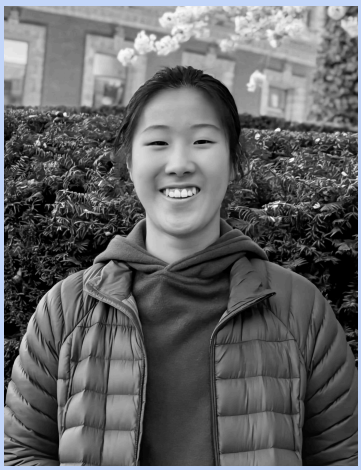
# Pillora

**Project Design Document**

**Carys Leung, Philippa Flintoff, Judy Chourbaji, Ying Yan Chen**

**Mentors:** PM: Cindy Evans, Tech: Farah Pankhania

# Meet the Team



## Carys Leung

Backend Developer

## Philippa Flintoff

Frontend Developer

## Judy Chourbaji

Product Manager

## Ying Yan Chen

Database Developer

# Project Overview

## Problem Statement

**Managing medications** is primarily a tracking and coordination challenge for older adults and people with chronic conditions. **Today, there's no single, reliable source of truth for "what pills were taken, when, and their number."** Schedules can be complex (varying times, Pro Re Nata (PRN) doses, titrations), generic reminder tools don't adapt to real behavior, and caregivers lack a definitive way to confirm intake retrospectively. When a dose is taken late or early, the rest of the day's plan often becomes unclear, creating confusion that can later **lead to missed or double doses.**

## Problem Objectives

**Build "Pillora" a user-centred mobile app that creates a trustworthy, shared record of medication intake for patients and caregivers.**
Primary focus: accurate, real-time tracking and shared visibility of every dose.
Secondary benefit: reduce missed and double doses through safeguards and adaptive reminders.

**Concretely, the app will:**

### Intake tracking with ML assistance

- Uses on-device **ML** to help recognize pills/packages, read labels, match to the regimen, and **validate entries**.
- Each intake automatically logs a **timestamp**, **medication name, strength,** and optional photo or note.

### Dual-sided confirmation

- A **Caregiver Mode** shows the live log for **two-party confirmation** and an acknowledgement trail.
- Caregivers can **request a check-in** if no confirmation arrives.
- The dashboard provides summaries, real-time status, dual confirmations, alerts, and an exportable adherence report.

### AI- driven scheduling and reminders

- **Builds schedules** from label scans or manual entry.
- If a dose is off-schedule, the app **recalculates** safe intervals and updates calendars/ reminders.
- Reminders **adapt to behavior** (snooze, preferred time), escalate if overdue, and suggest rescheduling.

### Privacy and reliability

- Offers **user-controlled sharing**, offline logging, and secure sync with clear audit trails.
- Provides an **accessible UI** with large tap targets, high contrast, and optional voice prompts for reliability.

# User Research

## Global Stats

**50%** **adherence to long-term therapies** in developed countries. [1]

This means that 1/2 patients does not take their medications as prescribed, increasing hospitalizations, and raising healthcare costs.

**33%**

of at-home intakes **involve errors** (missed doses or wrong meds). [3]

**1 in 30**

patients experience medication-related harm, **often preventable**. [4]

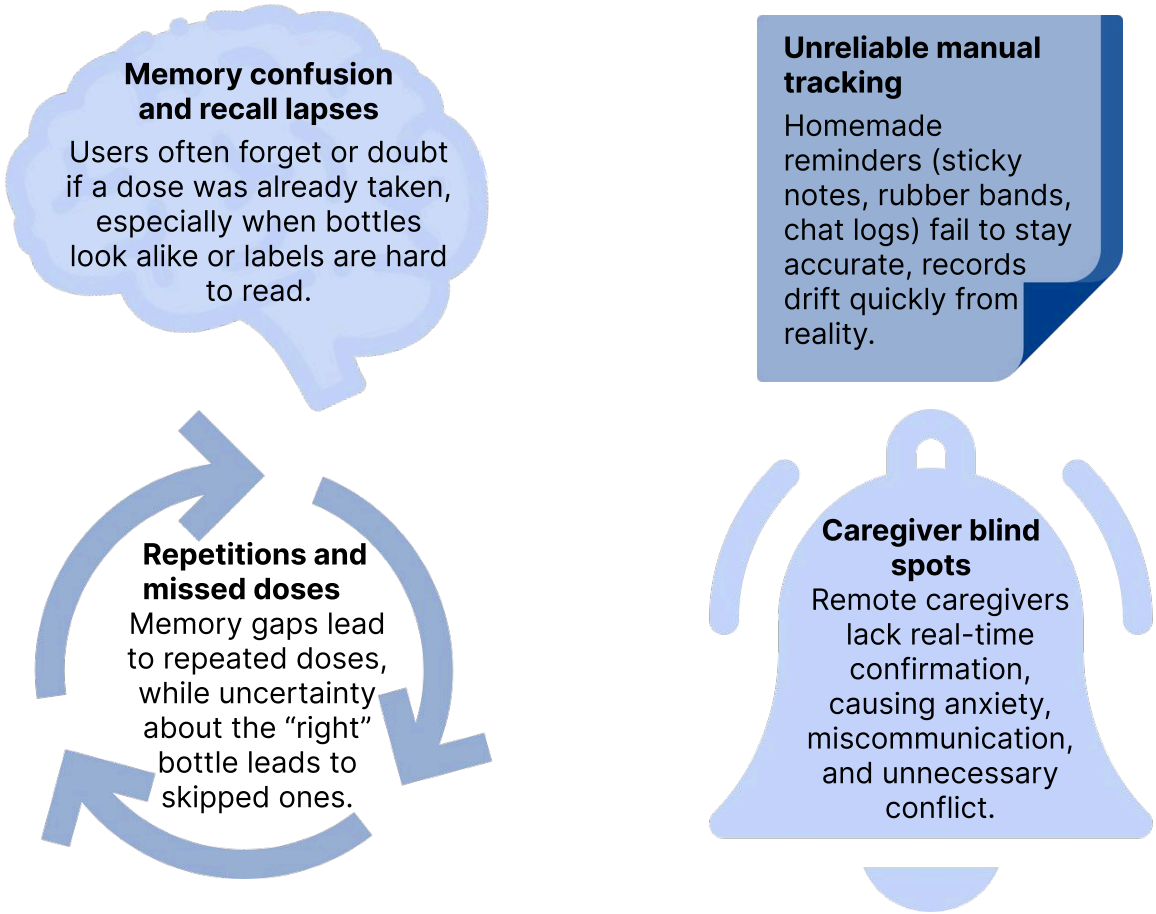
**1/3** older adults - in Europe, take **>5** medications

Managing such complex regimens **increases the risk of mistakes.** [2]

Importantly, evidence shows that **digital reminders and logging tools can improve adherence compared to usual care**, highlighting the potential for technology-driven solutions [5].

## Diary Study

**Method**: *Before introducing any app, we shadowed two older adults and one family caregiver for 7 days during daily routines (home, errands, video calls). These are the observed behaviors and breakdowns:*



# User Interviews

### Patient 1 - 78 years old woman

" By midday **I can't remember if I already took** the white tablet with lunch. Last month I think I took an extra BP pill. Now I'm anxious every lunchtime."

"I put rubber bands on bottles I've 'done,' but I forget to move the band. For **notebooks I end up writing after the fact,** or not at all, so I don't trust it."

### Patient 2 - 71 years old man

"My mornings slide, if I take the first ones at 11, I'm **unsure what that means for the afternoon ones**. I don't want to do the math."

"It happens also **when I travel**, with time difference I can't tell what is the new appropriate time to take them."

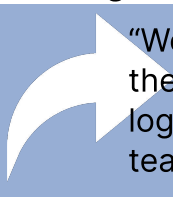
### Caregiver 1 - son of a patient

"We use a group chat with my brother. **People forget to update it**, or they type later, then we can't tell if they took theire medicine or not."

"Pharmacy switched packaging last week. On video, **I couldn't tell which bottle she had**. We argued because of it."

### Caregiver 2 - professional caregiver, 54

"I look after **five clients daily**, each with different medications. The hardest part is **keeping track** when someone insists they already took their dose, but I can't verify it."



"We write notes on paper and update them later. I wish there was a reliable log I could trust, shared across the team."

## What these interviews reveal:

1. The core breakdowns are **remembering whether a dose was taken** and **verifying the right medication**, worsened by look-alike packaging, tiny labels, variable routines, and off-schedule doses.

2. **Home workarounds are brittle**: pill boxes, rubber bands, sticky notes, and chat logs fail under real conditions.

3. The consequences are **emotional strain** (anxiety, conflict, fatigue) and **safety risks** (missed doses, duplicates, and incorrect timing).

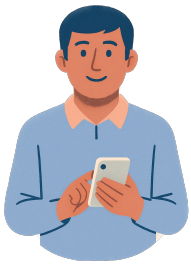
# Synthesis

## Personas

*To better understand user needs, we created fictional personas that represent key stakeholders in medication management. These made-up characters illustrate typical goals, pain points, and requirements, helping to ground the design in real-world contexts.*

Primary
**Evelyn**
**Patient, 73**

- **Goals**: Know if/what I took; be sure it's the right med; see a simple today view.
- **Pain points:** Forgetfulness; similar-looking meds; hates typing.
- **Needs:** One-tap "Taken" with ML verification (pill/label OCR/ imprint match), large text, clean timeline.



Primary
**Samir**
**Caregiver, 46**

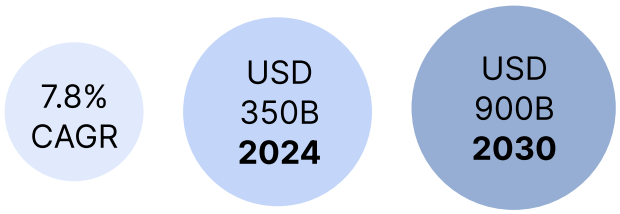
- **Goals:** See and confirm intakes remotely; get notified only when needed.
- **Pain points:** No definitive proof of intake; over- or under-alerting.
- **Needs:** Dual-sided confirmation, real-time feed, concise alerts, exportable summary.

Secondary
**Dr. Nguyen**
**Clinician**

- **Goals:** Quick adherence snapshot; spot risky gaps.
- **Needs:** Trustworthy log, audit trail, optional summary for records.

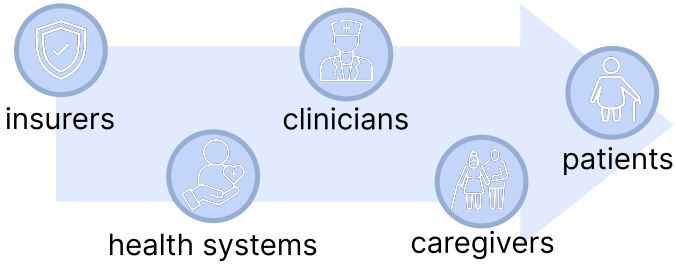
# Market Scope

## Market size and Growth [6]




**UK market example:** NHS App reports 37.4M registered users and 61.5M prescriptions ordered annually, signaling high comfort with digital health journeys.

## Key stakeholders




## Competitive Landscape

### OS-native baselines

Apple Health (iOS): Add/log meds, schedule reminders, camera-based label capture, interaction info. [7]

Samsung Health (Android): Medications tracking with visual search to scan pill bottles, adherence dashboard. [8]

### Standalone adherence apps

Medisafe: Evidence from an RCT shows small improvements in self-reported adherence (hypertension). Signals consumer demand for digital adherence aids. [9]

### Hardware/connected devices

Hero (countertop dispenser): ~$44.99/mo (+ one-time fee). [10]

MedMinder (automated dispenser): $125/mo typical list price. [11]

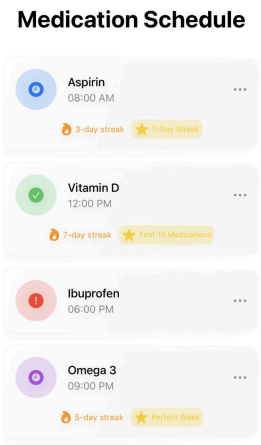

## Gap / Opportunity

Mainstream options remind and log, but typically lack two-sided (patient & caregiver) confirmations and robust ML verification of the specific medication taken; hardware routes are costly and higher-friction versus a phone-first approach. (See [7][8][10][11].)

# Key Features

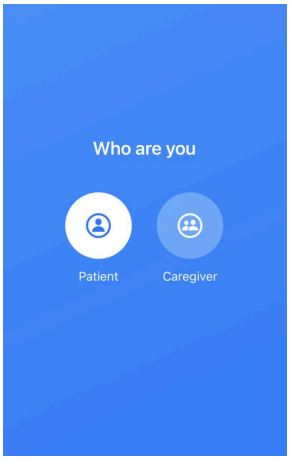
*Here are the features we focused on for this project given the short timeframe (a separate page will cover later implemetations).*

- **Verified medication identity:** On-device ML verifies medication identity before logging, producing an accurate, timestamped record that consolidates all intakes in one place.




- **Shared patient–caregiver visibility:** Shared visibility for patient and caregiver with dual confirmation: both see the same synchronized timeline, and the caregiver can register confirmation on their side; an audit trail preserves who confirmed what and when

- **Reminders, timing support & safeguards:** Behavior-aware reminders reduce noise and stop once intake is recorded; off schedule support updates the next appropriate time while respecting safe intervals; duplicate-dose safeguards detect likely repeats and require explicit confirmation.

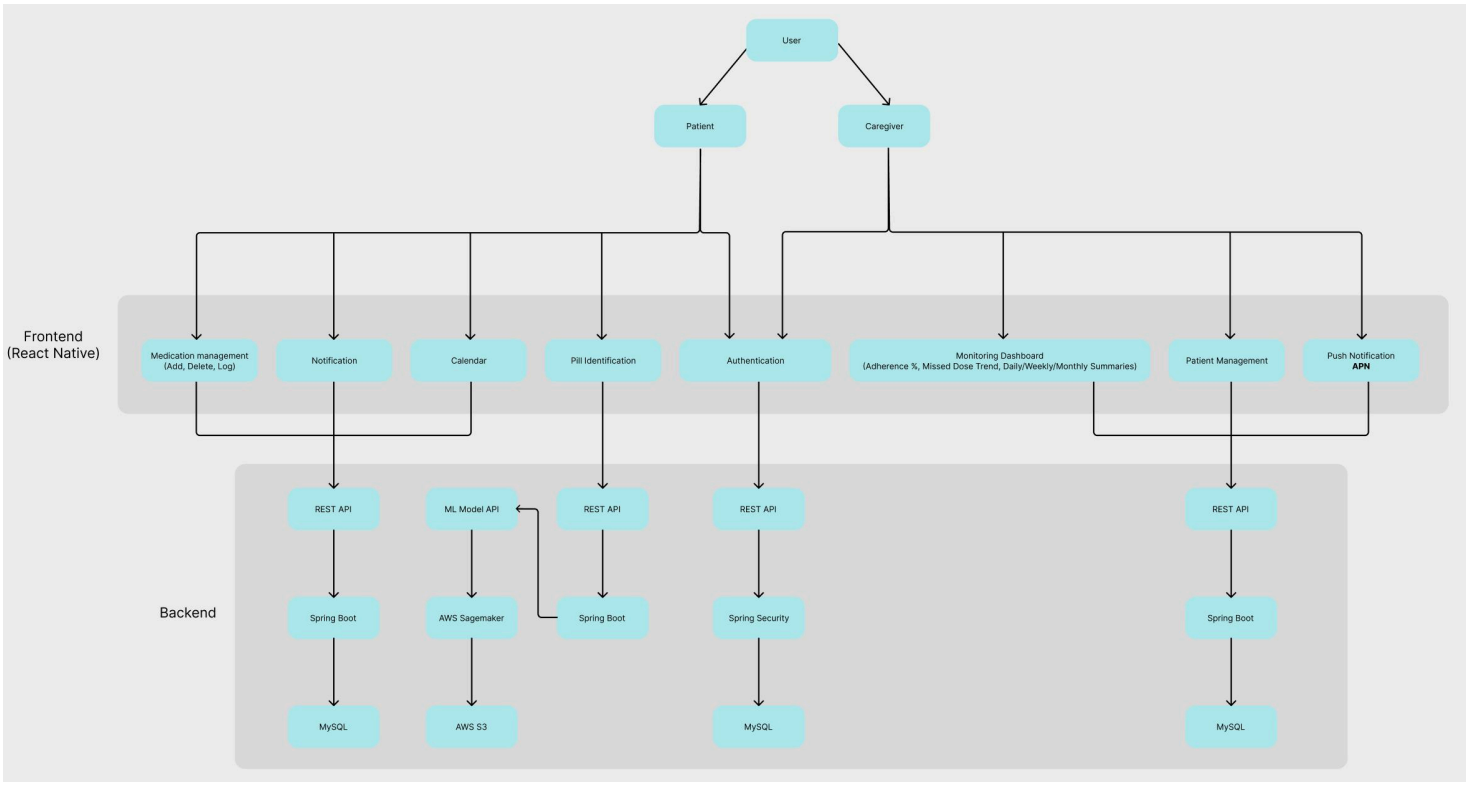



- **Privacy, reliability & control:** Privacy, reliability, and control by design: user-managed sharing permissions, offline first operation with secure sync, clear data-use disclosures, and exportable summaries for clinical conversations.

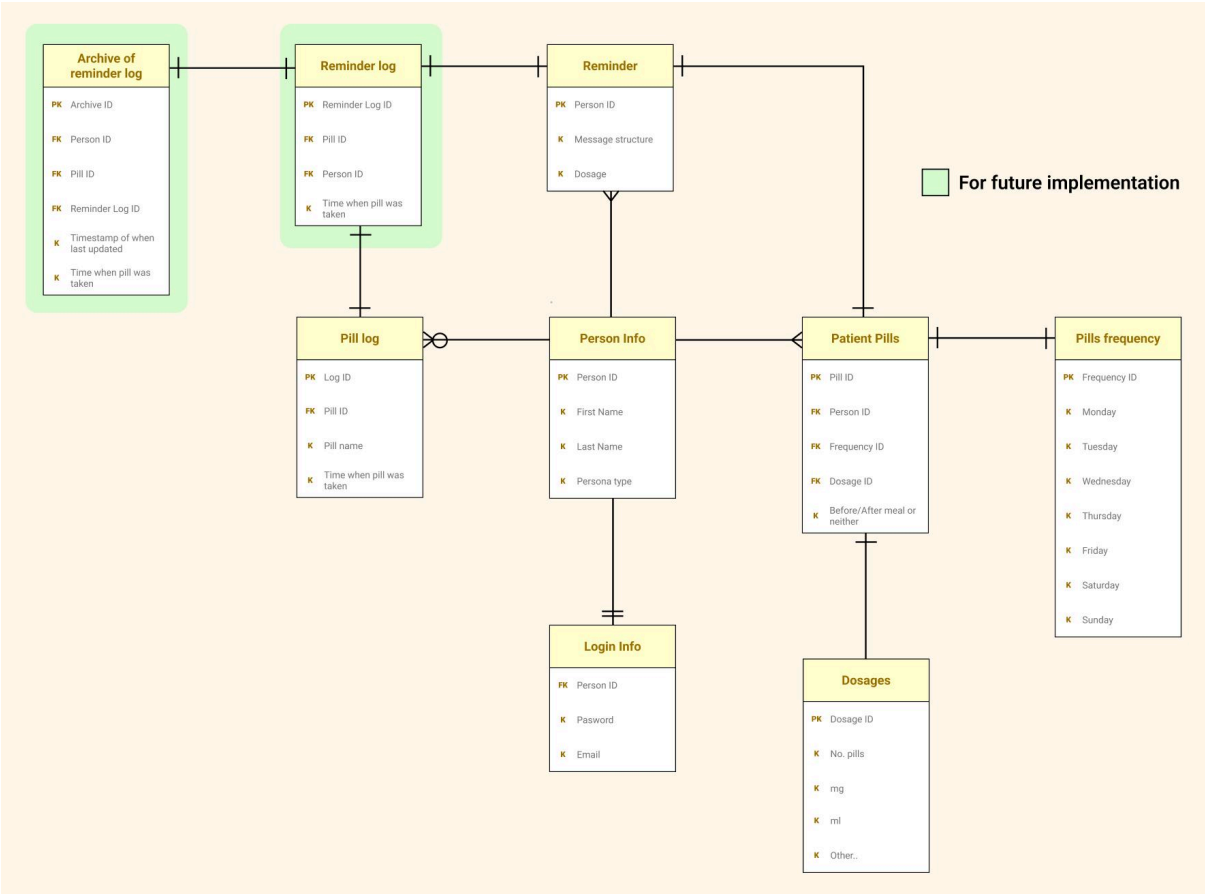
- **UX/UI principles:** Designed with older adults and caregivers in mind, the interface emphasizes accessibility and ease of use: large interactive targets and readable typography, high-contrast status cues, and a streamlined capture-to-log flow with immediate feedback. Notifications are concise and actionable, iconography is consistent, and brief tooltips explain schedule adjustments without adding clutter.

# Technical Design

## High Level Design




## Low Level Design



# Technical Design

## Frontend Tools and Programming Languages

The frontend of our application was developed using Xcode and Swift, chosen for their native integration within the Apple ecosystem and the ease of development across Mac and iPhone platforms.

### XCode

**Advantages:**

- Seamless integration with Apple's development ecosystem, efficient workflows from coding to testing and deployment
- Includes a built-in iPhone simulator, streamlines testing and debugging without requiring physical devices
- Comprehensive toolset for UI design, debugging, and performance profiling.
- Many learning resources available online, including tutorials, documentation, and community support

**Limitations:**

- Limited development - Mobile app is only available for Apple devices

### Swift

**Advantages:**

- Concise, readable, and beginner-friendly syntax
- High performance, comparable to C-based languages
- Strong safety features, such as optional handling and type inference, reduce runtime errors.
- Modern and well-supported, aligning with current iOS development best practices.

**Limitations:**

- Apple ecosystem dependency
- Rapid update of the language, which can occasionally cause compatibility issues with older projects
- Smaller community support compared to more mature, cross-platform languages such as JavaScript or Kotlin

## Frontend scalability

The frontend is an iOS-native application built using Swift and developed in Xcode. This design ensures high performance and stability on Apple devices but has scalability implications depending on deployment scope.

**Local Scale** (small group of patients or carers testing the app):

- Swift and Xcode allow for rapid iteration of design and highly optimised performance on Apple hardware
- Deployment through direct device installation is simple and reliable
- Scalability concerns are minimal, as the app runs natively on users' devices with minimal server dependency

**Regional Scale** (hospital network or local health initiative):

- App can easily be distributed through the Apple App Store, allowing controlled access and updates
- Swift's maintainable codebase allows multiple developers to work in parallel, though code versioning and build management become critical
- Apple-only ecosystem introduces limitations — Android users cannot access the app, reducing adoption potential in mixed-device environments

# Technical Design

## Frontend scalability

**Global Scale** (public release or enterprise integration):

- Lack of cross-platform support becomes a major bottleneck; app would need to be rebuilt using a cross-platform framework (e.g., Flutter or React Native) or paired with an Android equivalent to achieve full market reach.
- Swift scales technically, but team scalability and device diversity become significant challenges
- Cloud-based CI/CD tools (e.g., GitHub Actions, AWS CodeBuild) could automate testing and deployment for larger teams.

## Backend Tools and Programming Languages

The backend was implemented using Spring Boot, MySQL, and AWS SageMaker to deliver a robust, scalable, and secure infrastructure capable of handling business logic, data management, and machine learning functionality.

### Spring Boot

**Advantages:**

- Comprehensive framework, offering built-in modules like Spring Security, Spring Data, and Spring Actuator
- Highly supported and well-documented, with an active community and extensive resources
- Simplifies REST API creation, configuration management, and dependency injection
- Provides built-in endpoints for metrics, application health checks, and other operational insights
- Seamless integration with databases such as MySQL

**Limitations:**

- Steeper learning curve for developers new to the Spring ecosystem
- Relatively high memory usage, which can impact lightweight or resource-constrained deployments

### MySQL

**Advantages:**

- Mature and stable relational database management system widely used across industries
- Easy visualization and management through the MySQL Workbench GUI
- Scalable and reliable, suitable for production environments and future data expansion
- Open-source with strong community and enterprise support

**Limitations:**

- Rigid schema design, making it less flexible than NoSQL alternatives for unstructured data
- Performance limitations under extremely high concurrent loads compared to distributed databases
- Manual scaling and configuration may be required for large-scale deployments

# Technical Design

## Backend Tools and Programming Languages

**AWS SageMaker**
**Advantages:**

- End-to-end machine learning platform for building, training, and deploying models at scale.
- Industry-grade reliability, used by major enterprises such as Amazon, Expedia, and Samsung.
- Secure integration via AWS Identity and Access Management (IAM).
- Flexible deployment options, allowing model endpoints to be accessed via API Gateway + Lambda or directly through the AWS Amplify SDK / AWS iOS SDK.
- Supports real-time inference, such as object detection for camera-based applications.

**Limitations:**

- High operational cost, especially when training or deploying large models.
- Requires AWS-specific knowledge, increasing the learning curve for new developers.
- Latency concerns when communicating with remote endpoints from mobile apps.
- Limited offline capabilities, as inference requires a live network connection to the SageMaker endpoint.

## Backend Scalability

**Local Scale**

- Spring Boot can run on a single machine or local server, easily handling a small number of concurrent users.
- MySQL performs efficiently for small datasets and limited queries.
- AWS SageMaker endpoints can be called directly for testing ML features, though costs may be higher per request.

**Regional Scale**

- Spring Boot services can be containerised (Docker) and deployed on AWS Elastic Beanstalk or Kubernetes clusters, enabling horizontal scaling as the user base grows
- MySQL can be upgraded to AWS RDS (Relational Database Service) with read replicas to handle higher query loads and improve redundancy
- API Gateway + Lambda integration with SageMaker enhances security and request management.
- Monitoring tools (e.g. Spring Actuator, AWS CloudWatch) can ensure performance consistency across multiple regions

**Global Scale**

- Spring Boot microservices can be deployed across multiple regions using AWS Elastic Kubernetes Service (EKS)
- MySQL can be replaced or supplemented with Amazon Aurora
- AWS CloudFront and API Gateway can provide global content distribution and API caching to minimise latency
- SageMaker can serve multiple endpoints across regions, but cost and model version management become major scalability considerations

# Privacy Features

## Controlled Sharing

**Patient-initiated connection:** In the app settings, the patient sends a request to connect with a caregiver.

The caregiver receives a **unique code**, which the patient then enters to establish the link.

This ensures connections are mutual, verified, and not open to other users.

**Patient priority:** The patient fully controls access, since it is their health data. No caregiver action can override patient approval.

## Access Restrictions

**Role-based visibility:** Caregivers only see what the patient approves; clinicians or institutions receive only anonymized summaries.

**Screenshot protection:** Caregivers cannot take screenshots of patient data.

If a caregiver wants a **record**, they must **send a request** through the app → the patient must validate and approve before a downloadable PDF/ summary is generated.

This **prevents uncontrolled data sharing** and keeps ownership with the patient.

### Authentication & Security

- JWT-based authentication: The backend generates secure JSON Web Tokens for session management.
- Removes the need to repeatedly send username/password in API requests.
- Tokens are time-limited and renewable, ensuring protection against unauthorized use.

### Data Protection

- End-to-end encryption of all medication logs and confirmations (AES-256 at rest, TLS/HTTPS in transit).
- Offline-first logging with secure sync once online, preventing data loss.
- Audit trails document who accessed or confirmed data and when, reinforcing accountability.

### GDPR compliance

- Pillora is designed with privacy by design and privacy by default, in line with GDPR requirements.
- **Data minimisation:** Only essential information is collected (medication logs, timestamps, confirmations).
- **User ownership:** Patients remain the primary data controllers, they decide who can access or download their records.
- **Explicit consent:** Caregiver and clinician connections require active approval by the patient.
- **Right to be forgotten:** Users can request full data deletion at any time.
- **Secure processing**: All personal data is encrypted, access-logged, and stored in compliance with EU standards.

# Financial Plan

## Business Model

Pillora adopts a **freemium** model to ensure accessibility for patients while generating revenue through **premium caregiver features**, **clinical integrations**, and **B2B partnerships.**
The goal is to balance affordability for individuals with long-term sustainability through institutional collaborations.

**Revenue Streams:**

**Freemium Tier (Patients)** – Free access to basic tracking, reminders, and personal medication logs.

**Premium Tier (Caregivers)** – £4.99/month subscription unlocking dual-confirmation mode, adherence reports, and live status dashboards.

**Clinical Partnerships** – Hospitals, pharmacies, and insurance providers can license anonymized adherence data and use API integrations for £10,000–£25,000/year per institution.

**B2B Licensing** – Integration into existing healthcare platforms or white-label versions for chronic care management programs.

## Projected Costs (Year 1-3)

| Category | Description | Year 1 | Year 2 | Year 3 |
|---|---|---|---|---|
| Development | App design, ML model training, backend, QA | £65,000 | £25,000 | £15,000 |
| Operations | Hosting, database, security compliance (GDPR, NHS standards) | £12,000 | £15,000 | £18,000 |
| Marketing & Outreach | Launch campaign, partnerships, ads | £20,000 | £25,000 | £30,000 |
| Support & Maintenance | Tech support, updates, content | £10,000 | £12,000 | £15,000 |
| **Total** | | **£107,000** | **£77,000** | **£78,000** |

## Revenue Projections

Based on conservative adoption:

- 5,000 premium caregivers by Year 2 (£4.99/mo → ~£300,000/yr)
- 3 institutional partners in Year 3 (£15,000 avg each → £45,000/yr)
- Freemium users serve as organic marketing and potential upsell base.

→ Break-even expected by late Year 3 with 10–12K monthly active users.

## Monetization Rationale

- Most adherence apps (e.g., Medisafe, MyTherapy) rely on ad-supported or partnership models, but Pillora differentiates through caregiver-centric dual confirmation and ML-verified medication tracking.
- The subscription + institutional hybrid ensures financial stability without compromising user trust or privacy.
- Predictable recurring revenue allows reinvestment into AI accuracy, UX refinement, and clinical validation.

# Future Implementations

*While Pillora was initially designed with older adults and caregivers in mind, the next phase of development aims to broaden accessibility for users of all ages and lifestyles, from chronic patients to individuals managing short-term treatments or supplements.*

## Expanding beyond pills

Future iterations will support a wider range of medication formats (such as inhalers, syringes, and topical treatments) through flexible tracking methods. Each medication will have its own counter, appearing only when relevant (e.g., weekly injections), providing a more personalized and intuitive experience.

## Smarter, More Inclusive AI Dataset

The current prototype uses an open-source pill recognition dataset that we manually cleaned due to time constraints. In future versions, we plan to build a custom, large-scale dataset with verified data from pharmacies and anonymized user contributions. This will enable a more accurate and inclusive AI model capable of identifying diverse pill types and brands globally.

## New Features and Functionalities

- **Multilingual label translation:** Automatically translate medication packaging and instructions to reduce language barriers, helping travelers or immigrants understand prescriptions safely.
- **Pill information on demand:** Users can scan any pill to instantly view dosage, usage, and potential side effects, even without adding it to their schedule.
- **Symptom-based guidance:** By describing symptoms, users could receive intelligent recommendations from the app on which prescribed medication is appropriate to take.
- **Pharmacy Integration:** The app will track how many doses remain and send refill alerts. Through pharmacy partnerships, users will see stock availability, pre-order options, and delivery updates directly in the app.
- **Caregiver messaging & support:** Integrated chat and voice message features will allow caregivers to check in, send encouragement, or clarify doubts securely within the platform.
- **Use ML in Pillora Statistics:** We could use AWS Sagemaker to make a ML tool which could analyse the patient's history of pill taking to better inform the caregiver when serious issues arise.

## Using Human Psychology

- **Reward System:** For future implementation, the app will include a reward system to encourage regular use and engagement. User actions, such as checking in daily, completing tasks, or participating in activities, will be tracked by the backend. Rewards could include points for each activity, badges for milestones (like a week of consistent use), streak rewards for consecutive days of engagement, levels to show progress, virtual tokens that can be exchanged for small prizes, and special coupons or discounts for services they use. The app's frontend, built in SwiftUI, will show earned rewards, progress bars, and badges in a clear and friendly way. By keeping the reward system simple and visually appealing, it will motivate elderly users to stay active, complete tasks, and feel a sense of achievement while using the app.

# Appendix

## Sources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## Project management and collaboration

Throughout the project, our team maintained consistent communication and organization to ensure smooth progress and accountability. We held weekly meetings with our mentors, where we presented updates, discussed feedback, and aligned on next steps. In addition, we created a shared group chat with mentors for quick coordination and clarification between sessions. Within the team, we communicated through a dedicated workspace, holding three to four calls per week during intensive development phases to review progress, divide tasks, and resolve technical issues collaboratively.

One of our main challenges was managing time zone differences, as team members were spread across Hong Kong, the United States, Europe, and the Middle East. Despite this, we successfully coordinated by making schedule compromises and establishing flexible work blocks that overlapped across regions. This required a high level of adaptability, mutual respect, and proactive communication, which ultimately strengthened our teamwork and helped us deliver a coherent and functional final product.