining long-term engagement; accommodating cognitive decline
Data Integration	Incorporates clinical, lifestyle, and socioeconomic data for individualized care	Privacy and security risks; potential for bias; informed consent requirements
Virtual Care Platforms	Two-way communication between patients, caregivers, and providers; remote consultations	Integration into existing clinical workflows; acceptance by clinicians
Model Performance	High accuracy in predicting and managing chronic diseases (e.g., CNN models)	Limited focus on multimorbidity; need for real-world, external validation
Ethics & Regulation	Regulatory compliance planning; oversight boards proposed	Regulatory hurdles; ongoing need for transparency and robust consent

## 1.2. General Health and Wellness Tracking Platforms

Widely available health applications, such as Apple Health or Google Fit and similar integrated platforms, empower users to track a wide array of health information, share data, manage medications, and receive alerts. These platforms often serve as aggregators for health data from various sources and can provide longitudinal insights into a user's health trends [16] [17]. Limitations for Specific Needs: These general wellness platforms, while robust in data collection and sharing, are often not primarily designed for the intensive monitoring needs of high-risk elderly individuals or those with severe conditions. They may lack dedicated caregiver portals, proactive GPS-based safety alerts for wandering, or integrated AI-driven emergency first aid support.

### 1.2.1. Disease-Specific Management Applications: Example of Cancer.Net

Specialized applications like Cancer.Net Mobile, developed by the American Society of Clinical Oncology (ASCO), provide targeted support for patients with specific conditions, such as cancer [18]. These apps offer curated information, tools for tracking symptoms, managing appointments, logging medications and their side effects, and even recording physician responses. Limitations for Specific Needs: The strength of these applications lies in their specificity. However, this focus means they are not designed for the general elderly population or individuals managing other types of chronic diseases. Features like GPS tracking for patient safety or general AI first aid (beyond the scope of the specific disease) are typically absent. Language availability can also be a barrier for non-English-speaking users

### 1.2.2. Medication Management and Adherence Applications: Example of Medisafe

Medication adherence is a critical challenge in managing chronic conditions, addressed by numerous applications such as Medisafe Pill Reminder. These apps allow patients or caregivers to schedule medications, receive reminders [10] [19], track adherence, get information on drug interactions, and sometimes integrate with broader health platforms like Apple HealthKit to share reports with clinicians [20]. Limitations for Specific Needs: While highly effective for medication management, standalone reminder apps often do not provide comprehensive health status monitoring beyond medication intake, lack GPS tracking for patient safety, and typically do not include first aid guidance. Some user reports also indicate occasional inaccuracies in alert timings or side effect information for certain applications

## 1.3. Proposed Contribution

The reviewed applications demonstrate significant advancements in mHealth, addressing aspects like general health service access, elderly monitoring, wellness tracking, disease-specific support, and medication adherence. However, a notable gap exists for an integrated solution that specifically caters to elderly individuals

and chronic disease patients by combining:

- Comprehensive health status tracking.
- Reliable medication reminders.
- GPS-based location tracking for safety.
- AI-powered first aid assistance.
- A user-friendly interface designed for seniors.

Our proposed SmartCare application aims to bridge this gap by offering a holistic platform that integrates these critical functionalities. By doing so, SmartCare seeks to enhance user independence, improve medication adherence, ensure patient safety, and support caregivers more effectively than currently available disparate solutions.

This paper is organized as follows: Section 2 provides a detailed description of methodology, and approach used in this study. Section 3 presents the results obtained and offers a comprehensive discussion of these findings.

## 2. Methodology

The development of the SmartCare application was guided by a systematic and well defined lifecycle methodology. This process was divided into distinct stages to ensure the creation of a robust, user-centric, and efficient solution. The lifecycle began with comprehensive requirement analysis, followed by meticulous system design. The development phase involved building the application according to specified requirements, after which rigorous testing was conducted to verify functionality and reliability. Upon successful validation, the application proceeded to the deployment stage. Continuous maintenance and planned future enhancements ensure the app remains updated and responsive to evolving user needs. Each phase was carefully executed to guarantee the effectiveness and sustainability of the SmartCare solution. The key stages of the project lifecycle are outlined below.

### 2.1. Requirement Analysis

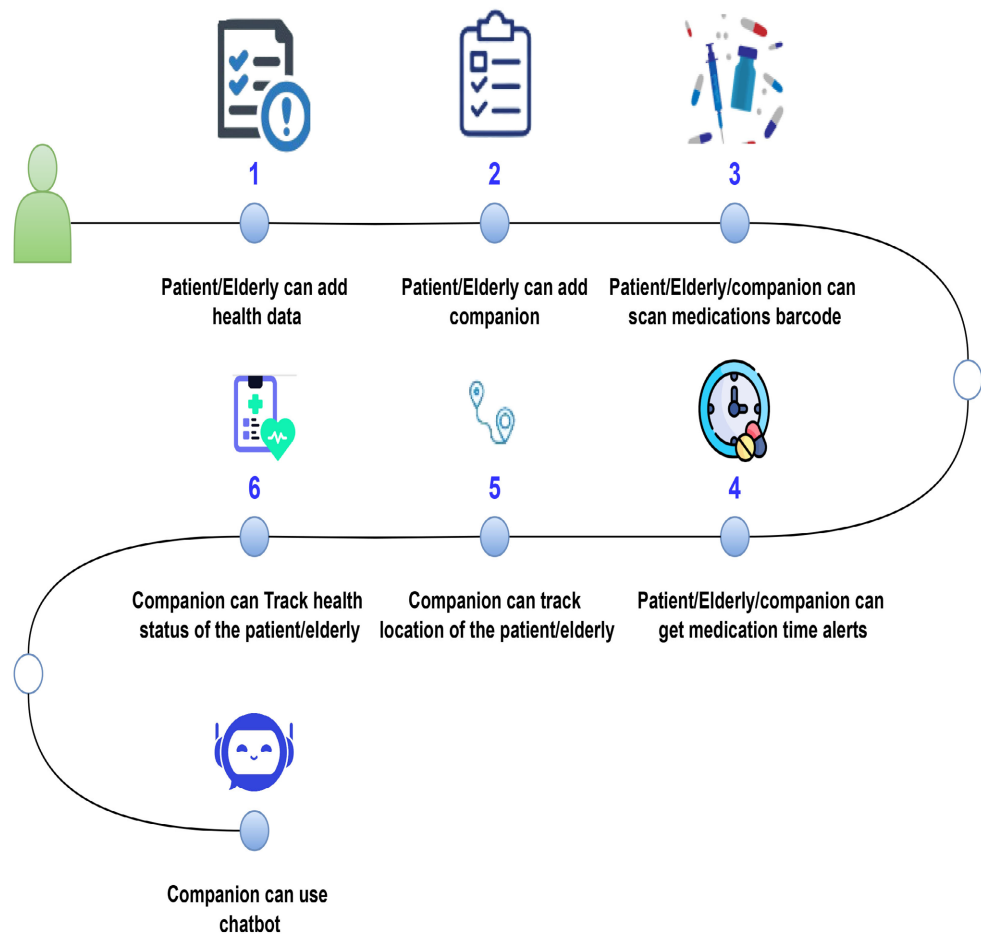
During the requirement analysis phase, data were gathered through a combination of surveys and interviews involving the primary user groups and key stakeholders. The surveys were designed to uncover the specific challenges that patients and elderly individuals encounter in managing their health. These surveys were collected from 331 patients and elderly people. Additionally, interviews with eight healthcare providers were conducted to obtain deeper insights into their professional needs and priorities regarding patient care and digital health tools. This comprehensive data collection enabled the identification and definition of the essential features and functionalities required in the application to effectively address user needs. These features emphasized two core needs: 1) the challenge of consistent medication adherence among elderly and chronic patients, which directly justified the implementation of intelligent medication reminders; and 2) the need for enhanced safety and caregiver oversight for wandering-prone individu-

als, leading to the integration of real-time GPS tracking. These insights formed the empirical basis for SmartCare's core feature set.

## 2.2. System Design

### 2.2.1. Conceptual Design

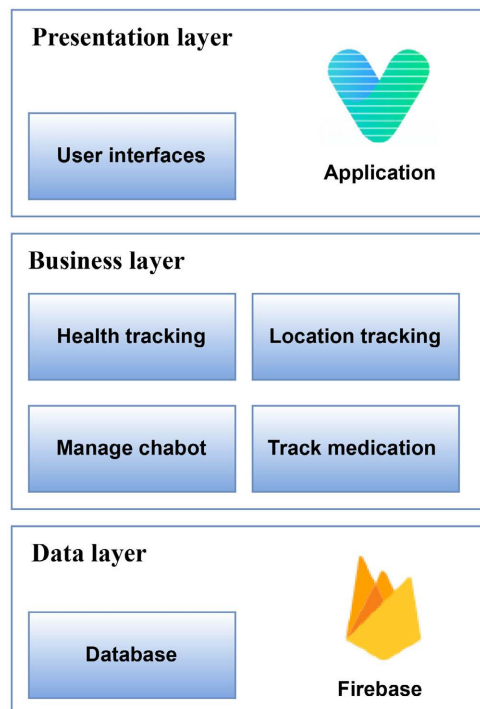
The conceptual design (CD) defines the foundational framework of the system by outlining its primary features and functionalities available to users. **Figure 1** presents the conceptual design of the SmartCare application. Within this framework, patients or elderly users can input their health data and subsequently add and verify information for their designated companions. The application enables both the patient and the companion to register medications seamlessly by scanning the drug's QR code, after which they can set medication schedules and dosages based on the physician's prescription. When it is time to take medication, timely alerts are sent to the patient's or the elderly user's account. Additionally, companions are able to monitor the patient's health status and track their location, a feature particularly beneficial for individuals with Alzheimer's disease. The system also integrates an AI-powered chatbot that provides users, whether patients, elderly individuals, or companions, with immediate first aid guidance as needed.



**Figure 1.** Overview of the proposed application's conceptual design.

### 2.2.2. System Architecture

The system architecture comprises a set of interconnected layers that collaboratively provide the core services of the application. As illustrated in **Figure 2**, the architecture is organized into three fundamental layers: the presentation layer, the business layer, and the data layer.



**Figure 2.** Architecture diagram of the SmartCare application.

- **Presentation Layer:** This layer is responsible for the application's user interfaces. It manages all interactions with the user, including the display of health data, location information, companion details, medication schedules and alerts, as well as chatbot interactions. The design prioritizes ease of use to ensure accessibility for elderly users and caregivers.
- **Business Layer:** The business layer handles the core logic and service processing of the application. It manages functionalities such as realtime location tracking, monitoring health status, managing medication schedules, and responding to user inquiries through the chatbot. This layer acts as the intermediary between the user interface and the data storage, ensuring that all business rules and processes are effectively executed.
- **Data Layer:** The data layer is responsible for the storage and retrieval of all patient and companion information. Initially, it utilizes local storage to support offline access to essential data. However, the architecture is designed to be scalable, allowing for future expansion to cloud storage solutions. This will enable seamless data synchronization across multiple devices, enhancing accessibility and reliability.

Together, these layers form an integrated and robust framework that delivers a

comprehensive health management experience for users, facilitating secure and efficient interaction, processing, and storage of vital health information. This storage process allows the offline-first functionality to ensure that users can continue to benefit from intelligent medication reminders and log essential health data such as vital signs, symptoms, or medication intake even when an internet connection is unavailable. These features are designed to operate seamlessly in offline mode, allowing users to manage their health routines without interruption. Once the device reconnects to the internet, all locally stored data are automatically synchronized with the central server, ensuring that health records remain up-to-date and accessible across devices. This approach not only enhances user convenience but also supports consistent and reliable health monitoring, regardless of connectivity limitations.

The entity-relationship (ER) diagram provides a visual representation of the database structure. It includes three primary components: entities, the attributes associated with each entity, and the relationships between them.

**Figure 3** presents the ER diagram for our system, illustrating how data is organized and how different components of the application interact within the database.

### 2.3. SmartCare Development

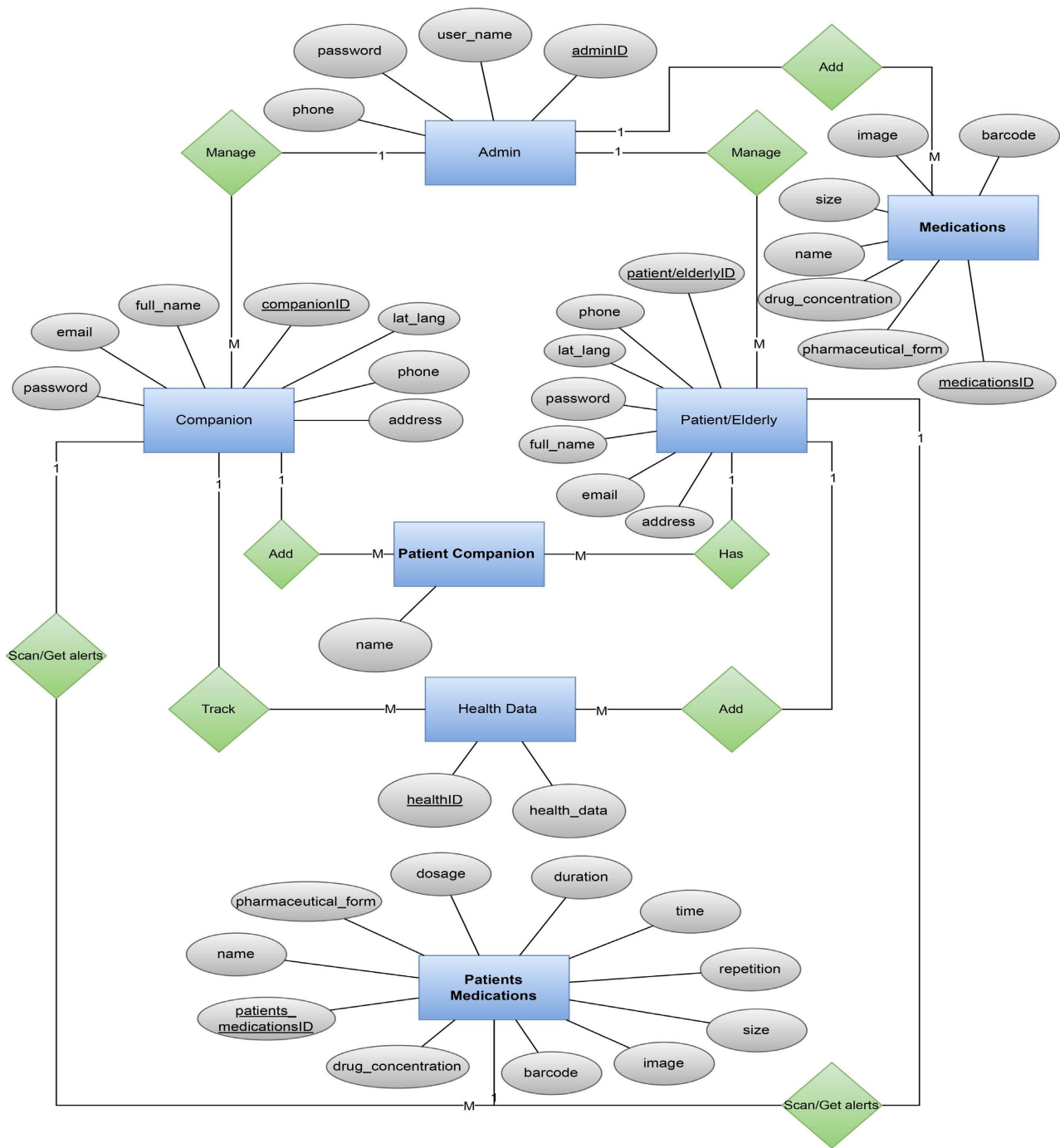
The SmartCare application was engineered through an iterative, test-driven workflow spanning requirements elicitation, prototyping, and production hardening. The stack was selected to ensure cross-platform reach, secure data handling, and real-time capabilities for alerts and location tracking.

#### 2.3.1. Mobile Application

Framework: Flutter (Dart) for a single, maintainable codebase targeting Android and iOS, with adaptive UI and accessible components suitable for elderly users [21]. State management: Provider/Riverpod for predictable, testable state flows across authentication, medication scheduling, chatbot interaction, and GPS tracking [22]. Maps and location: Google Maps Platform SDKs with Geolocator for foreground location and permission handling; background updates configured per OS policies [23] [24]. Notifications: Firebase Cloud Messaging (FCM) for push notifications and local notifications for on-device medication reminders with precise scheduling [25] [26].

#### 2.3.2. Backend and APIs

Backend-as-a-Service: Firebase for Authentication (email/password and token-based sessions), Firestore for real-time data synchronization (medication plans, health metrics, roles), and Cloud Functions for server-side scheduling and rule enforcement [27]. Storage: Firebase Storage for encrypted-at-rest asset handling (e.g., prescription photos, optional) [28]. Security: Firebase Security Rules for role-based access control and field-level validation; HTTPS Callable Functions for controlled privileged operations [29].



**Figure 3.** Entity relationship diagram illustrating key functionalities of the proposed application.

### 2.3.3. Chatbot and First-Aid Guidance

NLP integration: Dialogflow CX for intent recognition, slot filling, and multi-turn flows delivering step-by-step first-aid instructions with latency-optimized webhooks [30]. Fallback and safety: Deterministic response templates vetted by domain references to ensure clarity and actionability. This chatbot is intended for informational guidance only and should not be considered a substitute for professional medical consultation, diagnosis, or treatment.

### 2.3.4. Barcode and Medication Management

Scanning: ML Kit Barcode Scanning for fast, on-device decoding with support for EAN/UPC formats used in medication packaging [31]. Data model: Firestore collections for medications, schedules, and adherence logs; Cloud Functions to compute upcoming reminders and consistency checks.

## 2.4. SmartCare Testing, Quality Assurance, and Deployment

SmartCare's testing, quality assurance, and deployment processes were designed to ensure a robust and reliable experience across both Android and iOS platforms. Comprehensive automated testing was implemented using Flutter unit, widget, and integration tests [32], supported by Mockito for mocking dependencies. These tests validated core workflows, including authentication, health data management, medication reminders, GPS tracking, and chatbot interactions. To uncover device-specific issues, cross-device testing was conducted on Firebase Test Lab, while real-world telemetry and stability were monitored via Firebase Analytics and Crashlytics.

Continuous Integration and Continuous Deployment pipelines were established using GitHub Actions, which enforced code linting and automated testing at each stage of development. Fastlane was used to automate the process of building and distributing signed app versions for internal testing and release. Throughout development, design fidelity and accessibility standards were maintained using Figma and Material Design guidelines [33], with Jira providing traceability from requirements to test cases [34].

Security and privacy were prioritized through the use of TLS encryption for data in transit, Firebase encryption at rest, and role-based access controls enforced by Firebase Security Rules [35]. Additionally, the system supports consent-driven data export and deletion, ensuring user control over personal information.

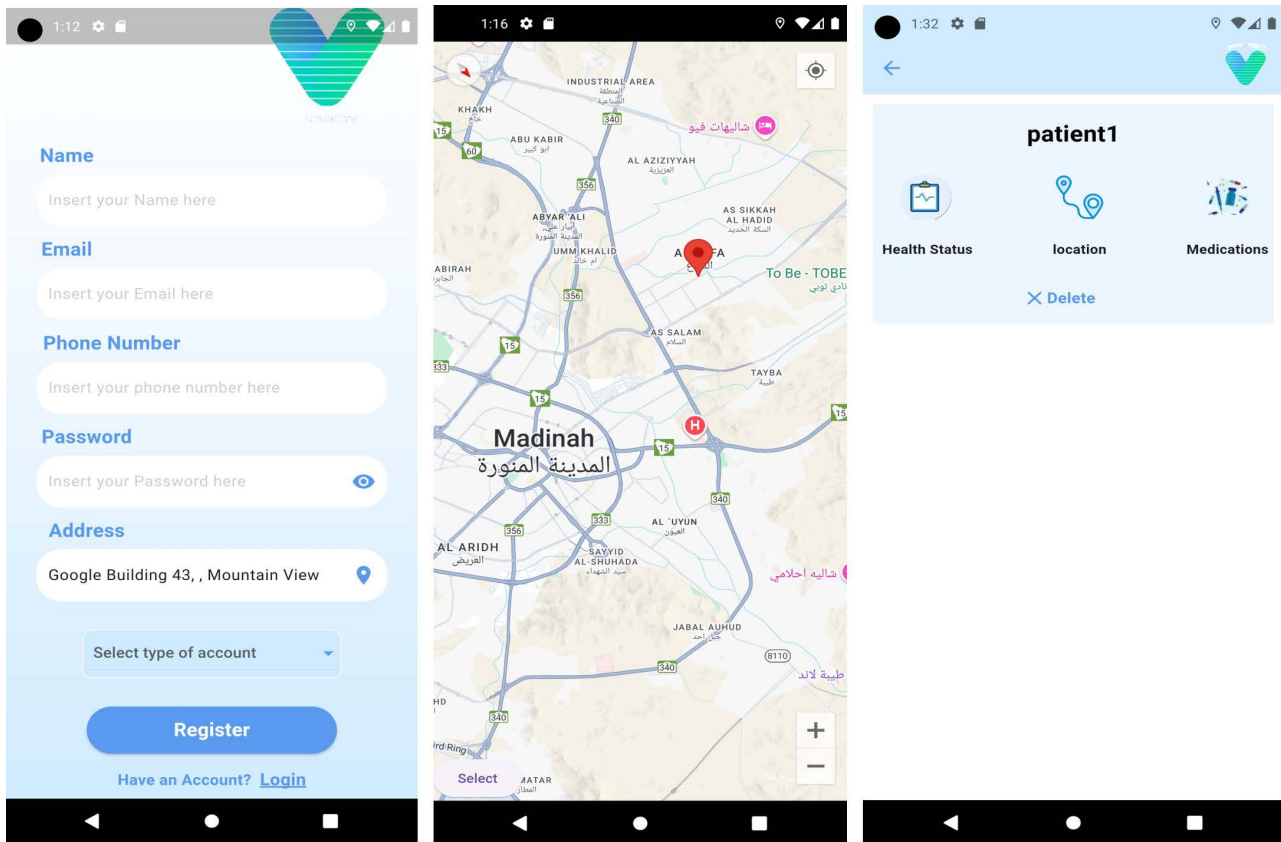
The deployment process was validated with extensive end-to-end, scenario-based, and black-box evaluations to confirm platform availability, GPS functionality, authentication integrity, and overall performance. These measures ensured that all critical user actions consistently met the sub-two-second latency target, providing a high-quality, secure, and responsive user experience.

## 3. Experimental Results and Discussions

This section presents the experimental results and performance evaluations of SmartCare across core user journeys and system capabilities. We validated the completeness of registration and role setup, the clarity of home dashboards for both companions and patients, the accuracy and usability of medication registration, the responsiveness of the first-aid chatbot, and the correctness of end-to-end workflows under test conditions.

**Figure 4** illustrates the account creation flow, where users provide personal details and a precise street address to initialize geolocation services. Successful registration establishes role linkage (patient/elderly or companion) and enables sub-

sequent GPS-based safety features. During testing, the form was completed consistently without validation errors, and address inputs propagated to the location services as expected.

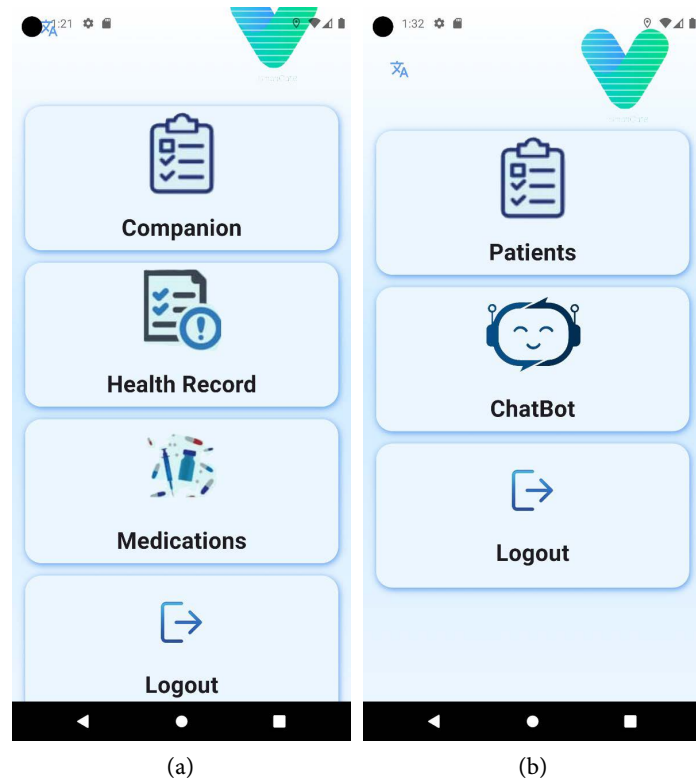


**Figure 4.** Registration of the user account including his street address for GPS tracking.

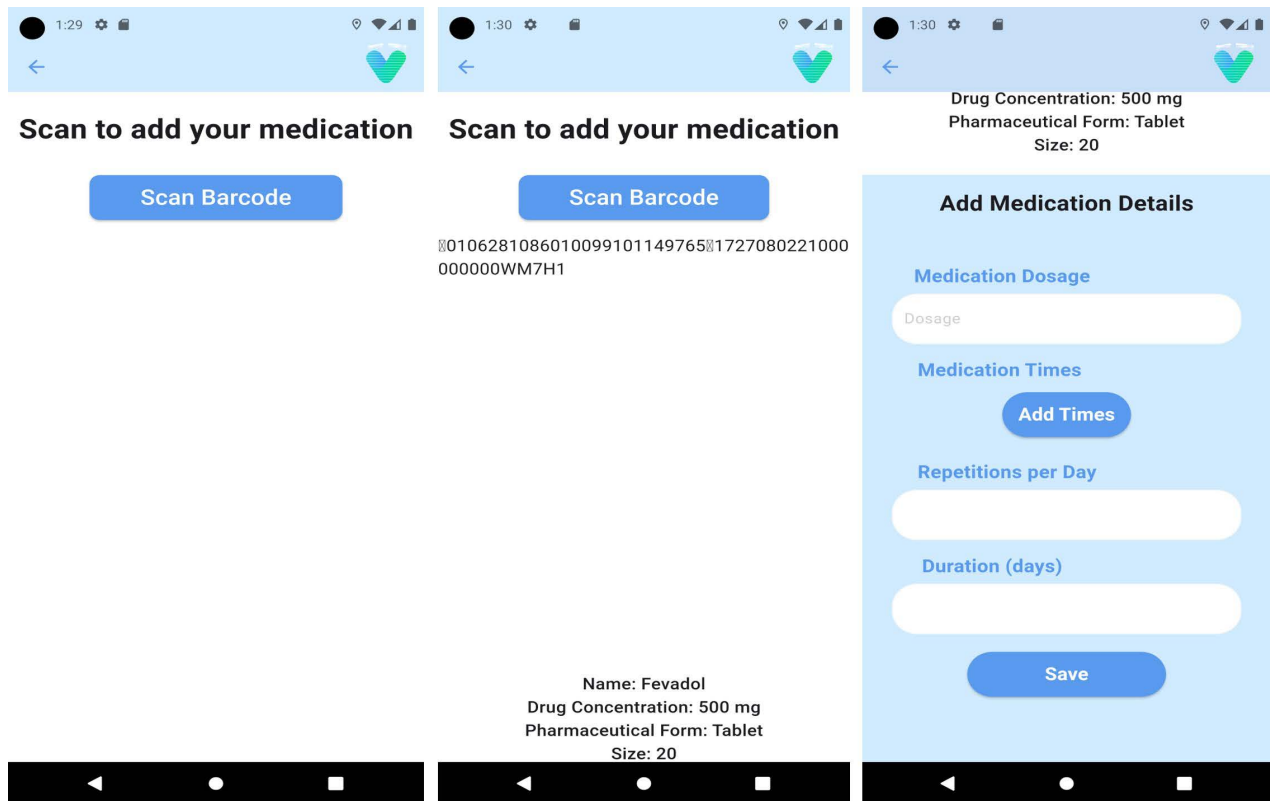
**Figure 5** shows the post-login dashboards for the two principal roles. The companion home screen (a) consolidates patient overview cards, medication schedules, alerts, and quick access to location tracking. The patient home screen (b) prioritizes upcoming medication reminders, personal health entries, and access to the chatbot. Usability walkthroughs confirmed that essential actions were reachable within two taps, with clear typography and large touch targets suitable for elderly users.

**Figure 6** demonstrates the medication onboarding interface. Users can add a medication by scanning its barcode or entering details manually, then specify dosage, frequency, and timing aligned with physician prescriptions. Test runs verified correct parsing of barcode data, accurate scheduling, and immediate persistence to the backend, with reminder notifications generated at the configured times.

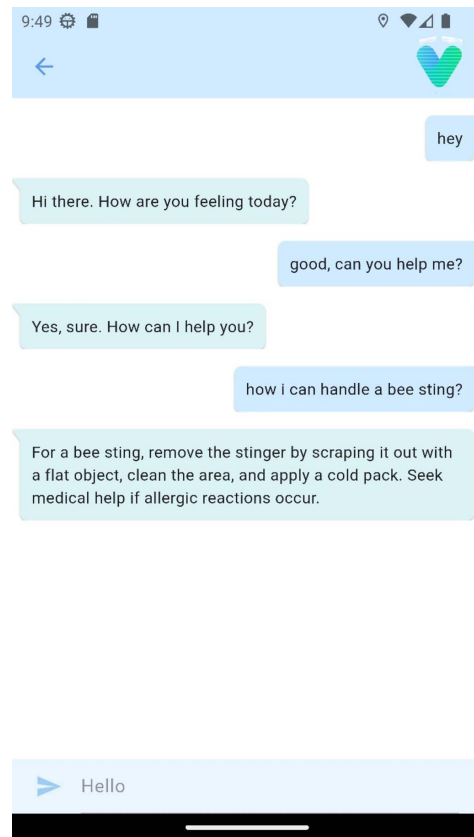
**Figure 7** presents the integrated first-aid guidance chatbot. Users can enter symptom descriptions or select from common scenarios to receive step-by-step instructions. Evaluation focused on response latency and clarity; typical responses were returned within the two-second target and provided concise, actionable guidance suitable for non-expert users.



**Figure 5.** SmartCare application home user interfaces. (a) Companion’s home screen post-login. (b) Patient’s home screen post-login.



**Figure 6.** Registration of a drug details.

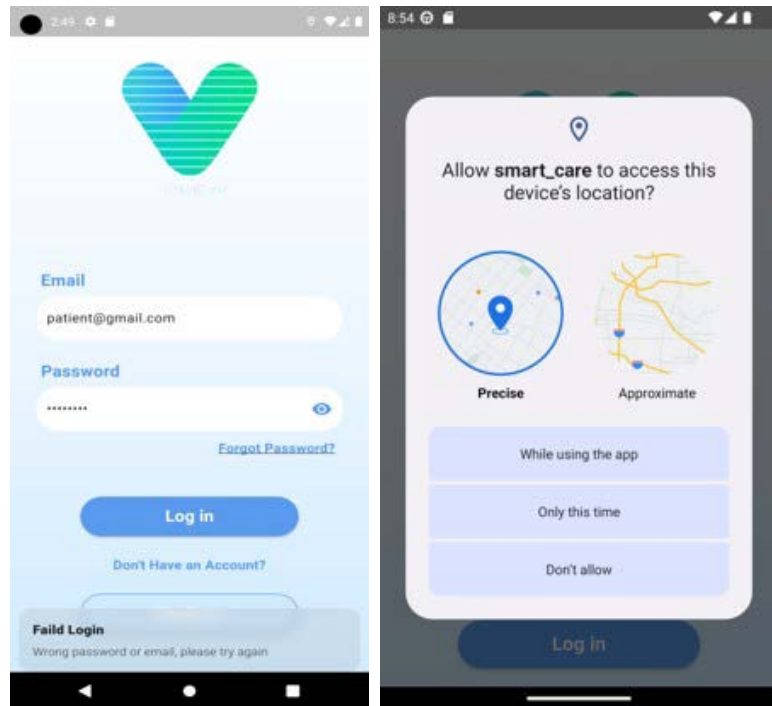


**Figure 7.** Screenshot illustrating the chatbot user interface in the SmartCare application.

**Figure 8** summarizes the principal workflow screens exercised during validation: (a) the registration view verifying successful account creation, (b) the GPS activation panel confirming granted permissions and active live tracking, (c) the health data module enabling addition and deletion of personal metrics, and (d) the medication management screen allowing updates to existing regimens. End-to-end testing verified consistent data integrity across these stages, accurate propagation of GPS updates to companion dashboards, and dependable delivery of medication-time alerts.

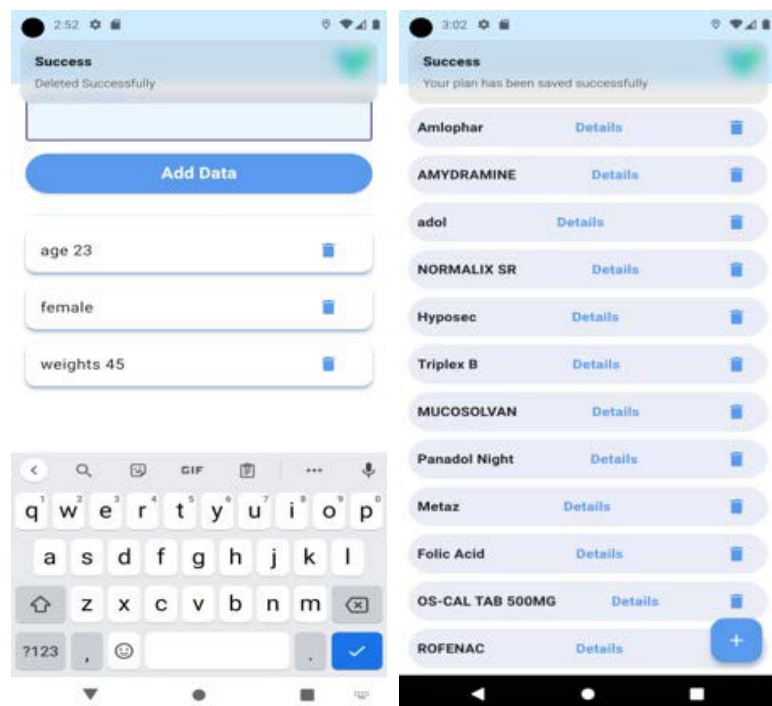
Overall, the figures provide concrete evidence that SmartCare fulfills its design goals across all user roles and system capabilities. For companions and patients, the role-specific home screens surface the most relevant actions within one to two taps, supporting elderly-friendly interaction. Medication workflows spanning barcode capture, manual entry, scheduling, and regimen edits operate reliably, trigger notifications at the configured times, and persist changes consistently to the backend. Location services initialize from the registered street address, obtain permissions correctly, and maintain stable, high accuracy GPS updates that are reflected in companion views with minimal latency. The integrated first-aid chatbot responds within the target sub-two-second window and supplies clear, actionable guidance for common scenarios. Taken together, these results show that SmartCare meets the functional requirements (registration, caregiving oversight, health data management, medication adherence, GPS safety, and first-aid guidance) and

satisfies key non-functional criteria, including availability, reliability, security, and performance.



(a)

(b)



(c)

(d)

**Figure 8.** Demonstrating key SmartCare application functionalities: Examples from testing. (a) Account registration interface. (b) GPS feature activation. (c) Interface for adding and deleting personal health data. (d) Interface for managing medicine details.

### 3.1. Performance Evaluation Results

This subsection reports the empirical evaluation of SmartCare against its specified requirements, focusing on both non-functional quality attributes and end-user functional capabilities. We conducted scenario based testing and black box validation on the deployed devices. For non-functional criteria, we verified service availability under typical network conditions, measured response latency for core interactions (login, medication alert scheduling, GPS update retrieval, and chatbot prompt handling), validated GPS tracking stability and accuracy during controlled movement scenarios, and executed basic security checks for authentication, role-based access, and protected data flows. For functional coverage, we assessed each primary user interface for patients/elderly users, companions, and administrators, including account management, health data entry, medication registration via barcode scanning, alert delivery, real-time location and health-status visibility for companions, and access to first-aid guidance through the integrated chatbot. The results, summarized in **Table 2** and **Table 3**, indicate that all tested non-functional targets were met (availability, reliability, security, and performance) and that all core user facing functions achieved the expected behavior across roles.

**Table 2.** SmartCare evaluating: non-functional requirement.

Method	Precision
Availability: The system is available to users at any time and in any place.	Pass
Reliability: The system is able to track the geographical location of the patient or elderly with high accuracy and without errors.	Pass
Security: The system protects sensitive data of patients, elderly and their companions from unauthorized access.	Pass
Performance: The system is able to respond to services without delay within a time not exceeding two seconds.	Pass

**Table 3.** SmartCare evaluating: Achieved functional requirement for users.

Method	Precision
Patient/Elderly can add companion.	Pass
Patient/Elderly can add health data.	Pass
Patient/Elderly/Companion can scan medications barcode	Pass
PPatient/Elderly/Companion can get medication time alerts	Pass
Companion can track the health status of the patient/elderly.	Pass
Companion can track the location of the patient/elderly.	Pass
Companion can get first aid guidance using chatbot.	Pass
Admin can manage accounts.	Pass
Admin can add medications.	Pass

### 3.2. Comparison of SmartCare with Other Applications

Here are the key ways SmartCare differs from existing mHealth apps:

- Integrated feature set vs. single-purpose tools:

Combines four pillars in one app: medication adherence (reminders + alerts), GPS-based safety tracking, basic health data logging, and an AI first-aid chatbot. Many existing apps focus on just one area (e.g., Medisafe for meds; elderly trackers for GPS; general wellness apps for data aggregation; disease-specific apps for one condition).

- Caregiver-centered design: Explicit companion/caregiver role with permissions to view health status and real-time location, receive alerts, and help manage meds. General platforms (Apple Health/Google Fit) and portals often lack dedicated caregiver views or proactive safety workflows.

- Safety for wandering-prone users:

Real-time GPS monitoring aimed at Alzheimer's and similar use cases. National portals (e.g., Sehhaty) and disease-specific apps typically do not include GPS wandering safeguards.

- First-aid guidance via chatbot: Built-in AI chatbot provides immediate first-aid tips. Medication apps and elderly trackers rarely integrate context-aware first-aid support; disease-specific apps limit guidance to their condition.

- Senior-friendly UI and accessibility: Large fonts, simplified navigation, and voice alert emphasis designed for elderly usability. Many general wellness or clinical portals are not optimized for low-tech senior users.

- Cross-platform with offline-first data layer:

Flutter front end for Android/iOS; Firebase backend; local storage to support essential offline access with a path to cloud sync. Some incumbents depend heavily on always-on connectivity or platform-specific stacks.

- Practical, low-cost deployment aim: Emphasis on scalability and cost-effectiveness for broad access, rather than premium device ecosystems or paid feature tiers.

- Limitations relative to incumbents: No current integration with wearables for vitals. No clinician-facing portal or direct provider messaging yet. Chatbot to be enhanced for more accurate, personalized guidance. Automated emergency escalation to contacts/services not yet integrated.

SmartCare's differentiator is unifying medication adherence, caregiver-oriented GPS safety, and immediate first aid guidance within a senior optimized app capabilities that are typically split across multiple existing mHealth solutions.

## 4. Conclusions and Future Work

### 4.1. Conclusions

This paper successfully presented SmartCare, a mobile health application meticulously developed to empower elderly individuals with more effective tools for their health. By integrating core functionalities including realtime GPS tracking for enhanced safety, timely medication reminders to improve adherence, personal health

record management, and an intuitive chatbot for immediate first aid guidance SmartCare directly addresses the critical daily needs of both patients and their caregivers. The application's robust design, implemented using Flutter for cross-platform accessibility and Firebase for reliable realtime data management, was validated through systematic analysis, user-centered design principles, and rigorous testing. These processes confirmed SmartCare's effectiveness in enhancing patient care, reducing medication errors, and improving the overall responsiveness and preparedness of caregivers.

SmartCare's commitment to a user-centered approach is evident in its intuitive interface, ensuring practicality even for users with limited technical proficiency. System testing verified the fulfillment of all specified functional and non-functional requirements, underscoring its strong performance, reliability, and data security. In essence, SmartCare emerges as a scalable, cost-effective, and impactful solution within the burgeoning field of mobile healthcare technology, offering tangible benefits to vulnerable populations.

## 4.2. Future Work

Building upon its current capabilities, the future trajectory for SmartCare involves several key enhancements aimed at broadening its impact and utility:

- **Integration with Wearable Devices:** The incorporation of data from smartwatches and fitness trackers will enable the seamless collection of realtime physiological metrics, such as heart rate, blood pressure, and physical activity levels, providing a more holistic view of the patient's health.
- **Enhanced Healthcare Provider Collaboration:** Future iterations will focus on establishing secure and direct communication channels, facilitating efficient data sharing between patients and their doctors for timely remote consultations and expert medical advice.
- **Development of a Comprehensive Web Portal:** To complement the mobile application, a web-based portal will be created, offering caregivers and medical professionals a dedicated interface for remote patient data monitoring, advanced report generation, and streamlined user account management.
- **Advanced AI-Powered Chatbot:** The chatbot capabilities will be significantly augmented through the integration of advanced machine learning and natural language processing techniques, enabling it to provide more accurate, context-aware, and personalized medical guidance.
- **Integrated Emergency Response System:** A critical future development will be the integration of an automated emergency response feature, designed to alert nearby hospitals or predefined emergency contacts immediately upon the detection of critical health events by the application.

By pursuing these advancements, SmartCare is poised to evolve into a more comprehensive and indispensable digital health ecosystem. This evolution will further solidify its role in supporting proactive, preventative, and personalized care for vulnerable populations, ultimately contributing to improved health out-

comes and quality of life.

## Disclosure Statement

The authors declare no conflicts of interest.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

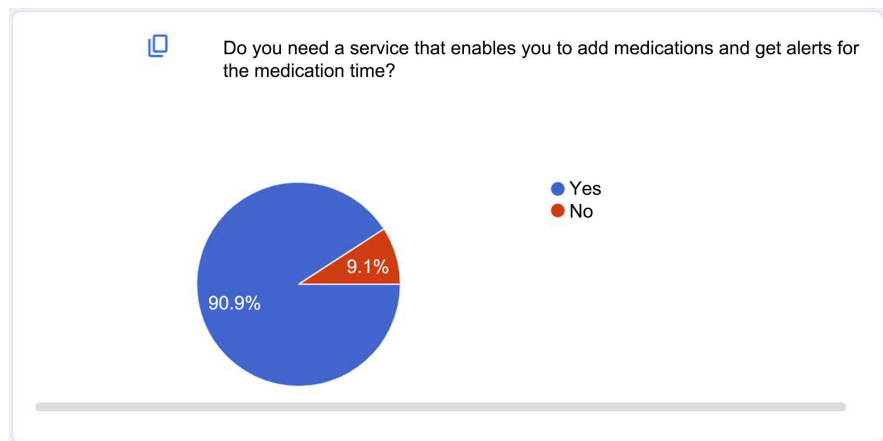
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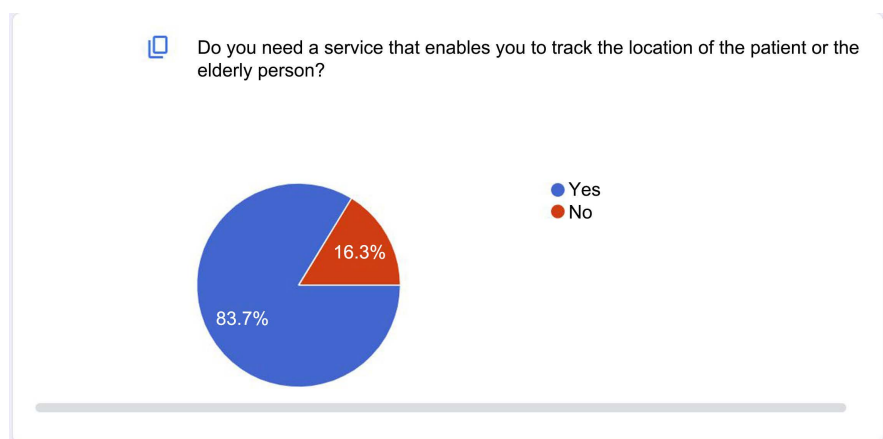
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## Appendix. Participant Responses to Questionnaire on Application Functionalities

This appendix presents supplementary visuals and brief analyses that reinforce the main findings by illustrating SmartCare's core workflows, safety mechanisms, and usability results. **Figure A1** highlights the need for medication reminders, underscoring how timely, intelligent alerts support adherence and reduce missed doses. **Figure A2** demonstrates real-time GPS tracking under typical movement, showing stable update accuracy, proper permission handling, and rapid, low-latency updates on caregiver dashboards. **Figure A3** showcases the AI-driven first-aid guidance interface, providing clear, actionable, step-by-step instructions with sub-two-second responses for common scenarios. Collectively, these figures substantiate the evaluation in Section 3 by offering concrete visual evidence of elderly usability, the robustness of GPS-based safety features, improved medication adherence, and the responsiveness of the integrated first-aid chatbot, aligning with observed availability, reliability, security, and performance targets.



**Figure A1.** The need for medication reminders.



**Figure A2.** Necessity of patients GPS-tracking.

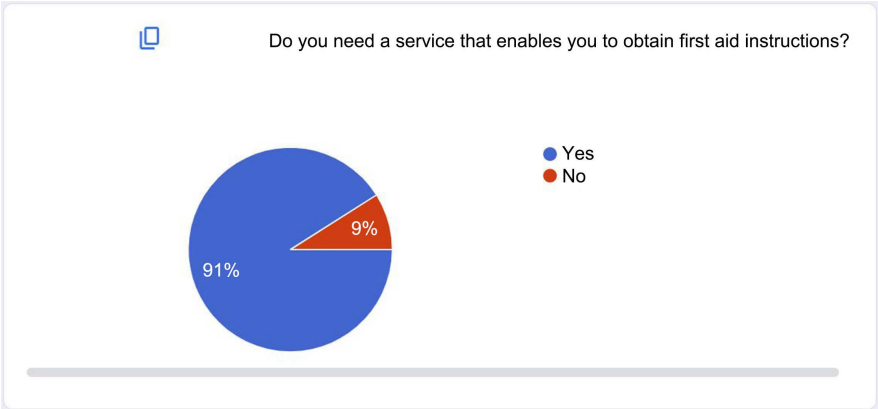


Figure A3. The necessity of AI-driven first-aid guidance.