Bilkent University
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CS491: Senior Design Project I

Analysis and Requirement Report

Team ID: T2518
ReMind

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1. Introduction

Dementia and/or Alzheimer's disease create emotional challenges and practical difficulties that affect both patients, their family members, and their caregivers [1]. The diseases affect patients' spatial awareness, navigation abilities, and executive control, while simultaneously causing memory loss that occurs in specific moments. The symptoms necessitate ongoing supervision for patients, as they need protection from wandering, forgetfulness, and disorientation [2]. The need for patient safety supervision creates a conflict because it protects the patient but violates their independence and privacy. The constant need for supervision leads to anxiety and burnout among the caregivers [3].

ReMind is a mobile health assistant that will address these exact problems. It will offer various helpful features to achieve its goal of helping caregivers and protecting patients. For example, its location tracking feature will help the caregiver feel at ease whenever they are not with the patient. Its MoodAI will monitor the patient's data, alerting the caregiver of possible dangerous situations, such as confusion or distress. To help MoodAI make more accurate predictions, ReMind will be integrated with a smartwatch, which will enable it to collect more functional data from the user. Moreover, all features will be implemented in a privacy-conserving way, via on-device MoodAI, encrypted data storage, clear indications of what data is used for what purpose, and so on. This way, the application aims to provide a helpful tool for patients to maintain their daily routines safely, without feeling overwhelmed or pressured, while keeping caregivers informed and reassured.

2. Current System

There are currently existing systems that solve similar problems; however, they do so in a fragmented manner. What makes ReMind different from those systems will be how it unites these fragmented tools, combines them with mood analysis via Mood AI, while focusing on the privacy and dignity of patients. Below is an analysis of the traditional caregiving methods and existing technological solutions, along with their limitations.

2.1 Traditional Caregiving Methods

Currently, dementia care is performed manually through human supervision.

- **Constant Supervision:** Caregivers (often family members) must provide 24/7 observation to prevent wandering, which can lead to caregiver burnout, high stress, and anxiety.
- **Physical Barriers:** Safety is often enforced through physical means, such as locking doors or hiding keys, to prevent patients from wandering, which can infringe on their dignity and sense of independence.
- **Manual Reminders:** Caregivers rely on sticky notes, whiteboards, or phone calls to remind patients of medication and daily tasks. These are passive and easily ignored or forgotten by a patient with memory impairment.

2.2 Existing Technological Solutions

Table 2.1 is an analysis of the existing technological solutions and their deficiencies.

Application / Solution	**Primary Functionality**	**Key Deficiencies (Addressed by ReMind)**
AngelSense	**Safety & Tracking:** dedicated GPS hardware with real-time continuous tracking, 2-way voice, and "listener" mode.	**Privacy Violation:** Continuous "surveillance" style tracking violates patient privacy. **No Health Data:** Does not analyze physiological data (HR/HRV) or mood. **Stigma:** Requires wearing a separate, bulky tracker device.
Jiobit	**Location:** Small, discreet GPS tracker focusing on long battery life and geofencing.	**Passive:** Purely a location beacon; lacks SOS buttons or interaction for the patient. **No Cognitive Features:** Does not monitor mental state or provide reminders. **Limited Alerting:** Updates are less frequent to save battery, potentially delaying "exit" alerts.

Medisafe	**Medication:** Advanced reminder system for pills with drug interaction warnings and refill reminders.	**Fragmented:** Solves only one problem (medication). **No Safety Net:** No location tracking or SOS features. **Passive:** Relies on the patient to actively confirm intake; easy for dementia patients to ignore or falsify.
MindMate	**Cognitive:** "Digital companion" offering brain games, nutrition advice, and basic reminders.	**No Monitoring:** Lacks physiological monitoring (HR/HRV) or active safety features (GPS). **Generic:** "One-size-fits-all" content rather than personalized AI-driven mood analysis. **No Caregiver Link:** Primarily patient-facing; keeps caregivers out of the loop regarding immediate safety.
Lumosity	**Brain Training:** General purpose cognitive training games (memory, attention, speed).	**Disputed Efficacy:** Research suggests skills often don't transfer to daily life. **No Care Context:** Purely a game; offers no safety, reminders, or caregiver connection. **Not Dementia Specific:** Designed for the general public, not tailored to neurodegenerative decline.

Constant Therapy	**Rehabilitation:** Clinical-grade speech and cognitive therapy exercises.	**Clinical Focus:** Excellent for therapy but offers no daily life utility (safety, reminders, mood). **High Cost:** Expensive subscription model aimed at clinical recovery rather than daily maintenance.
Apple Watch (Standard)	**General Health:** Fall detection, heart rate monitoring, activity rings.	**Complexity:** The standard UI is too complex for dementia patients. **Privacy vs. Safety:** Native "Find My" tracks continuously or not at all; lacks "Safe Zone only" privacy logic. **Battery:** Continuous tracking drains battery in <18 hours, leaving patients vulnerable.

Table 2.1: *Existing Technological Solutions and their Deficiencies*

2.3 Limitations of the Current System

What the current market lacks, which ReMind aims to satisfy, is in three key areas:

1. **Privacy vs. Safety Trade-off:** Current GPS solutions typically upload all location data to the cloud. There is a lack of "Privacy-by-Design" systems that only track the user when they are in danger (outside a Safe Zone), respecting their privacy when they are safe.
2. **Lack of Mood & Cognitive Analysis:** Existing tracking tools do not monitor the patient's emotional state. There is no existing system that correlates physiological data (HR/HRV) with mood to detect anomalies (agitation/distress) before they escalate.
3. **Data Security:** Many health apps transmit raw data to servers, increasing the risk of sensitive health data breaches.

3. Proposed System

3.1. Overview

ReMind is pictured as an intelligent mobile assistant that aims to support patients with Alzheimer's disease or other types of dementia and their caregivers. It is planned to do so by managing daily activities, monitoring patient safety and mood, while considering privacy requirements. Geofencing, navigation, and AI and data analysis features of the application are to ensure the patient's safety and well-being, and address challenges such as disorientation, caregiver burden, and mood fluctuations. The system aims to achieve all of these goals without compromising the patient's privacy.

The proposed solution covers two primary functionalities:

1. **Patient Support and Monitoring:** The system provides safe-zone monitoring through geofencing, offering location-based support for the patient. The patient is also supported by reminders for their tasks/medicine/appointments and appointments, as well as an SOS mechanism that immediately alerts the caregiver. Thus, this feature aims to detect potential risks that could harm the patient and generate alerts early on to prevent them.

2. **Caregiver Assistance:** This feature allows caregivers to monitor the patient's daily activity/sleep/health data, their location, and their reminders. The caregiver is also notified when the MoodAI output implies mood oscillations. Thus, the caregivers are relieved and can successfully monitor the patient.

ReMind is designed by prioritizing scalability, reliability, and privacy-by-design principles. It comprises three main components:

- **Data Collection & Management:** Emphasizes privacy-by-design principles and is compatible with data protection regulations while collecting and storing data from smartwatches, phones, and user inputs.

- **Core Processing Module:** The core component of the system handles location evaluation, reminders, notifications, and alerts, as well as AI-based mood analysis.

- **User Interaction Layer:** Prioritizes usability; it is designed as simply as possible for elderly patients to use. It is an interface designed for both patients and caregivers, supporting accessibility.

ReMind aims to improve the quality of life for patients and caregivers by assisting them with day-to-day tasks and reducing the burden and stress of caregivers. The app aims to do this by using intelligent monitoring, AI assistance and alert mechanisms, providing a supportive and ethical system.

3.2. Functional Requirements

3.2.1 User and Account Management

FR-UM-01 - User Roles
The system must support two main user roles: **Patient** and **Caregiver**.

FR-UM-02 - Registration and Authentication
The system must allow Patients and Caregivers to register, log in, and log out through email authentication, which must be done via a username and password combination or passwordless email link verification.

FR-UM-03 - Account Verification
The system must verify that the input emails belong to the user by using a verification link or code before permitting access to authenticated actions.

FR-UM-04 - Caregiver–Patient Linking
The system must allow the Caregiver and Patient profiles to be linked after both have approved the request.

FR-UM-05 - Link Cancellation
The system must allow Patients or Caregivers to terminate an existing caregiver–patient link at any given time.

3.2.2 Reminders, Medication, and Daily Routines

FR-REM-01 – Schedule Definition
The system must provide an interface for Patients and Caregivers to create medication schedules and daily routine reminders for each Patient.

FR-REM-02 – Reminder Delivery
The system must deliver reminders at scheduled times via local notifications or in-app prompts to both the patient and the caregiver.

FR-REM-03 – Reminder Interaction
For each reminder, the Patient application must allow the Patient to respond with one of the following options: **“**Done**”**, **“**Skipped**”**, or **“**Snoozed**”**.

FR-REM-04 – Snooze Behavior
When a reminder is snoozed, the system must reschedule it after a short delay.

FR-REM-05 – Adherence Logging
The system shall log reminder responses (including timestamp and response type) for each Patient.

FR-REM-06 – Patient Remainder Tracking
The system must allow caregivers to track patient reminders and responses.

3.2.3 Location Monitoring and Safe Zones

FR-LOC-01 – Safe Zone Definition
The system must allow Caregivers to establish and modify up to three safe zones per patient, defined as circular geofences, by a map-based interface.

FR-LOC-02 – Safe Zone Limits
The Patient mobile application must monitor the patient's location using OS-level geofencing until the patient leaves the safe zone. This way, the system must meet the privacy and battery optimization constraints regarding location tracking, as the exact location tracking is not yet activated.

FR-LOC-03 – Current Location Display
While the patient is in the safe zone, the system must not allow the caregiver to see the patient's exact location; it must only display a message stating which safe zone the patient is in. The exact current location feature must be activated whenever a patient leaves a safe zone.

FR-LOC-04 – Safe Zone Violation Detection
The system must use geofencing to detect when the patient enters or exits a safe zone.

FR-LOC-05 – Safe Zone Exit Alert
The system must alert the Caregiver when the patient goes outside of a safe zone.

FR-LOC-06 – Take Me Home Feature
The system must display a "Take Me Home" feature for the patient when they leave the safe zone. When this feature is used, the system must guide the patient back to the selected safe zone using map-based navigation.

FR-LOC-07 – Foreground Requirement for Take Me Home Feature
The "Take Me Home" feature must be available when the Patient application is in the foreground. The background navigation behavior must match the mobile OS's background execution restrictions.

FR-LOC-08 – Location Monitoring Indicator
The Patient application must display a clear indicator when location tracking is active.

3.2.4 Mood Check-ins and Cognitive Support

FR-MOOD-01 – Mood Check-in Prompts
The Patient application must periodically prompt the Patient to complete a Mood Check-in, designed to be completed in approximately 10–15 seconds, using simple questions and/or image selection.

FR-MOOD-02 – Mood Timeline Storage
The system must store Mood Check-in result logs for each patient, which include timestamps and the patient's responses.

FR-MOOD-03 – Mood Trend Visualization
The Caregiver interface must allow Caregivers to review mood trends over time (e.g., daily/weekly graphs or summaries) for each Patient.

FR-COG-01 – Cognitive Games Library
The Patient application must offer cognitive and memory games that are calming and non-competitive.

FR-COG-02 – Non-Competitive Design
The cognitive games must avoid competitive elements such as leaderboards, timers, or rankings.

3.2.5 Sensor and Smartwatch Integration

FR-SEN-01 – Smartwatch–Phone Pairing
The system must allow a Patient's smartwatch application to pair with the Patient's mobile application on the same account.

FR-SEN-02 – Supported Wearable Platforms (Initial Scope)
The system shall support integration with at least one smartwatch platform for each mobile OS in scope:

- **iOS**: Apple Watch via HealthKit and watchOS health APIs
- **Android**: Wear OS smartwatch via Health Connect and/or Health Services APIs

FR-SEN-03 – Phone-Only Mode
When a smartwatch is not paired or available, the system must switch to a phone-only mode that relies on built-in phone sensors and provides a limited but functional feature set. If smartwatch data suddenly becomes unavailable, both the Caregiver and the Patient must be notified.

FR-SEN-04 – Periodic Vital and Activity Collection
When a smartwatch is available and paired, the system must periodically collect basic vital and activity data from platform health APIs (e.g., sleep, steps, activity, heart rate, heart rate variability, etc.), at a sampling interval that is compatible with the privacy and battery constraints.

3.2.6 MoodAI Anomaly Detection and Support Cards

FR-AI-01 – On-Device MoodAI Module
The Patient application must include an on-device MoodAI module that computes an anomaly score for the Patient's current state using available signals, such as:

- gait speed or activity patterns (where available),
- step counts and movement patterns,

- adherence to reminders and routines,
- mood check-in responses,
- engagement with cognitive games.

FR-AI-02 – Input Adaptation by Mode
The MoodAI module must adapt its input feature set based on available sensors and data sources (e.g., smartwatch + phone vs. phone-only mode) and must not assume that all signals are always present.

FR-AI-03 – Anomaly Thresholds
The system must define configurable thresholds or levels for anomaly scores, such as normal, moderate, and high. The system's behavior must adapt according to the score at each level, and the details of this adaptation are outlined below.

FR-AI-04 – Support Card Triggering
When MoodAI detects a moderate anomaly, the system must display a support card on the Patient's phone and act according to the Patient's response to the card.

FR-AI-05 – Support Card Options
Support cards must offer at least the following response options to the Patient:

- "I'm okay."
- "Alert my caregiver."
- "Take me home."

FR-AI-06 – Escalation of Persistent Anomalies
If a moderate anomaly continues past its established time limits, or if MoodAI detects a high anomaly, the system must escalate by generating a high-priority alert to the Caregiver.

3.2.7 Alerts and Caregiver Notification Management

FR-ALR-01 – High-Priority Alert Conditions
The system must generate a high-priority alert to the Caregiver when at least one of the following conditions occurs:

- The Patient exits a configured safe zone.
- MoodAI detects a high anomaly state.
- A moderate anomaly continues beyond the configured duration.
- The Patient generates an alert by selecting "Alert my caregiver" on the support card or SOS on the dashboard.

FR-ALR-02 – Alert Content
Each high-priority alert sent to a Caregiver must contain at least a human-understandable reason for the alert, the patient's last known location, and a timestamp.

FR-ALR-03 – Alert Delivery Channels
The system must support notifications as the primary and default channel. Additional channels, such as SMS or email, may be supported depending on implementation and platform.

FR-ALR-04 – Alert History View
The Caregiver interface must provide a history of alerts for each Patient.

FR-ALR-05 – Notification Preferences
Caregivers must be able to configure notification preferences, including:

- quiet hours,
- preferred alert channels,
- sensitivity levels for MoodAI-generated alerts.

3.2.8 Privacy, Consent, and Data Governance

FR-PRV-01 – Enrollment Consent Flow
During enrollment, the system must present explicit consent flows that allow Patients to:

- approve linking with Caregivers,
- approve collection and limited sharing of location and health data,
- configure when and how location data is shared with Caregivers.

FR-PRV-02 – Privacy & Data Use Page
The application must provide a "Privacy & Data Use" page that clearly describes:

- what categories of data are collected,
- how each category is used (e.g., alerts, mood trends, navigation),
- which data is shared with Caregivers and under what conditions.

FR-PRV-03 – Minimal Server Storage
The system shall store only essential summary events on the server for caregiver awareness, while raw sensor data and detailed behavior logs remain on the device whenever possible.

FR-PRV-04 – Monitoring Awareness
The Patient application must display clear visual indicators when monitoring and data collection related to location and health signals are active.

FR-PRV-05 – Account and Data Deletion
Patients must be able to request deletion of their account and associated cloud-stored data, subject to legal retention requirements.

FR-PRV-06 – Data Export for Clinical Use
The system must allow Patients and Caregivers to export a summary of relevant data for a selected time range, including at least:

- alert history,
- reminder adherence,
- mood trends,

in a human-readable format, such as PDF, suitable for sharing with clinicians.

FR-PRV-07 – Caregiver Limitation
The system must allow the caregiver to see only:

- alerts (SOS, safe-zone exit, MoodAI anomaly),
- reminder status,
- exact location only when outside safe zone, “In Safe Zone” text otherwise.

FR-PRV-08 – Encryption in Transit
The system must use TLS 1.3 for all network communication between the mobile app, backend services, and any third-party services.

FR-PRV-09 – Encryption at Rest
All stored patient-related data must be encrypted using AES-256.

FR-PRV-10 – Data Minimization: Restricted Sensors and Inputs
To minimize sensitive data collection, the system must enforce the following constraints:

- No microphone access.
- No raw accelerometer/gyroscope collection or storage.
- No wearable GPS ingestion.

FR-PRV-11 – Data Minimization: Logging Controls
The system must not store or transmit detailed behavior logs.

FR-PRV-12 – Compliance Principles
The system must be designed and implemented according to privacy-by-design principles and support GDPR and KVKK-aligned data protection requirements (e.g., consent, purpose limitation, minimization, access/deletion/export).

FR-PRV-13 – Security Management Standard Alignment
The system must maintain security controls aligned with an ISO/IEC 27001-style information security management approach for the components that store/process patient data.

3.3. Nonfunctional Requirements

3.3.1. Usability

The system needs to provide clean, immediate access to its features and be user-friendly, as the target users are patients and their caregivers. This requires an interface with clear, basic navigation, restrained color use, and a calm, non-overstimulating design.

- Ease of Navigation
  - The patient application should feature a clean interface that uses large buttons and minimal text usage.
  - The system should allow users to access the “Take Me Home” feature, reminders, and mood check-ins through an always-visible interface. This eliminates the need for complex menu navigation and is a simpler choice for patient comfort.
  - The caregiver interface should display information based on priority levels, starting with alerts (also sorted by priority) and then daily summaries.

- Accessibility
  - The system should follow WCAG 2.2 Level AA accessibility standards to support users with visual, motor, and cognitive disabilities.
  - The system should use colors, text, and symbols for clear indications.
  - System designers should create mood check-ins and game interfaces in a way that minimizes user confusion and frustration (e.g., avoiding time limits and failure states).

- Enrollment & Guidance
  - Both patient and caregiver apps should include short enrollment flows that explain controls in plain language.
  - Tooltips and tutorials should clarify safe zone setup, alert logic, and device-sensor permissions. The patient and caregiver applications should begin with basic sections that describe their controls using clear terminology.

3.3.2. Reliability

The system must operate reliably under real-world conditions, which may include network fluctuations, battery limitations, and sensor signal interruptions.

- System Continuity
  - The system should support background monitoring of location and safe zone events using OS-level services, while respecting mobile operating system constraints on background execution and sensor access.
  - When watch data is unavailable, the system should fall back to phone sensors.
- Fail-Safe Alerting

    - The system needs to deliver safety alerts, and it requires network connectivity to function properly. The system stores outgoing notifications in a queue until delivery success is achieved, since the network might fail.
    - MoodAI should operate as a local anomaly detection system that functions independently from any network requirements.
- Resilience
    - The system should return to its safe operational state following crashes, while maintaining all current alerts and system logs.

3.3.3. Performance

Optimal performance is a necessity for the system, both for user safety and system reliability. Therefore, for better performance, the system should optimize its use of sensors, data processing, and alert transmission.

- Latency Requirements
    - The system should begin generating and sending safe zone breach alerts immediately through a process that should take no longer than five seconds upon detecting any breach.
    - The system should perform MoodAI anomaly inference within one second to generate real-time support cards.
- Sensor Efficiency
    - The system should adjust its background polling rates for GPS, heart rate, and movement data based on user behavior.
    - The system must perform low-frequency sampling during normal activities to conserve battery power, but switch to high-frequency sampling when it detects anomalies or when the user leaves the safe zone.
- Server Performance
    - The caregiver dashboard should display summary information immediately, using a 3–5 second display that shows data from previous months.

3.3.4. Supportability

The system requires operational maintenance to enable developers to perform maintenance work and resolve problems without disrupting user access.

- Supportability
    - The system should support troubleshooting and maintenance without disrupting user access.
- Logging & Diagnostics
    - The system must store detailed local logs, which include sensor data, alert generation conditions, and geofence entry events in secure storage.
    - With user consent, the system should provide anonymized telemetry to help resolve problems that affect battery life or cause abnormal app crashes and synchronization issues.
- Error Transparency
    - When failures or misconfigurations occur, the system should present clear, plain-language notifications with steps to restore functionality.

- Modular Architecture
  - The system requires separate feature modules, which allow developers to make separate updates and bug fixes.

3.3.5. Scalability

The system architecture needs to handle an expanding number of users, rising sensor data, and new AI functionality additions.

- User Scalability
  - The system should support thousands of caregiver–patient pairs with no degradation in alert delivery speed or dashboard responsiveness.
  - Each caregiver may manage multiple patients without performance loss.
- Data Scalability
  - The cloud storage system should handle extended log retention periods, which include multiple months of patient data.
  - The system needs caregivers to access previous data through fast retrieval methods.
- Compute Scalability
  - The backend services should automatically scale their resources to handle peak alert processing demands, which can occur when GPS outages affect multiple devices simultaneously.
  - The system should have a direct device execution of MoodAI fine-tuning and anomaly detection operations to minimize server processing needs.
- Feature Growth
  - The system design must support the addition of new cognitive games and advanced anomaly models through non-disruptive architectural changes.

3.4. Pseudo Requirements

1. The available screens, actions, and data should be dependent on the active role, and the system should make a clear distinction between the roles of patient and carer.
2. By default, location-related features should prioritize patient privacy. Precise location data should only be processed or shared when necessary, like in the event of a safe zone breach.
3. User consent should play a central role in location sharing and alert escalation. Patients should be able to view, or revoke consent settings at any time.
4. When direct sensor integration is not possible, simulated or mock data should be used to represent safe zone exits, reminder triggers, and mood anomaly detection.
5. Messages and feedback to users should avoid technical language and focus on clarity, especially in patient interfaces.
6. Reminder handling, alert generation, and notification delivery should be structured modularly to allow future extensions or changes.
7. When necessary, notification mechanisms (such as push, SMS, and email) should be simulated during development while maintaining realistic system behaviour.
8. During testing and demo sessions, time-based behaviours like alert timestamps, quiet hours, and reminder schedules should be able to be changed or accelerated.

9. To guarantee uniformity and clarity, all analysis and design models should adhere to UML 2.5.1 conventions.

3.5. System Models

3.5.1. Scenarios

Scenario 1	**Patient Registration**
Actors	Patient candidate
Entry Conditions	- User clicks the “Create Patient Account” button in the ReMind mobile application home page
Exit Conditions	- Successful registration - Failed registration - Canceled registration
Flow of Events	1. The registration form is displayed after the user clicks the “Create Patient Account” button. 2. The user enters their general information (name, age, gender, email etc.) and clicks next. 3. The user enters brief information about their health conditions. 4. The user reviews and accepts the terms and conditions. 5. The user submits the registration form. 6. The system validates the inputs. 7. If the form is validated, the system sends an email with a verification code to the provided email address of the user. 8. If the user enters the correct code, the patient account is created and the user is directed to the login page. 9. If registration fails because of input validation or email verification, the user is allowed to try again. 10. The user can change their mind and cancel the registration at any step.

Table 3.1: *Scenario 1 - Patient Registration*

Scenario 2	Caregiver Registration
Actors	Caregiver candidate
Entry Conditions	- The user clicks the "Create Caregiver Account" button in the ReMind mobile application.
Exit Conditions	- Successful registration - Failed registration - Canceled registration
Flow of Events	1. The registration form is displayed after the user clicks the "Create Caregiver Account" button. 2. The user enters their general information (name, age, gender, email etc.) and clicks next. 3. The user enters brief information about their previous caregiving experiences. 4. The user reviews and accepts the terms and conditions. 5. The user submits the registration form. 6. The system validates the inputs. 7. If the form is validated, the system sends an email with a verification code to the provided email of the user. 8. If the user enters the correct code, the caregiver account is created and the user is directed to the login page. 9. If registration fails because of input validation or email verification, the user is allowed to try again. 10. The user can change their mind and cancel the registration at any step.

Table 3.2: *Scenario 2 - Caregiver Registration*

Scenario 3	Patient-Caregiver Linking System
Actors	Patient, Caregiver
Entry Conditions	- Patient and caregiver accounts are successfully created and both are logged in. - The patient/caregiver visits the "Link Management" section in the ReMind mobile application.
Exit Conditions	- Successful link creation

	- Rejected link request - Canceled link request - Failed link request
Flow of Events	1. The requester (Patient or Caregiver) visits the "Link Management" section in the ReMind mobile application. 2. The requester enters the email of the receiver to find their account in the system. 3. The requester views the receiver's profile, and if they click the "Send link request" button, a link request is sent to the receiver. 4. The receiver views the request and basic information about the requester. 5. If the receiver approves the request, the link is created. 6. The requester is notified about the response (approve/reject) the receiver gave to the link request. 7. Both users' dashboards update accordingly. 8. The request may be rejected by the receiver or canceled by the requester before it is responded to. 9. If the request fails because system errors occur or the receiver is not found, the requester can try again.

Table 3.3: *Scenario 3 - Patient-Caregiver Linking System*

Scenario 4	**Patient Dashboard System**
Actors	Patient
Entry Conditions	- The patient successfully created an account and logged in. - The patient visits the main page/dashboard of the ReMind mobile application.
Exit Conditions	- The patient leaves the dashboard. - One or more dashboard components fail to load. - Dashboard is successfully displayed.
Flow of Events	1. The patient visits the dashboard of the ReMind mobile application. 2. The dashboard displays an SOS button, links to cognitive games, daily activity data, reminders and mood check-in.

	- The patient clicks the SOS button to alert the caregiver about an emergency. - The patient clicks the game section to participate in cognitive games. - The patient clicks on daily activity data to view details. - The patient clicks to the reminders and has the options to create, edit, delete, view, snooze, and complete reminders. - The patient clicks to the mood check-in to select an image and complete their mood check-in. - The patient clicks the notification history and views previous notifications. 3. If any section of the dashboard fails to load, the system will display an error message.

Table 3.4: *Scenario 4 - Patient Dashboard System*

Scenario 5	**Mood Check-in System**
Actors	Patient
Entry Conditions	- The patient successfully created an account and logged in. - The patient visits the mood check-in section from the dashboard to complete their daily mood check-in. - The patient has granted permission for their data to be stored/processed.
Exit Conditions	- Successful mood check-in - Failed mood check-in - Canceled mood check-in
Flow of Events	1. The patient clicks to complete their mood check-in. 2. The system displays several pictures from the OASIS dataset. 3. The patient selects an image according to their mood. 4. The corresponding image label is logged and sent to MoodAI as input. 5. MoodAI outputs an anomaly score, using patient data such as mood image label,

	sleep, health and activity data. 6. If a significant anomaly in the mood is detected, the caregiver is alerted. 7. The patient can exit the mood check-in page without selecting an image, not completing and canceling the mood check-in. 8. If the process fails at any point (images could not be loaded, system error, etc.) the mood check-in is failed and the patient will be asked to complete their mood check-in again.

Table 3.5: *Scenario 5 - Mood Check-in System*

Scenario 6	**Reminder System**
Actors	Patient, Caregiver
Entry Conditions	- The patient and caregiver successfully created accounts and both are logged in. - The patient/caregiver visits the Reminders section of ReMind. - The patient has granted permission for their data to be stored/processed.
Exit Conditions	- The user views reminders and exits. - Requested reminder operation is completed successfully. - Requested reminder operation failed. - Requested reminder operation is canceled.
Flow of Events	1. The user navigates to the Reminders section. 2. The user views a list of the existing reminders. ● The user decides to create a new reminder. ● The user decides to edit an existing reminder. ● The user decides to delete an existing reminder. ● The user decides to mark a reminder as completed. 3. When the assigned time of a reminder comes, the system sends a notification to the patient and caregiver. 4. The reminder can be snoozed or completed.

	5. The system logs the reminder and the response (snoozed/completed). 6. The user may change their mind and cancel the requested reminder operation such as clicking "Create a reminder" and leaving without entering details. 7. If the requested reminder operation fails due to system errors or invalid inputs, the user can try again.

Table 3.6: *Scenario 6 - Reminder System*

Scenario 7	**Safe-zone Exit Detection and Response System**
Actors	Patient, Caregiver
Entry Conditions	- The patient and caregiver successfully created accounts and both are logged in. - The patient and caregiver successfully created a link. - The caregiver has defined at least one safe-zone. - The patient has granted permission for location monitoring.
Exit Conditions	- The patient leaves the safe-zone. - The patient stays within the safe-zone. - Monitoring fails.
Flow of Events	1. The system checks the patient's location using geofencing. 2. If the patient exits a safe-zone, the system starts actively tracking their location. 3. The system sends notifications to the patient and the caregiver. 4. The caregiver can choose to view the patient's location, and can actively track the patient. 5. The patient can choose to "Navigate Back" or "Ignore" the notification. 6. If the patient clicks "Navigate Back", the navigation system is displayed with instructions. 7. The patient reaches the safe-zone with the help of the navigation system. 8. The caregiver is notified. 9. Active location tracking and location sharing is stopped.

	10. If location tracking or navigation fails, the patient and the caregiver are alerted.

Table 3.7: *Scenario 7 - Safe-zone Exit Detection and Response System*

Scenario 8	**Emergency Alert System**
Actors	Patient
Entry Conditions	- The patient successfully created an account and logged in. - The patient has a link with a caregiver.
Exit Conditions	- Alert sent successfully. - Alert failed. - Alert creation canceled.
Flow of Events	1. The patient clicks the “SOS” button on the dashboard. 2. The system displays a confirmation before creating an alert. 3. If the user does not cancel the alert, the caregiver is notified. 4. The alarm is logged for future use. 5. If alert creation fails, the system retries several times. If the alert still cannot be sent, it is marked as failed and the patient is notified.

Table 3.8: *Scenario 8 - Emergency Alert System*

Scenario 9	**Caregiver Dashboard System**
Actors	- Caregiver
Entry Conditions	- The caregiver successfully created an account and logged in. - The caregiver has a link with a patient.
Exit Conditions	- The caregiver leaves the dashboard. - One or more dashboard components fail to load. - Dashboard is successfully displayed.
Flow of Events	1. The caregiver visits the dashboard of the ReMind mobile application. 2. The dashboard displays the patient summary data, reminders, and safe-zone management. ● The caregiver clicks to the reminders

	and has the options to create, edit, delete, view, snooze, and complete reminders. ● The caregiver clicks to safe-zone management and has the options to create, edit or delete safe-zones. ● The caregiver clicks to the daily summary section and views detailed patient data. ● The caregiver clicks the notification history and views previous notifications. 3. The caregiver navigates to other sections including reminders, safe-zone management etc. 4. If any section of the dashboard fails to load, the system will display an error message.

Table 3.9: *Scenario 9 - Caregiver Dashboard System*

Scenario 10	**Patient-Caregiver Unlinking System**
Actors	Patient, Caregiver
Entry Conditions	- The patient and caregiver successfully created accounts and both are logged in. - The patient and caregiver successfully created a link.
Exit Conditions	- Unlinking is successful. - Unlinking failed. - Unlinking canceled.
Flow of Events	1. The requester (patient or caregiver) opens the Link Management section of ReMind. 2. The requester clicks the "Unlink" button next to the linked account. 3. The system asks for confirmation. 4. The requester can cancel or submit the unlinking request. 5. If the user submits it, the system removes the link between the patient and caregiver. 6. Both users receive a notification confirming unlinking has been completed. 7. Dashboards of the patient and caregiver are updated accordingly. 8. If unlinking fails due to a system error, the requester is notified and can try again.

Table 3.10: *Scenario 10 - Patient-Caregiver Unlinking System*

3.5.2. Use Case Model

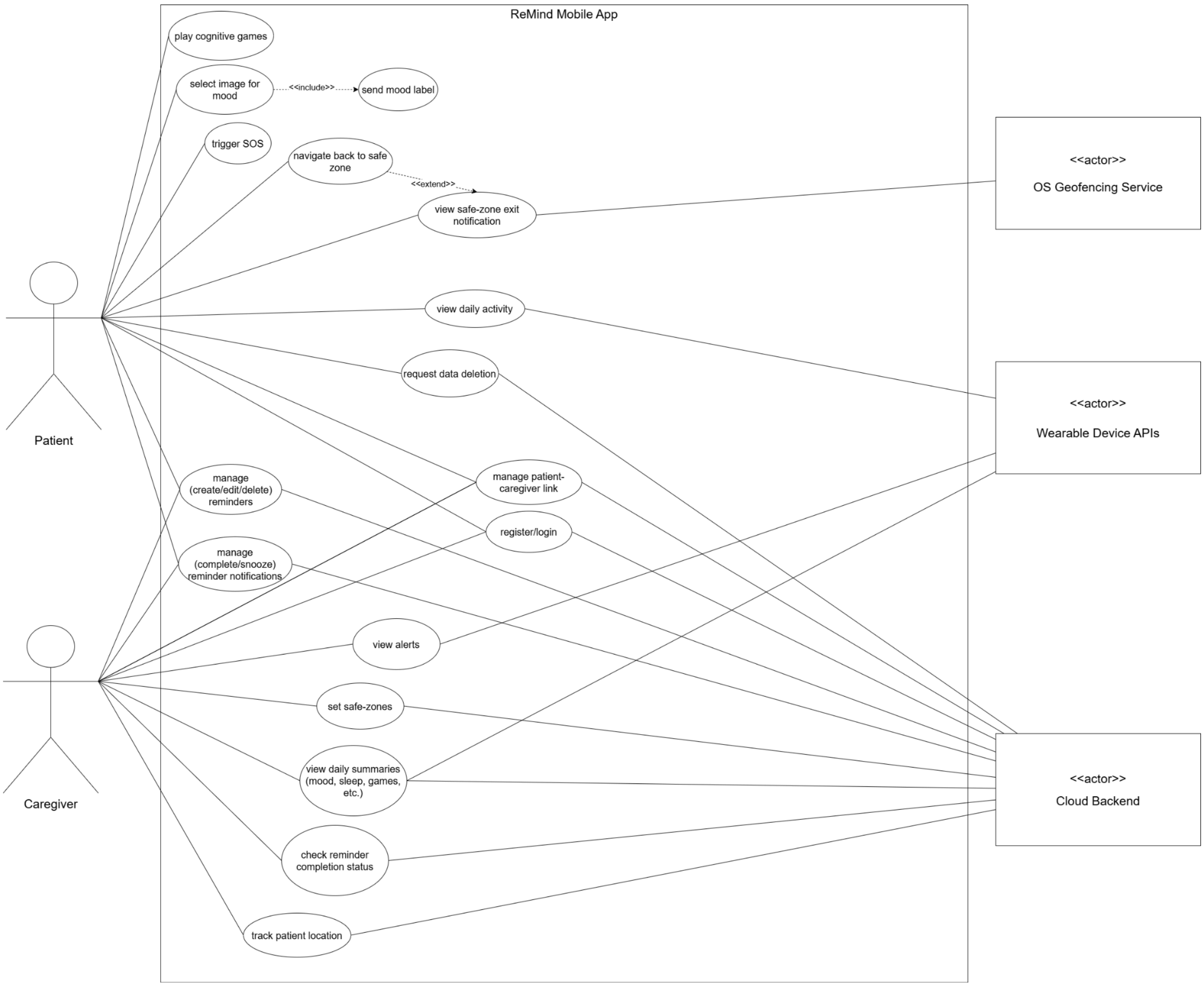


Figure 3.1: *Use Case Model of ReMind*

Higher quality version of **Figure 3.1** can be found:
https://drive.google.com/file/d/1RivYdXR6wy7S5RzrxsH4UorqZJdu6fNl/view?usp=sharing

3.5.3. Object and Class Model

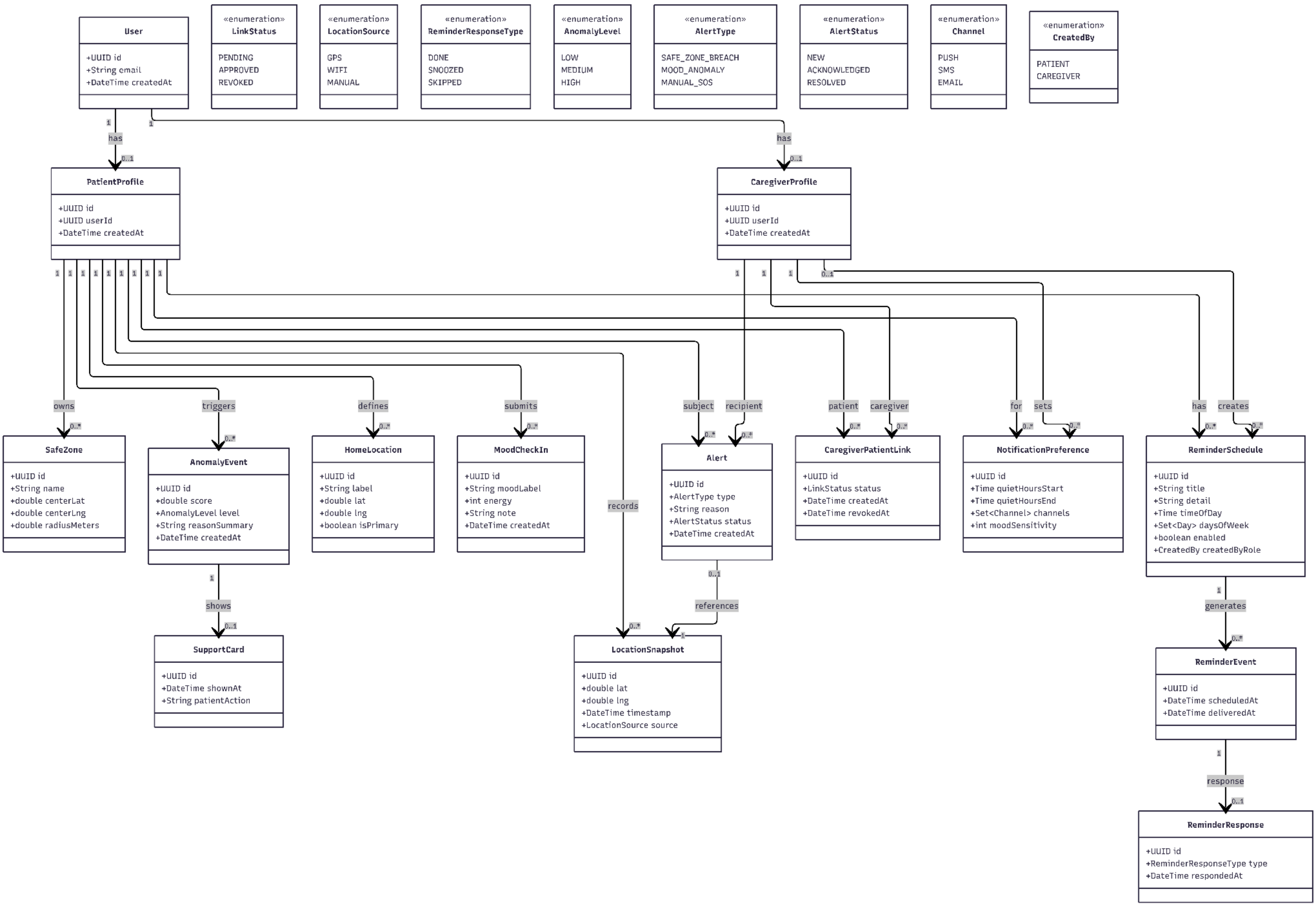


Figure 3.2: *Object and Class Model of ReMind*

Higher quality version of **Figure 3.2** can be found:
https://drive.google.com/file/d/1CLyutMU9xuH715woAxkHhOYvOcIrB6ZQ/view?usp=sharing

3.5.4. Dynamic Model

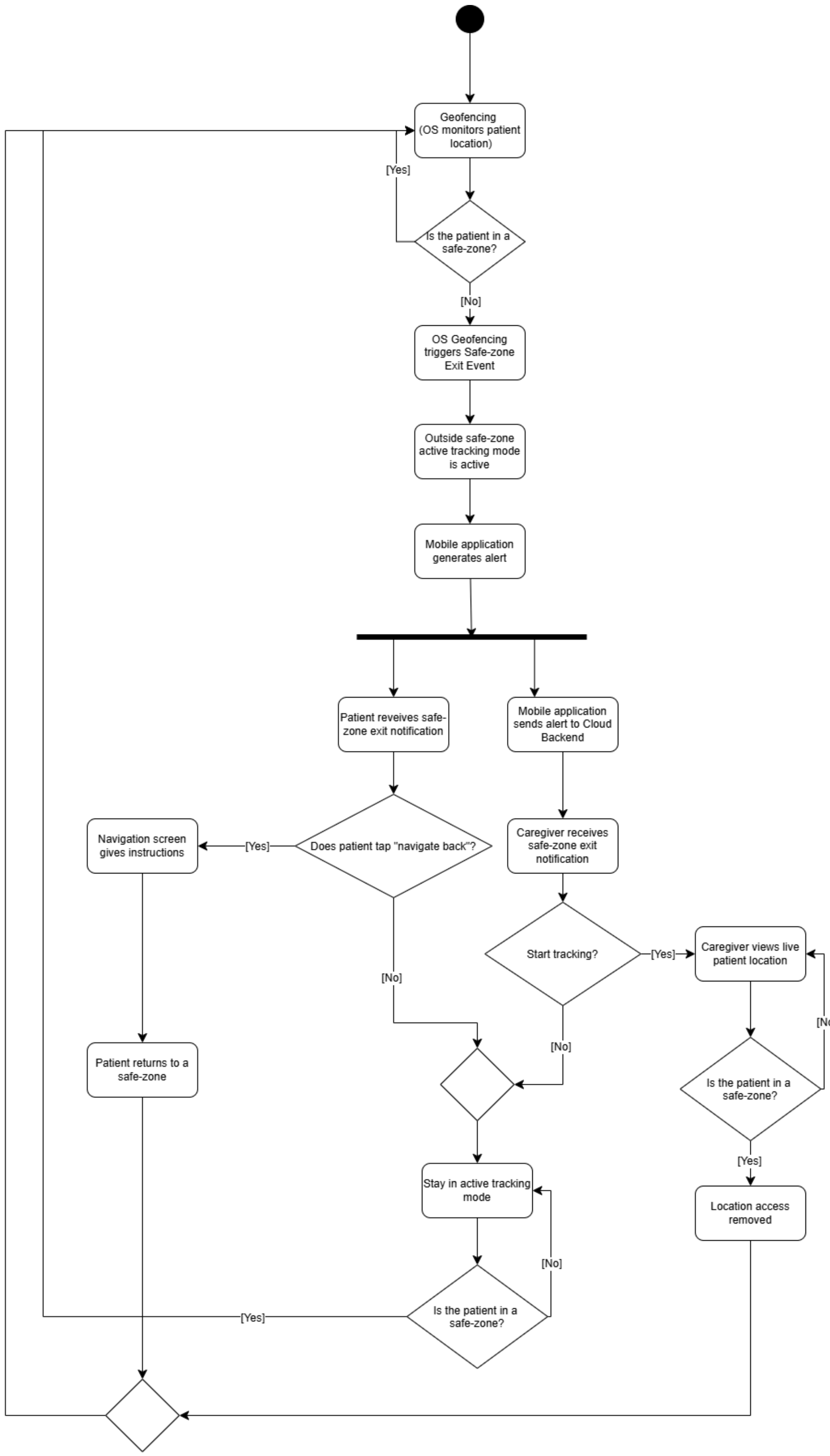


Figure 3.3: *Activity Model of the Safe Zone Feature of ReMind*

Higher quality version of **Figure 3.3** can be found:
https://drive.google.com/file/d/1RivYdXR6wy7S5RzrxsH4UorqZJdu6fNl/view?usp=sharing

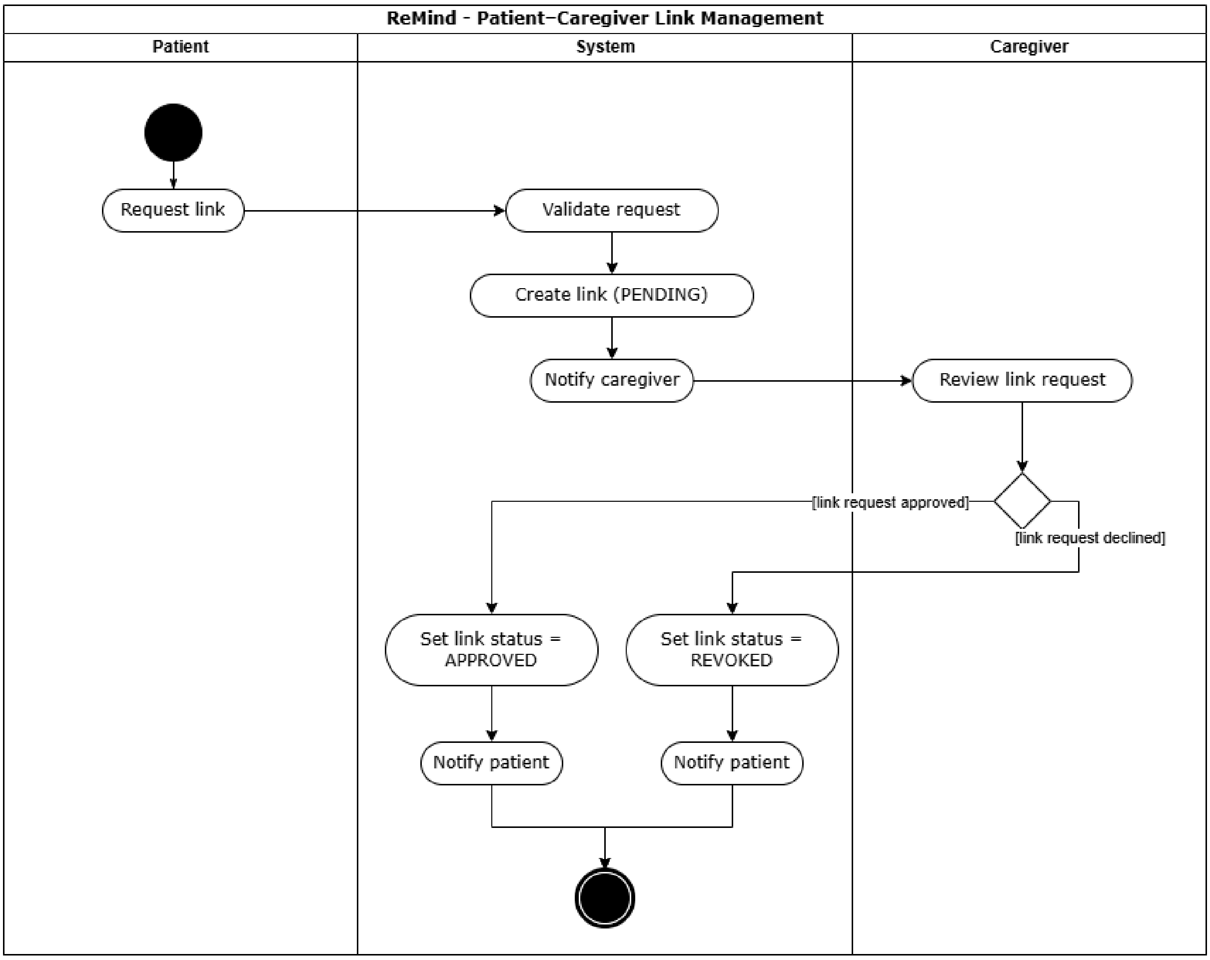


Figure 3.4: *Activity Model of the Patient-Caregiver Linking Feature of ReMind*

Higher quality version of **Figure 3.4** can be found:
https://drive.google.com/file/d/1P7aPFEkuWJztr6BAHb-HPNuw1BdkZ5q4/view?usp=sharing

3.5.5. User Interface - Navigational Paths and Screen Mock-ups

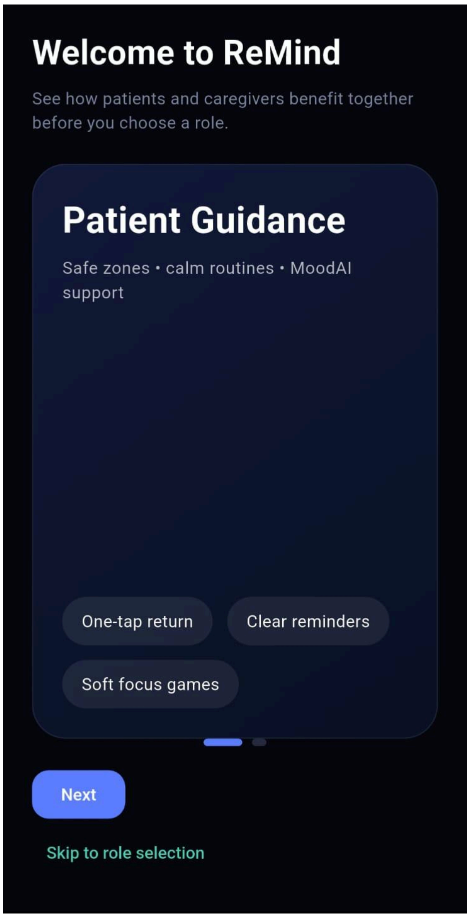


Figure 3.5: Onboarding Screen 1

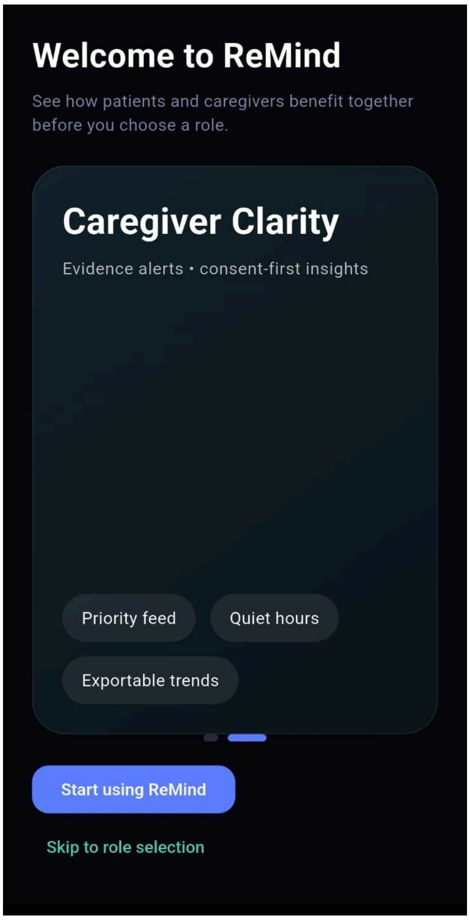


Figure 3.6: Onboarding Screen 2

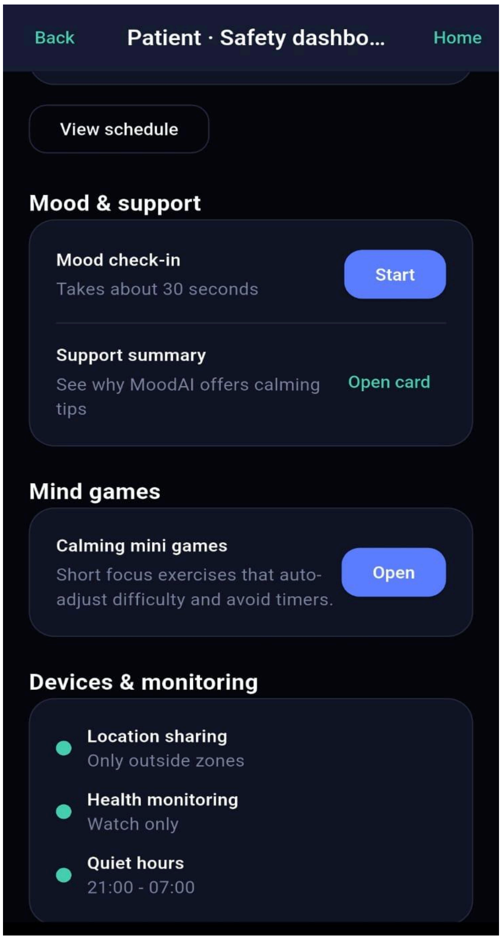


Figure 3.7: Patient Safety Dashboard

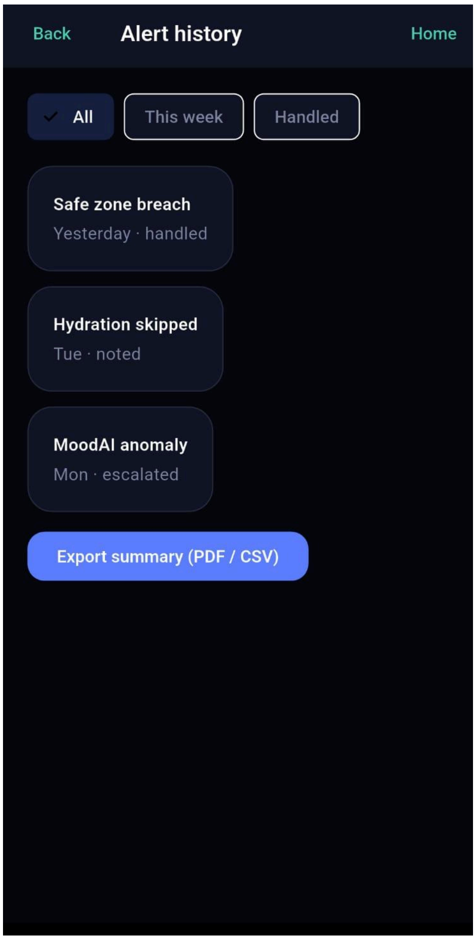


Figure 3.8: Alert History

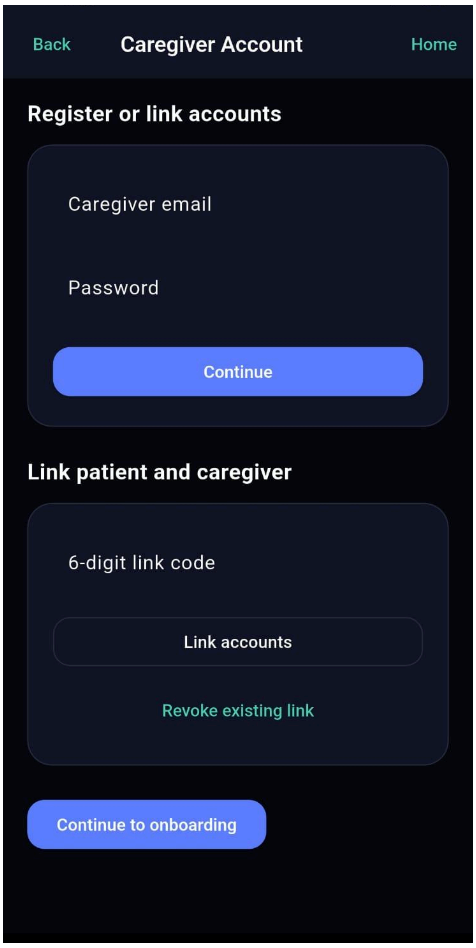


Figure 3.9: CareGiver Account

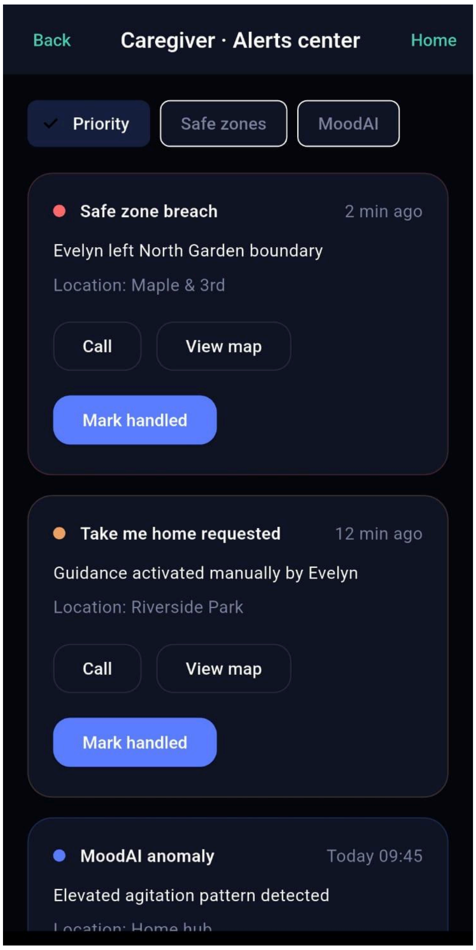
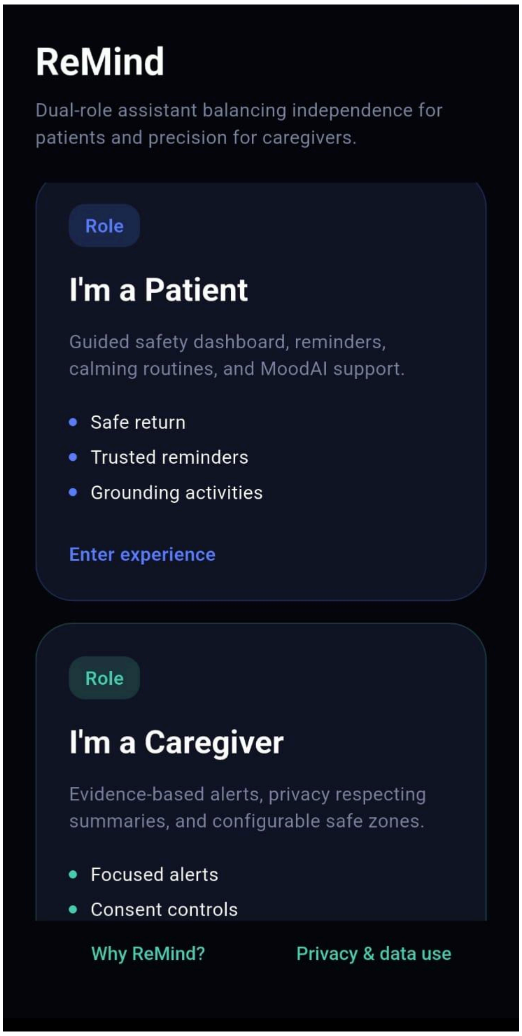


Figure 3.10: CareGiver Alerts Center



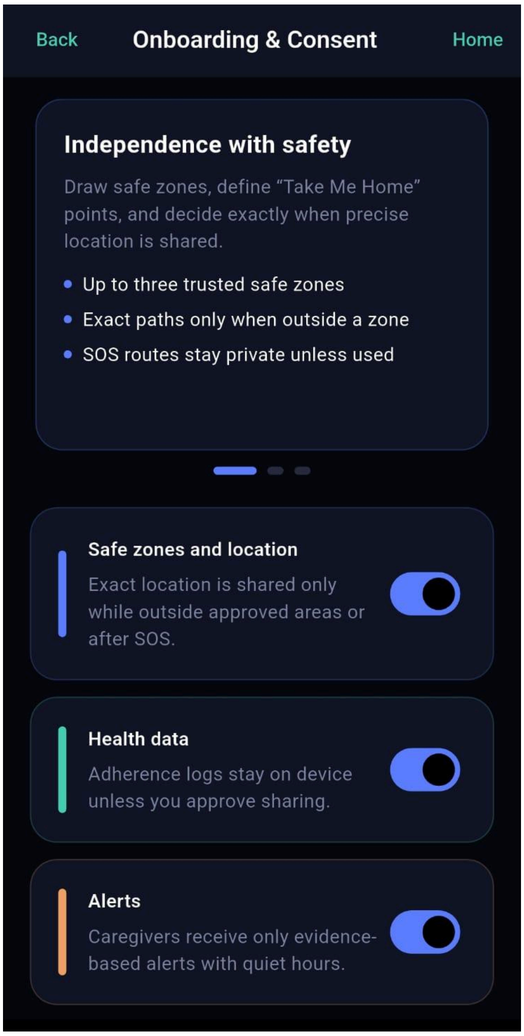


Figure 3.11: Patient Or CareGiver Selection **Figure 3.12:** In-role Onboarding and Consent

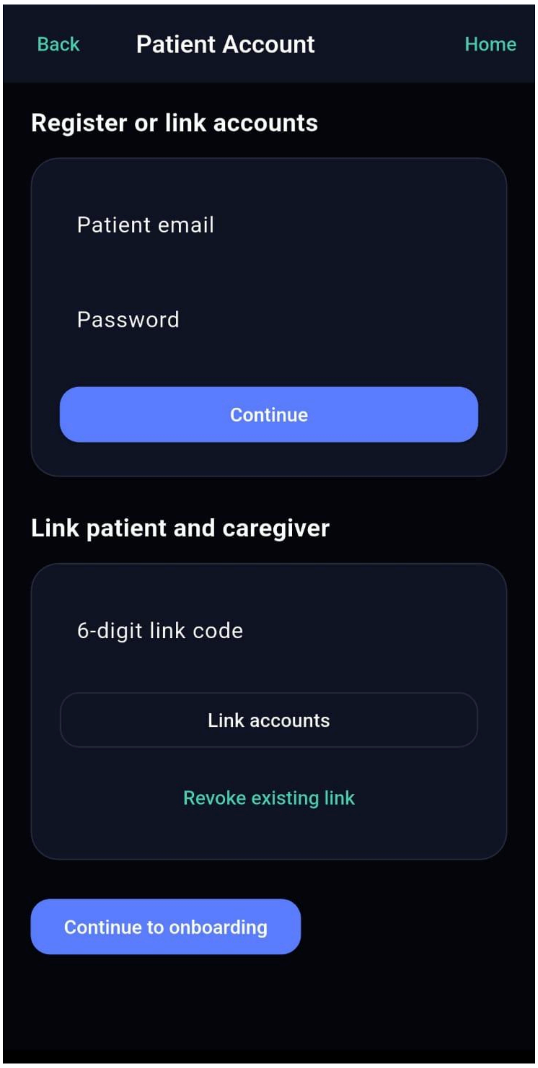


Figure 3.13: Patient Account

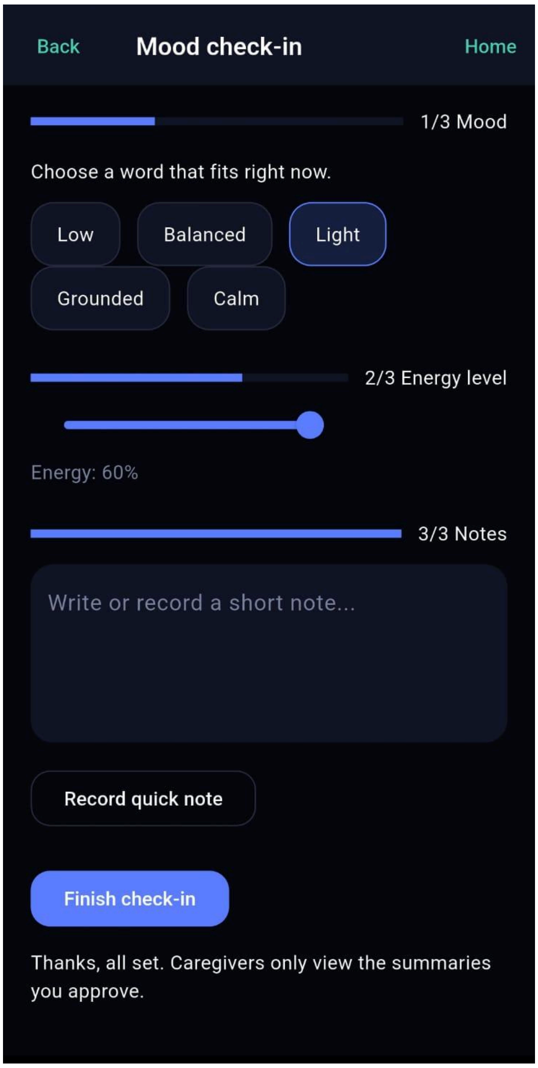


Figure 3.14: Mood Check-In

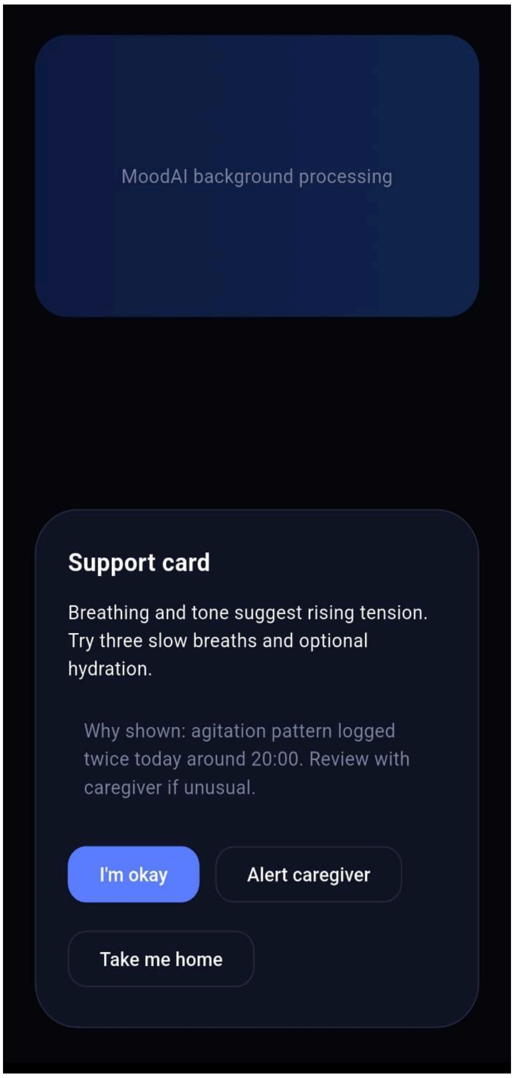


Figure 3.15: Mood AI Support

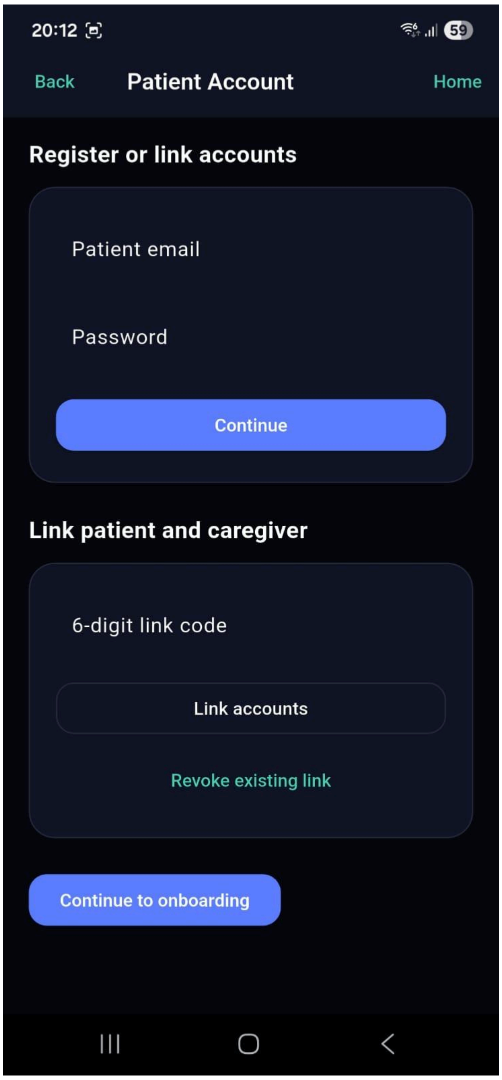


Figure 3.16: Authentication Page

4. Other Analysis

4.1. Consideration of Various Factors in Engineering Design

In the design and analysis of ReMind, the broader impact of the system, beyond just technical functionality, must be considered. Since this solution addresses a critical health issue (Dementia/Alzheimer's), the impact on public health, safety, and social factors is particularly high.

- **Public Health**: The system addresses a major public health concern: the care of individuals with neurodegenerative diseases. By monitoring physiological data (HR, HRV) and mood, the system's aim is to improve the quality of life for patients and reduce mental burden on caregivers.

- **Safety**: This is the most critical factor. The system is designed to protect patients from wandering (geofencing) and distress (SOS). A failure in safety features could result in physical harm to the patient.
- **Welfare**: The system aims to enhance the well-being of caregivers by reducing caregiver burnout and anxiety. Simultaneously, it protects the patient's dignity by allowing independence within safe boundaries.
- **Social/Cultural**: There is a delicate balance between supervision and surveillance. Culturally, the acceptance of tracking elderly family members varies. The system addresses this social friction by implementing "privacy-by-design" (tracking only outside safe zones) to respect the social contract between parents and children/caregivers.
- **Economic**: The solution relies on smartwatches and smartphones. Therefore, the economic burden on families, who may already be facing high medical costs, must also be considered. That is why the app can function without relying on smartwatch data; there will be a “phone-only” mode, which is exactly for such cases.
- **Legal**: The collection of sensitive health and location data is strictly regulated. The system must comply with GDPR and KVKK to protect user rights.

Below is an analysis of factors and effects for referencing and better complying with them during production.

Factor	Effect Level (0-10)	Impact Description
Public Health	**10**	The core mission is health management for dementia patients.
Safety	**10**	Critical reliance on SOS and Geofencing for physical safety.
Welfare	**9**	Directly impacts the mental health of caregivers and patient dignity.
Social	**8**	Addresses the privacy vs. safety dilemma in family dynamics.
Legal	**8**	Strict compliance with GDPR/KVKK is mandatory for health data.

Economic	**5**	Requires purchase of wearables/phones; affects accessibility.
Environmental	**3**	minimal impact; primarily concerns device energy efficiency.

Table 4.1: Analysis of Factors and Effects

4.1.1. Constraints

There are certain constraints to be aware of before and during the development. Below are some of the constraints that will cause limitations and shape the engineering of ReMind.

- **Accessibility & Usability**: The patient-side application faces strict accessibility constraints. Users may have cognitive decline, meaning the UI must be extremely simple, use large fonts, and require minimal interaction. Complex flows or navigation paths are not tolerable for the patient dashboard.
- **Privacy & Legal**: The system is constrained by GDPR and KVKK regulations. We are legally restricted from storing raw health or location data on the server. All raw processing must happen on-device, and only encrypted summaries can be transmitted.
- **Hardware Specifications**: The system relies on the availability of sensors (HR, HRV, Accelerometer) on the patient's smartwatch. The project is constrained by the APIs provided by the wearable OS (e.g., WatchOS, WearOS). If the API does not grant access to this data, the HRV calculation must be adapted.
- **Connectivity**: Features such as SOS and geofence alerts require an active internet connection. The system must handle cases where connectivity is lost (e.g., caching data or alerting the caregiver of disconnection).
- **Battery Life**: Continuous monitoring and location tracking consumes battery quickly. The design is constrained by the need for the device to last a full day; otherwise, the patient is left unprotected while charging.
- **Schedule**: The project must be completed within the academic timeline of the CS491 and CS492 courses, which limits the scope of features (e.g., the initial exclusion of location tracking directly from the watch due to complexity).

4.1.2 Standards

Reliability and security are at the core of ReMind. To achieve these goals, the following engineering and security standards will be employed.

- **Software Engineering Standards**:
  - ISO/IEC/IEEE 12207: Used to define the software life cycle processes.
  - UML: Used for creating system models to formalize requirements.

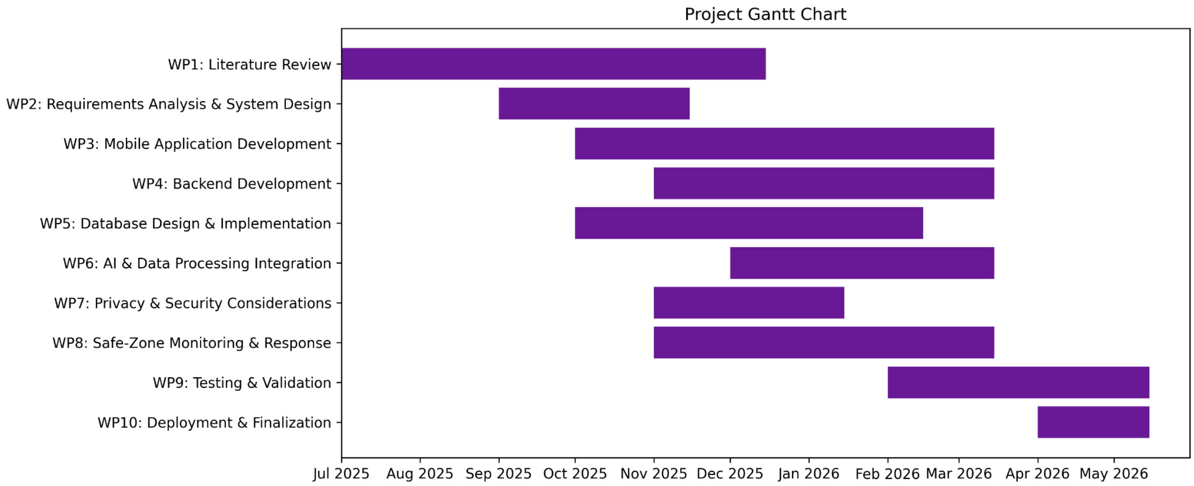
- **Security and Privacy Standards**:
  - ISO/IEC 27001: Information Security Management Standards will be referenced to guide the handling of sensitive data.
  - TLS 1.3 (Transport Layer Security): Will be implemented for all data in transit to prevent eavesdropping.
  - AES-256 (Advanced Encryption Standard): Will be used for encrypting data at rest (both local storage on the device and server-side summaries).
- **Data Protection**:
  - GDPR (General Data Protection Regulation) & KVKK: The architectural decision to use on-device processing and data minimization is derived directly from these data protection standards.

4.2. Risks and Alternatives

The time limitation and broad scope of the project require potential risk analysis to be prepared for cases that might risk the project's success. Below are some of those risks, along with the "Plan B" strategies to reduce their impacts.

- **Risk 1: MoodAI Model Accuracy:** The MoodAI model is initially trained on the "StudentLife" dataset, which may not represent the behavioral patterns of dementia patients correctly. There is a risk that the model may fail to detect anomalies in the target demographic.
  - Plan B: If the AI model fails to make accurate predictions during the initial phase, we will implement a rule-based system (e.g., "If HR > 100 and Steps < 10, trigger alert") alongside the AI model until sufficient patient data is collected for fine-tuning.
- **Risk 2: Wearable API Limitations**: We plan to access Heart Rate Variability (HRV) and raw accelerometer data. Some wearable operating systems restrict access to raw sensor data to preserve battery or for privacy reasons.
  - Plan B: We will shift reliance to the smartphone's sensors for activity recognition (accelerometer/gyroscope) and use the smartwatch solely for basic Heart Rate (BPM) and notifications.
- **Risk 3: False Positives in Geofencing**: GPS drift can sometimes show a user as being outside a safe zone when they are actually inside, leading to panic for the caregiver.
  - Plan B: The system will require the user to be outside the safe zone for a set duration (e.g., 60 seconds) or a set distance (e.g., 50 meters past the boundary) before triggering a "Safe Zone Exit" alert.
- **Risk 4: Patient Non-Compliance (Refusal to wear device)**: Dementia patients may forget or refuse to wear the smartwatch.
  - Plan B: The system will be designed to function with just the smartphone carried in a pocket. While biometric data (HR/HRV) will be lost, the location tracking and SOS features will remain functional via the phone.

4.3. Project Plan



Figıre 4.1: *Gantt Chart of Project Timeline*

WP#	Work Package Title	Leader	Members Involved
WP1	Literature Review	Emine Noor	All members
WP2	Requirements Analysis and System Design	Ayça Candan Ataç	All members
WP3	Mobile Application Development	Ahmet Yağız Sarıdoğan	Ahmet Yağız Sarıdoğan, Elif Ceren Çelik
WP4	Backend Development	Elif Ceren Çelik	All members
WP5	Database Design and Implementation	Elif Ceren Çelik	Ahmet Yağız Sarıdoğan, Elif Ceren Çelik
WP6	AI and Data Processing Integration	Ayça Candan Ataç	Ayça Candan Ataç, Irmak İmdat
WP7	Privacy and Security Considerations	Emine Noor	Emine Noor, Irmak İmdat, Ayça Candan Ataç
WP8	Safe-Zone Monitoring and Response System	Irmak İmdat	Emine Noor, Irmak İmdat
WP9	Testing and Validation	Irmak İmdat	All members
WP10	Deployment and Finalization	Ahmet Yağız Sarıdoğan	All members

WP 1: Literature Review	
Start Date: July 2025	**End Date: December 2025**
Leader: Emine Noor	**Members Involved: All members**
Objectives: Review existing applications, identify gaps and come up with a project topic. Decide the features, tech stack, and scope of the project.	
Tasks: **1. Review existing Alzheimer-Dementia mobile assistant applications** **2. Study literature on AI-assisted health systems and health-related mobile applications** **3. Analyze good and weak features of the existing applications and identify unmet needs** **4. Define the features, tech stack and scope of the project**	
Deliverables: Project Information Form	

Table 4.2: *Work Package 1*

WP 2: Requirements Analysis and System Design	
Start Date: September 2025	**End Date: November 2025**
Leader: Ayça Candan Ataç	**Members Involved: All members**
Objectives: Define and describe the structure and behavior of ReMind, perform a detailed analysis about the system components, constraints, functional and non-functional requirements, standards, feasibility discussions. Support the system description and decisions with diagrams.	
Tasks: **1. Create the high level system architecture diagram** **2. Define professional and ethical issues** **3. Select standards to follow throughout the implementation of the project** **4. Determine functional and non-functional requirements** **5. Complete academic and market analysis** **6. Create system models (scenarios, use-case, class and activity diagrams)** **7. Prepare UI mockups** **8. List risks and alternatives** **9. Determine the detailed project plan with deadlines** **10. Write ethical and professional responsibilities, learning strategies and pseudo requirements**	
Deliverables: Project Specification document, Analysis and Requirements Report	

Table 4.3: *Work Package 2*

WP 3: Mobile Application Development	
Start Date: October 2025	End Date: March 2026
Leader: Ahmet Yağız Sarıdoğan	Members Involved: Ahmet Yağız Sarıdoğan, Elif Ceren Çelik
Objectives: Design and implement a simple, easy to use interface for patients and caregivers, centering accessibility and usability.	
Tasks: 1. Select UI components that are easy to use/understand for dementia patients 2. Create a simple design on Figma to finalize the UI decisions 3. Implement UI for home page 4. Implement UI for login and register pages for two account types (patient, caregiver) 5. Implement UI for profile pages for two account types (patient, caregiver) 6. Implement UI for forgot password page 7. Implement UI for patient and caregiver dashboards 8. Implement UI for notifications page 9. Implement UI for link management page 10. Implement UI for reminder management page 11. Implement UI for mood check-in page 12. Implement UI for daily summary page 13. Implement UI for cognitive games page 14. Implement UI for patient monitoring page 15. Implement UI for navigation page	
Deliverables: Complete frontend of the project, UI mockups in Analysis and Requirements Report	

Table 4.4: *Work Package 3*

WP 4: Backend Development	
Start Date: November 2025	End Date: March 2026
Leader: Elif Ceren Çelik	Members Involved: All members
Objectives: Implement the backend logic to handle the application logic and ensure communication between the mobile application, backend server, database components and AI module.	
Tasks: 1. Design the backend architecture 2. Implement API endpoints for application communication 3. Implement authentication services 4. Support link management logic through backend services 5. Support safe-zone monitoring and navigation logic through backend integration	

6. Support reminder management logic 7. Implement notification, alert and SOS logic 8. Implement database-backend communication logic 9. Integrate backend with MoodAI 10. Ensure secure data management, compatible with privacy-first logic 11. Implement basic error handling logic
Deliverables: Complete backend of the project

Table 4.5: *Work Package 4*

WP 5: Database Design and Implementation	
Start Date: October 2025	**End Date: February 2026**
Leader: Elif Ceren Çelik	**Members Involved: Ahmet Yağız Sarıdoğan, Elif Ceren Çelik**
Objectives: Design and implement a scalable and structured database that is compatible with privacy-first principles.	
Tasks: 1. Decide what is going to be stored on the database to ensure maximum data privacy and security 2. Determine the encryption methods that are going to be applied to the data at rest 3. Identify the core entities and their relations 4. Design the database components 5. Determine primary keys, foreign keys etc. 6. Create database tables according to the design 7. Apply rules for data consistency and integrity 8. Add basic security measures for data storage	
Deliverables: Complete database system of the project	

Table 4.6: *Work Package 5*

WP 6: AI and Data Processing Integration	
Start Date: December 2025	**End Date: March 2026**
Leader: Ayça Candan Ataç	**Members Involved: Ayça Candan Ataç, Irmak İmdat**
Objectives: Complete the MoodAI module, ensuring it is trained and fine-tuned with the proper data and is able to detect abnormal mood according to the patient's data.	
Tasks: 1. Determine the data sources to give MoodAI	

2. Select the model to train and fine-tune 3. Find a useful open source dataset to complete the model's initial training 4. Preprocess the dataset to extract useful information and be compatible with tabular data type 5. Train the model using an initial dataset 6. Fine-tune the model with patient data 7. Evaluate model behavior 8. Integrate mood analysis mechanisms into the system 9. Determine what rules and parameters will affect the anomaly score 10. Define the rules and thresholds for detecting abnormal status 11. Connect AI outputs to the backend (to alert and summary logic) 12. Ensure the data exchange with MoodAI is secure and compatible with privacy-first principles. 13. Test the performance of the MoodAI outputs and apply refinement methods if the performance does not meet system expectations
Deliverables: MoodAI module of the project

Table 4.7: *Work Package 6*

WP 7: Privacy and Security Considerations	
Start Date: November 2025	**End Date: January 2026**
Leader: Emine Noor	**Members Involved: Emine Noor, Irmak İmdat, Ayça Candan Ataç**
Objectives: Define and implement the privacy and security considerations to ensure privacy-first approach.	
Tasks: 1. Classify data types as sensitive and insensitive 2. Determine which data to store/transit 3. Determine data access based on user types 4. Design the system compatible with data minimization principles 5. Determine the encryption and security principles for data at rest and data in transit 6. Review ethical, professional, and legal requirements 7. Add clear permission requests to the UI for every data access/usage scenario	
Deliverables: Defined privacy and security requirements, Access control and data protection definitions	

Table 4.8: *Work Package 7*

WP 8: Safe-Zone Monitoring and Response System	
Start Date: November 2025	**End Date: March 2026**

Leader: Irmak İmdat	Members Involved: Emine Noor, Irmak İmdat
Objectives: Implement safe-zone and location monitoring system that allows the tracking of the patient location, creates alerts if the patient is out of the safe-zone and navigates the patient back to the safe-zone.	
Tasks: 1. Define safe-zone configuration details (how many safe-zones can be created per patient etc.) 2. Determine the location monitoring process by deciding when the active tracking starts, when the caregiver is allowed to view the location of the patient etc. 3. Implement safe-zone configuration system 4. Implement safe-zone alerting system 5. Implement active tracking and location sharing systems 6. Implement navigation system to get the patient back into a safe-zone 7. Test the safe-zone and location monitoring systems	
Deliverables: Secure location tracking and navigation system, safe-zone configuration implementation	

Table 4.9: *Work Package 8*

WP 9: Testing and Validation	
Start Date: February 2026	End Date: May 2026
Leader: Irmak İmdat	Members Involved: All members
Objectives: Upgrade the final application to be more robust and trustworthy under expected scenarios by testing and validating it.	
Tasks: 1. Determine test cases by analyzing functional and non-functional requirements 2. Complete unit testing of system components 3. Complete integration tests across frontend, backend, database and AI modules 4. Evaluate system robustness and make the required changes to fix identified issues 5. Perform a final test to verify the fixes made 6. Confirm the application is ready for deployment	
Deliverables: Validated frontend and backend, robust and trustworthy mobile application	

Table 4.10: *Work Package 9*

WP 10: Deployment and Finalization	
Start Date: April 2026	**End Date: May 2026**
Leader: Ahmet Yağız Sarıdoğan	**Members Involved: All members**
Objectives: Ensure the application is ready, finalize and present the completed application.	
Tasks: 1. Unite all system components and perform final checks 2. Complete the system setup and deployment configurations 3. Get demo and presentation materials ready 4. Complete final presentation and demo 5. Finish project documentations and submissions	
Deliverables: Complete working prototype of the application, Demo presentation	

Table 4.11: *Work Package 10*

4.4. Ensuring Proper Teamwork

The multi-disciplinary nature of the ReMind System requires the project team to work together effectively in order to successfully complete the project. To achieve this, the project team implemented a formal collaborative model based on clearly defined roles and responsibilities, openness and transparency, and continual coordination among team members.

The project team defined work packages at the commencement of the project. Each work package was then allocated to a team member who was the lead technical expert in the area covered by the work package; however, it was also expected that team members would have some level of secondary familiarity with all aspects of the project in order to minimize the risk of project dependencies.

Regular weekly team meetings are conducted to monitor progress toward the project goals, identify and review any integration challenges that arose from collaborative development, and ensure that the project met its milestones and deliverables.

To facilitate collaboration and teamwork within the project team, version control and collaboration tools such as a common Git repository are used to track changes to the source code and documentation, manage tasks, and provide a mechanism for quality assurance through issue tracking and pull requests. Each major design and implementation decision made during the course of the project was documented and subjected to review and approval by the project team to ensure a high degree of consistency and traceability among the various components of the system.

In cases where disputes or disagreements arose among team members regarding the direction of the project, these issues are openly discussed. Consensus-based decision-making is the preferred method for resolving disagreements. When consensus could not be achieved, decisions are made through a voting process using a simple majority vote. In extreme cases where additional guidance is required, the project team sought input and direction from the project supervisor.

This structured teamwork model allowes for greater accountability among team members, reduces the likelihood of integration errors, and supports the project team in delivering a comprehensive and reliable system on time.

4.5. Ethics and Professional Responsibilities

As a means of respecting patients' right to self-governance while limiting the invasive nature of monitoring ReMind does not use continuous surveillance but instead uses event based methods such as exiting safe zones and detecting anomalies. In order to respect patients' rights to self-governance patients will be clearly informed when any features of the monitoring aspects of ReMind are active and they will have to provide consent prior to allowing caregivers to link their accounts, collect data and share data.

Data privacy and security are viewed as an obligation to do ethically. As a result of privacy by design ReMind will implement measures to protect privacy through minimization of data collected performing all AI related functions locally to prevent the transmission of personal data (on-device processing); using encryption and secure communication protocols to encrypt the storage of sensitive health and location data and by complying with all provisions of the General Data Protection Regulation (GDPR) and Turkey's Personal Data Protection Law (KVKK).

The development team views professional accountability as a critical component of the development process of ReMind. The team recognizes the limitations of AI-related components (MoodAI), specifically the anomaly detection module is intended to function as a decision support mechanism; not as a medical diagnostic tool therefore, the team does not intend to supplant the professional judgment of a healthcare provider. All potential risks associated with AI-based decision-making tools such as false positive rates, false negative rates and bias in algorithms are being taken into consideration and the team is developing mechanisms to mitigate these risks. The mechanisms include configuring the level of sensitivity of alerts and implementing escalation thresholds all of which can help to limit or eliminate harm. By clearly articulating the limitations of ReMind and providing human oversight, the development team intends to follow the guidelines of responsible AI practices and the standards of ethical software engineering.

4.6. Planning for New Knowledge and Learning Strategies

In order to successfully implement the ReMind project, the team will need to gain knowledge in several domains outside of normal undergraduate course work: domain knowledge related to mHealth and wearables, regulatory knowledge and technology knowledge. The team has developed a structured, continuous learning process which is integrated into their overall project plan in order to address the technical, domain, and regulatory challenges they anticipate.

These key areas of learning include: mobile health and wearable technologies, on-device machine learning frameworks, privacy preserving system designs and cognitive impairment user focused UI/UX principles. Additionally, the team learnt about relevant data protection regulations (GDPR) and standards (KVKK and WCAG 2.2 Level AA).

As such, in order to minimize learning risk, the team will employ an incremental learning and validation strategy. Specifically, the team has and will study official documentation, literature and resources provided by developers prior to implementation of each component then test the functionality of each component individually to determine technical feasibility prior to integrating components into a fully functioning system. For example, testing of wearable data access, geofenced behavior, and on-device AI performance will occur separately so that constraints can be identified as early as possible.

Internal communication will facilitate collaboration between team members regarding problem solving and documentation of findings and insights as they develop. As new insights are gained, existing design decisions may require revision to ensure best practices are reflected in the development process. A proactive learning strategy enables the team to respond to unforeseen technical issues, minimize risk due to knowledge gaps and create a comprehensive, ethically acceptable and functional solution.

5. Glossary

AI: Artificial Intelligence
API: Application Programming Interface
AES: Advanced Encryption Standard
BPM: Beats Per Minute
FCM: Firebase Cloud Messaging
GDPR: General Data Protection Regulation
GPS: Global Positioning System
HCI: Human–Computer Interaction
HR: Heart Rate
HRV: Heart Rate Variability
ISMS: Information Security Management System
KVKK: Kişisel Verileri Koruma Kanunu
ML: Machine Learning
mHealth: Mobile Health
OS: Operating System
SOS: Emergency distress signal requesting immediate assistance
TLS: Transport Layer Security
UI: User Interface
UX: User Experience
WCAG: Web Content Accessibility Guidelines
Wi-Fi: Wireless Fidelity

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