

# Analysis Report

## 1. Introduction

In today's fast-paced world, maintaining a balanced diet is a significant challenge due to busy schedules and a lack of sustained motivation. Research indicates that approximately 69% of users abandon health apps within the first 90 days due to time-consuming manual data entry and limited personalization [1].

The purpose of this project is to develop NutriGame, an intelligent, gamified mobile application designed to simplify nutrition tracking. NutriGame leverages AI for food recognition (reducing logging time), offers a supportive AI chatbot, and incorporates gamification elements (challenges, points, streaks) and interactions to promote long-term healthy eating habits. The system aims to function as a personal wellness companion rather than a simple calorie counter.

## 2. Current system (if any)

Currently, no single system exists that fully integrates all proposed features of NutriGame. However, the market includes several "Current Systems" that attempt to solve similar problems. An analysis of leading applications reveals the following limitations:

- **MyFitnessPal** [2]: A widely recognized app with a comprehensive database. It relies heavily on manual entry or barcode scanning. It focuses primarily on quantitative data and lacks integrated emotional support or gamification to sustain motivation.
- **Lifesum** [3]: Offers personalized diet plans and health assessments. While effective for structured guidance, it lacks AI-based photo logging features and emotional tracking capabilities.
- **AteMate Food Journal** [4]: Focuses on mindful eating via visual journaling. However, it does not provide nutritional data analysis, calorie tracking, or personalized meal planning.

The current ecosystem lacks a holistic solution that combines automated AI tracking, emotional well-being support, and gamification with interactions. NutriGame is proposed to fill this market gap.

## 3. Proposed system

### 3.1 Overview

NutriGame is a cross-platform mobile application designed to make healthy eating easy, fun, and social. It acts as a personal wellness assistant. The core functionality centers on Intelligent Nutrition Tracking (via text, photo, or manual search), Personalized Planning, AI Chatbot Support, and Gamification.

The system targets individual users (students, professionals) and excludes medical diagnosis or clinical use.

### **3.2 Functional Requirements**

- FR-01 – The system shall generate recommended calorie intake plans based on the user's goals.
- FR-02 – The system shall allow users to log meals using three methods: manual search (users can search for foods in the provided database), natural language input (users can add new foods with nutritional values to the database), and photo upload.
- FR-03 – The system shall estimate calories by recognizing food items from the scanning photos.
- FR-04 – The system shall analyze food descriptions entered by the user and retrieve corresponding nutritional values (e.g., protein, carbohydrate, fat, calorie) from the system's database.
- FR-05 – The system shall track information related to water intake, weight changes, mood, as well as daily calorie intake and burned calories.
- FR-06 – The system shall provide gamification elements by awarding points when users achieve their daily goals.
- FR-07 – The system shall store user profile information, including age, gender, weight, height, goals, dietary preferences, and avatar.
- FR-08 – The system shall track and store users' data including daily meals, mood entries, weight records, and achievements.
- FR-09 – The system shall access the mobile device's camera to allow users to take and upload food photos.
- FR-10 – The system shall allow users to interact with each other.
- FR-11 – The system shall allow users to upload and share their own recipes in their profile.
- FR-12 – The system shall allow users to register and authenticate using email or username/password.
- FR-13 – The system shall maintain daily login streaks and display streak count to users.
- FR-14 – The system shall award badges upon completing specific achievements.
- FR-15 – The system shall allow users to permanently delete their accounts and all associated data.
- FR-16 – The system shall provide push notifications for daily reminders and challenge updates.
- FR-17 – The system shall allow users to edit or delete previously logged meals.
- FR-18 – The system shall allow users to view a daily and weekly nutrition summary.
- FR-19 – The system shall allow users to add other users as friends.
- FR-20 – The system shall allow users to create challenges and invite selected friends.
- FR-21 – The system shall allow invited users to accept or reject a challenge request.
- FR-22 – The system shall allow users to share challenge-related posts within the app.
- FR-23 – The system shall reward the winner(s) of a completed challenge with badges or points.

### 3.3 Nonfunctional Requirements

#### 3.3.1 Performance Requirements

- Under normal network conditions ( $\geq 10$  Mbps), the system must return food image analysis and calorie estimation results within 10 seconds.
- Basic database queries must complete in  $\leq 3$  seconds.
- The architecture shall support at least 150 concurrent active users without performance degradation.
- The system shall handle up to 5,000 requests per day reliably.
- Monthly uptime shall be maintained at  $\geq 90\%$ .
- The acceptable API error rate shall not exceed 1% of total requests, excluding user input errors.
- In case of a system failure, automated recovery shall restore service within 6 hours.
- The system must be able to process at least 10,000 food images per month without exceeding computational or storage limits.
- Image uploads of up to 5 MB must complete in under 3 seconds under standard broadband conditions.

#### 3.3.2 Security & Privacy Requirements

- Encryption: All client-server communication shall be encrypted using HTTPS with TLS 1.2/1.3 [5].
- Data Protection: User data processing shall comply with GDPR [6] and KVKK [7] regulations.
- Authentication: Passwords must be hashed using bcrypt [8]; sensitive data must never be stored in plain text.

#### 3.4 Pseudo requirements

- PR-01 (Development Ecosystem): The entire system stack must be implemented using TypeScript to ensure type safety and code consistency across both the frontend and backend.
- PR-02 (Mobile Framework): The mobile application must be developed using React Native (Expo) to ensure a native experience on both Android and iOS from a single codebase.
- PR-03 (Backend Infrastructure): The backend services must be built on the Node.js runtime using the Express framework.
- PR-04 (Database & ORM): The system shall utilize CockroachDB (PostgreSQL-compatible) for persistent data storage and Prisma ORM for all database interactions.
- PR-05 (AI Integration): The system shall integrate external AI services, including Google Gemini for the conversational agent and Hugging Face Spaces (or equivalent inference endpoints) for food recognition.
- PR-06 (Operating System Support): The mobile application shall support devices running Android 11 or later and iOS 14 or later.

## 3.5 System models

### 3.5.1 Scenarios

- **Scenario 1 (AI Food Recognition Page):** As a user, I want to navigate to the dedicated "Scan Food" page and take a photo of my meal so that the AI automatically identifies the dish and displays its nutritional information (calories, protein, etc.) for me to review before saving it.
- **Scenario 2 (Goal-Based Recommendation):** As a new user, I want to input my current weight and target weight goal in the "Goals Section" so that the system automatically calculates and recommends a daily calorie limit to help me reach my target.
- **Scenario 3 (Social Following):** As a user, I want to visit and "follow" other users' profiles so that I can see their shared recipes, challenges and healthy eating updates on my community feed.
- **Scenario 4 (Challenge & Notification):** As a user, I want to start a "No Sugar Challenge" and have a notification sent to all my followers so they can easily apply and join the challenge with me.
- **Scenario 5 (Recipe Sharing):** As a user, I want to upload my own "High-Protein Oat Bowl" recipe with a photo and ingredients to my profile so that my followers can try it themselves.
- **Scenario 6 (Motivational Chatbot):** As a user, I want to chat with the AI Assistant when I feel discouraged so that it can provide motivational support and personalized tips to keep me going.
- **Scenario 7 (Gamification):** As a user, I want to earn points for hitting my daily calorie and water goals to unlock achievements and keep my motivation high.
- **Scenario 8 (Structured Daily Tracking):** As a user, I want to log my food intake under specific categories such as Breakfast, Lunch, Dinner, and Snack and separately track my glasses of water, so that I can maintain an organized view of my daily nutrition and hydration habits.

### 3.5.2 Use case model

#### 1. Actors

- User (Primary Actor): The individual using the application to manage their nutrition and interact with the community.
- AI Service (System Actor): The internal engine responsible for processing images and generating chatbot responses.

#### 2. Use Case Descriptions

##### A. Fundamental Tools (Tracking & Management)

- UC-01: Set Goals: The user inputs their current weight and target weight to receive a recommended daily calorie limit.

- UC-02: Log Meal (Manual): The user manually searches for or inputs food items into specific categories (Breakfast, Lunch, Dinner, Snack) to track their daily intake.
- UC-03: Log Water: The user records their daily water consumption to track hydration levels.
- UC-04: View Daily Progress: The user views their consumption against their daily calorie and hydration goals.

#### **B. AI Tools (Assistance & Information)**

- UC-05: Chat with Motivational Assistant: The user interacts with the AI chatbot to receive motivation, encouragement, and general wellness advice .
- UC-06: Scan Food for Information: The user takes a photo of a meal to instantly retrieve nutritional information (calories, macros).

#### **C. Social Sharing (Community)**

- UC-07: Follow User: The user follows other profiles to view their updates and shared content.
- UC-08: Share Recipe: The user uploads and publishes their own recipes (photo + ingredients) to their profile for followers to see .
- UC-09: Create/Join Challenge: The user starts a challenge (e.g., "No Sugar Challenge"), which notifies followers, or joins an active challenge.

#### **D. Gamification (Engagement)**

- UC-10: Earn Points: The user automatically receives points for completing daily tasks (e.g., hitting calorie goals, logging water).
- UC-11: View Leaderboard/Badges: The user views their achievements and ranking compared to friends or the global community.

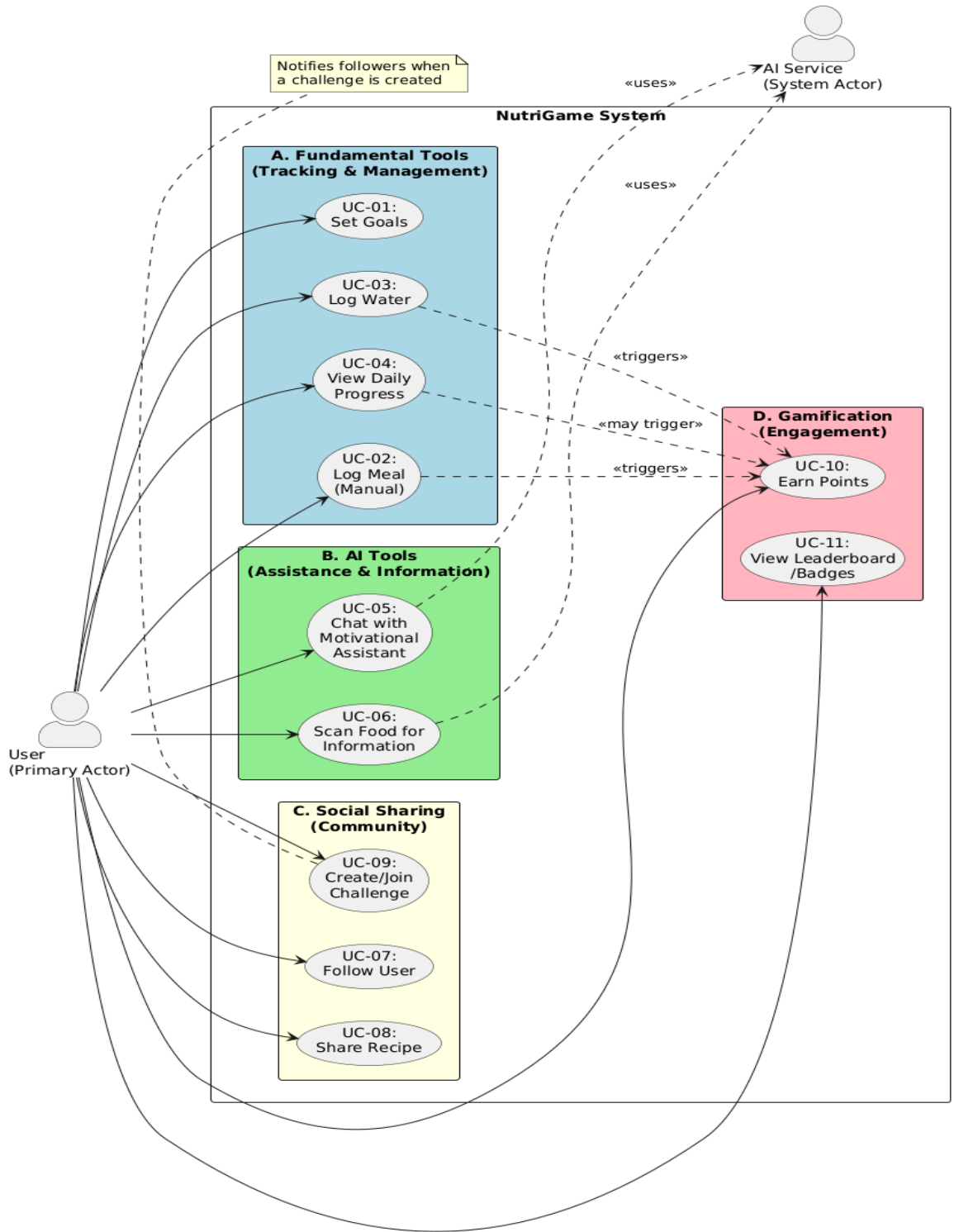


Figure 3.0. Use Case Model Diagram

### 3.5.3 Object and class model

The NutriGame system is built around a central User entity that connects to all major functionalities through well-defined relationships. The class diagram 3.1. illustrates the data structure and associations between system components.

- **User and Profile Management:** The User class handles authentication and serves as the central hub for all user-related data. Each user has one UserProfile containing personal information (age, gender, weight, height, target weight) and the system-calculated recommended daily calorie intake based on their goals.
- **Food and Meal Tracking:** FoodLookup serves as the master food database, storing nutritional information for all available foods including portion sizes and macronutrient values (calories, protein, fat, carbohydrates). When users log meals, a MealLog entry is created that references the FoodLookup table by foodId. The system calculates total nutritional values by multiplying the portion nutritional data by the user's portion count. MealTotals aggregates daily consumption by meal category (breakfast, lunch, dinner, snack), providing summary statistics for each day. WaterLog tracks daily water intake separately.
- **Visual Meal Documentation:** MealPhoto allows users to upload photos of their meals, organized by date and meal category. These photos serve as a visual diary without AI processing, helping users maintain awareness of their eating habits.
- **Progress Tracking and Gamification:** DailyProgress monitors whether users meet their daily calorie goals, tracking consumed calories against recommended targets along with weight changes and mood entries. This data feeds into the Streak system, which implements Duolingo-style consecutive day tracking. When users consistently meet their daily goals, their streak increases, encouraging sustained engagement. The Streak entity also maintains the user's longest streak and total points earned.
- **Social Features:** The social component enables community engagement through three main entities. Recipe allows users to share their favorite recipes as posts containing a title, descriptive content, and optional image. UserFollow implements a follower system where users can follow others to see their shared content. Challenge and ChallengeParticipant work together to enable users to create challenges (such as "No Sugar for 7 Days") and allow their followers to join these challenges, fostering community motivation and accountability.

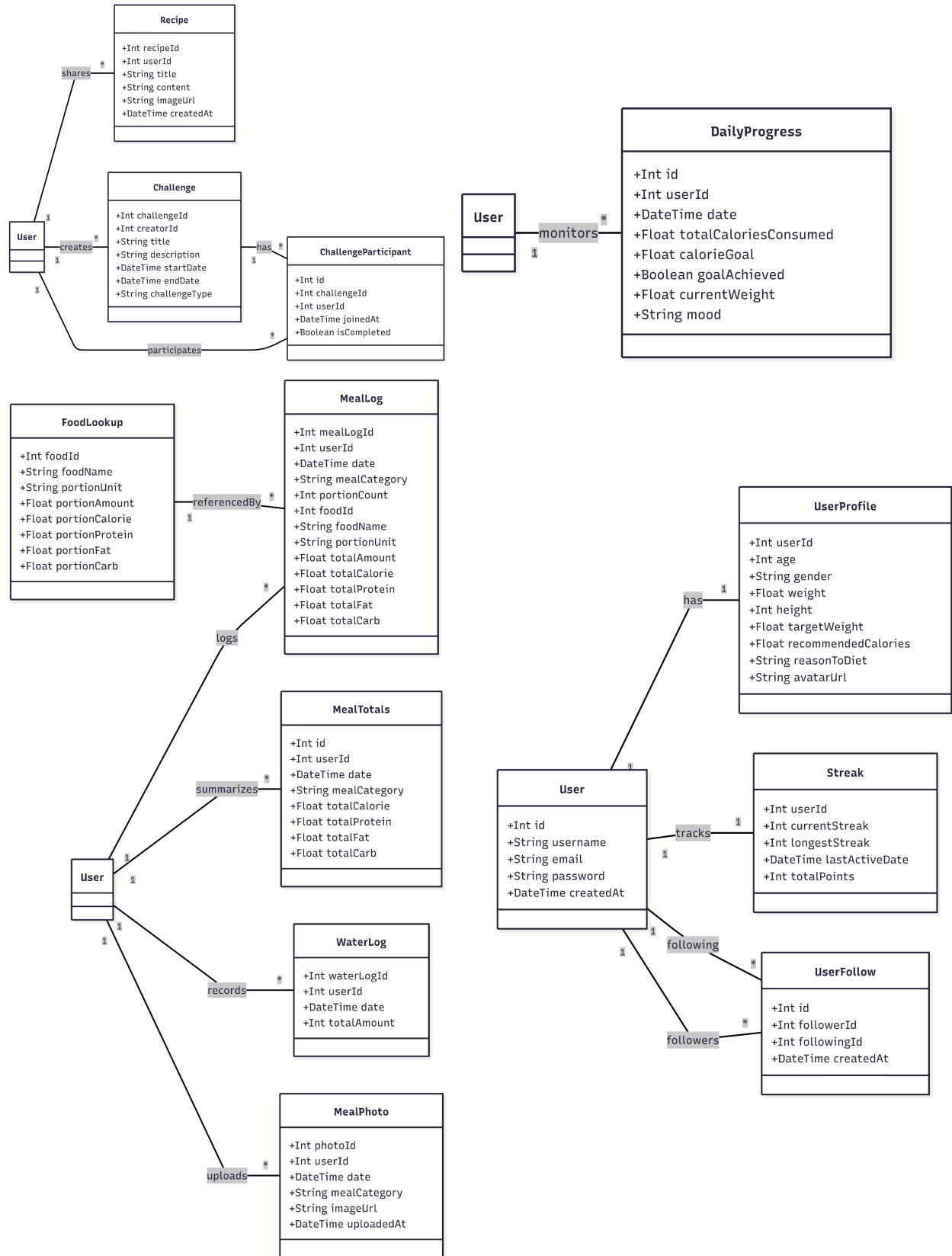


Figure 3.1: Class Diagrams of the Overall System

### 3.5.4 Dynamic models

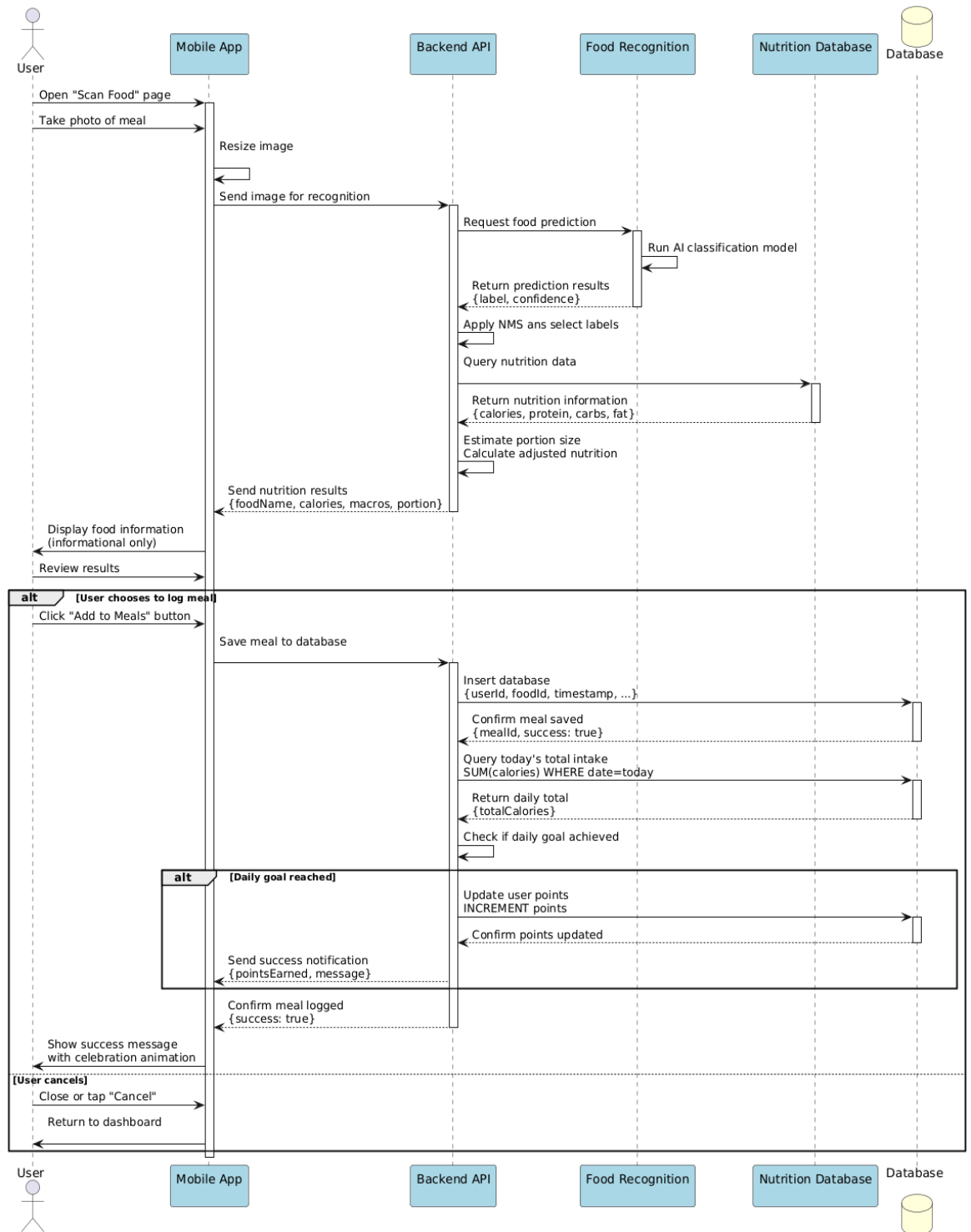


Figure 3.2. : Logging Meal (by taking the photo of meal)

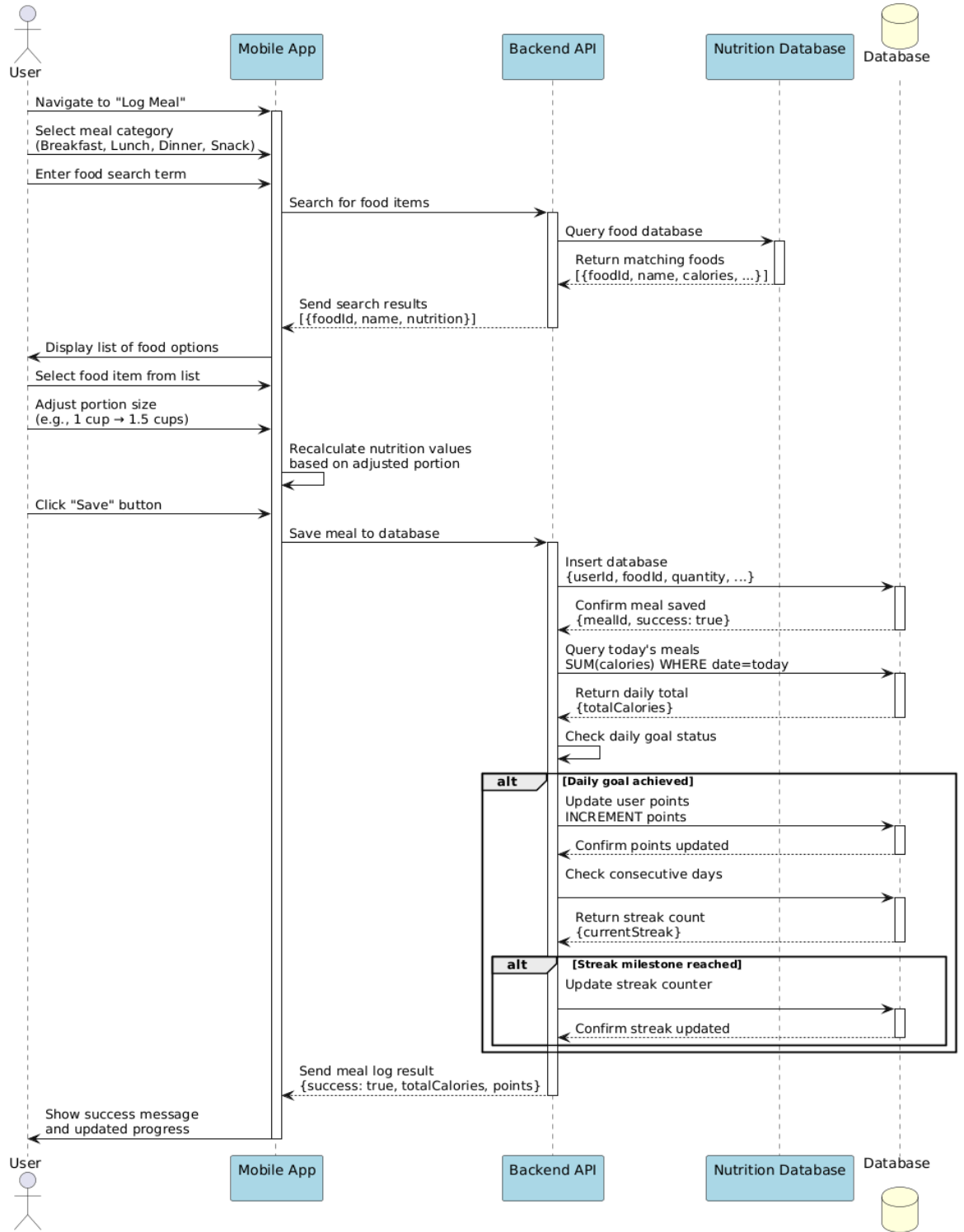


Figure 3.3. Logging Meal (by manually adding from the database)

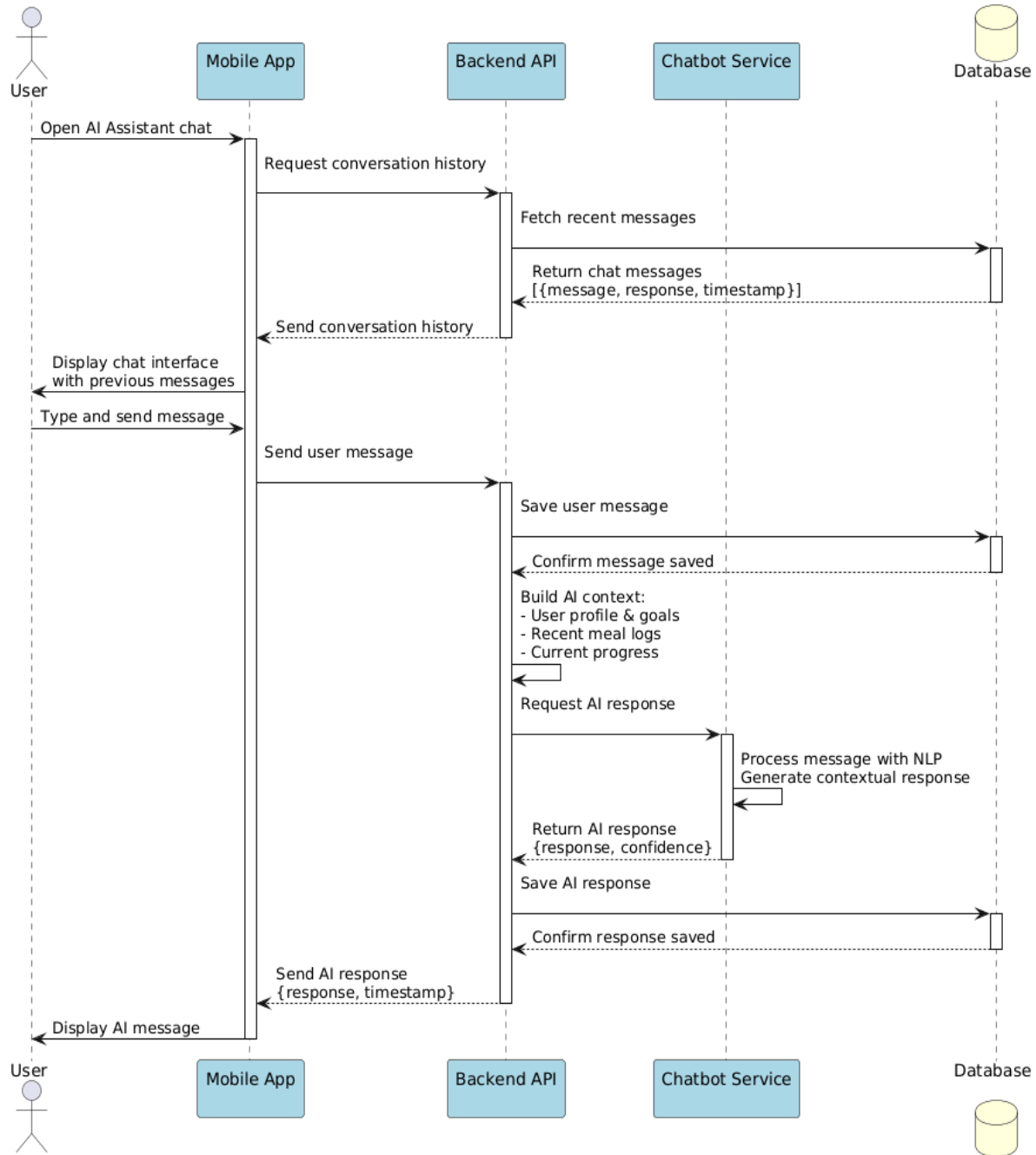


Figure 3.4. Chat with AI assistant

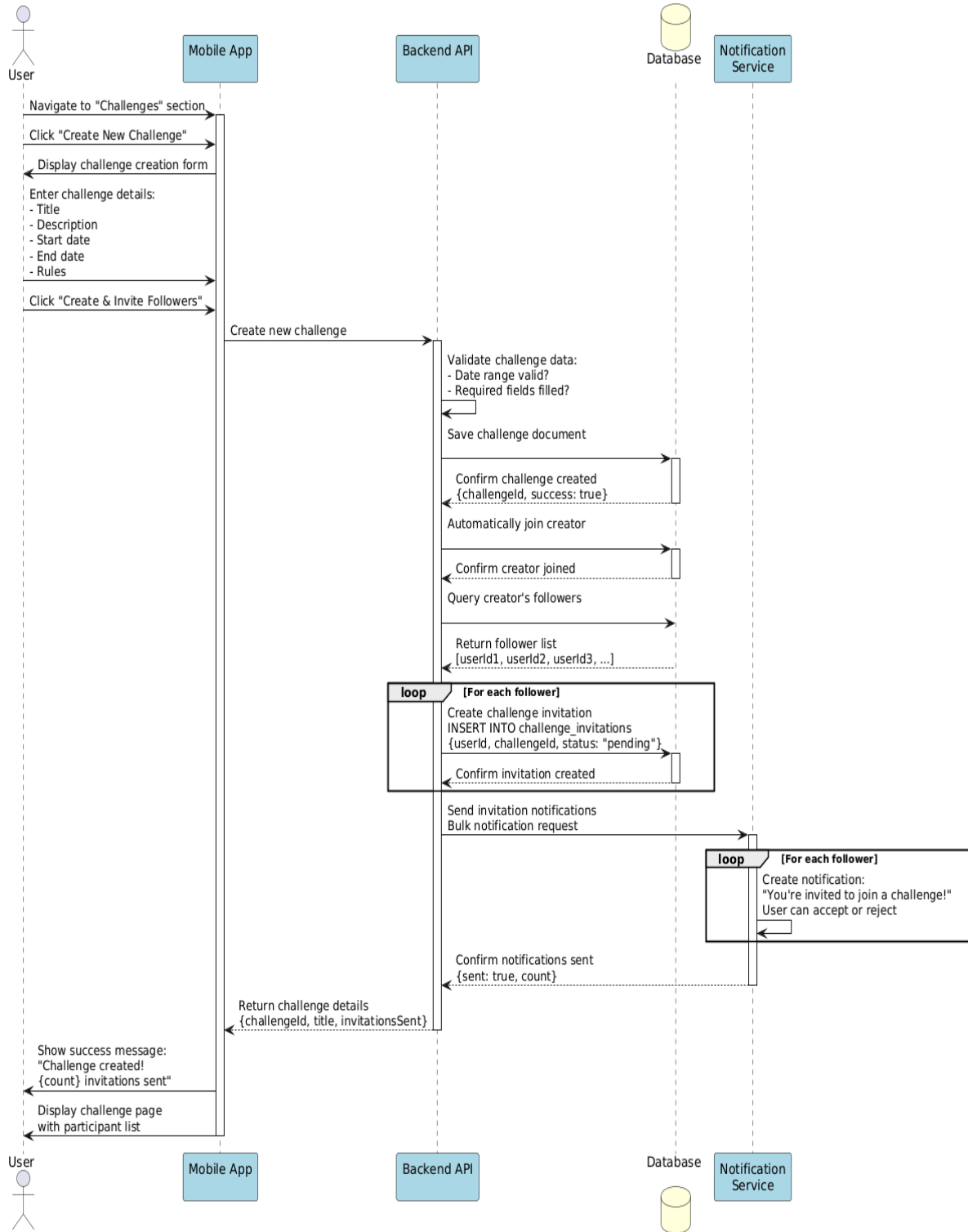


Figure 3.5. Create Challenge / Earn Points (Triggered Event)

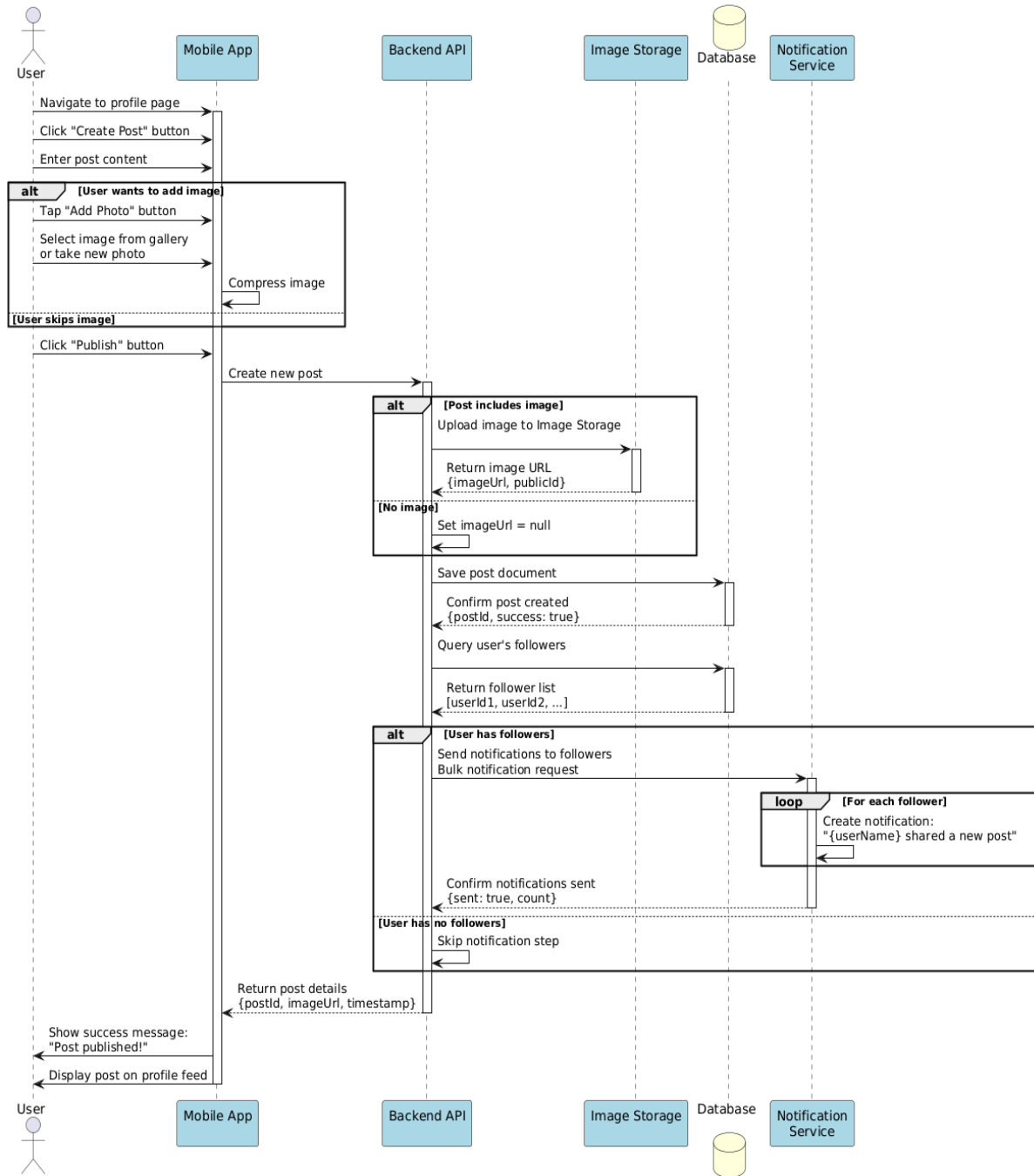


Figure 3.6. Share Post-Recipe (social interaction)

### 3.5.5 User interface - navigational paths and screen mock-ups

The NutriGame user interface is designed for simplicity and speed. The navigation structure is centered around a single Main Dashboard, with specific tools and menus accessible via peripheral controls (top corners and bottom bar) to minimize clutter.

#### 1. Welcome & Authentication Flow

Upon launching the application, users are greeted by a Welcome Page.

- **Action:** Users can choose to Log In (for existing accounts) or Sign Up (for new accounts).
- **Onboarding:** If signing up, the user completes a brief setup to define their physical metrics (weight, height) and health goals.

#### 2. Main Screen (Dashboard)

This is the central hub of the application where the user spends most of their time. The screen layout is divided into four key zones:

##### A. Center Area (Tracking & Status)

The middle of the screen focuses on daily progress.

- **Calorie Tracker:** A large circular indicator showing calories consumed vs. the daily limit.
- **Meal Logging:** Organized sections (Breakfast, Lunch, Dinner, Snack) where users can view logged items or tap to add new ones manually.
- **Hydration:** A quick-tap counter to track water glasses.

##### B. Top-Left Corner (Social Community)

- **Action:** Tapping the icon in the top-left corner opens the Social Module.
- **Features:** This section allows users to view the Community Feed, see updates and recipes from friends, and access the "Challenges" section to join or create competitions.

##### C. Top-Right Corner (User Menu)

- **Action:** Tapping the "Three-Line" (Hamburger) menu in the top-right corner opens the Profile & Settings menu.
- **Features:** Access to Account Details, Avatar Customization, "My Recipes" uploads, and App Settings.

##### D. Bottom Line (AI Tools)

The bottom of the screen features a dedicated toolbar for intelligent assistance.

- **AI Chatbot Button:** Opens the Motivational Assistant interface for chatting and advice.
- **Food Recognizer Button:** Launches the camera for the AI Food Scanner, which identifies meals and provides nutritional information (informational only).

### 3. Secondary Interfaces (Pop-ups & Sub-pages)

- **Social Interface:** Accessed via the top-left button. Displays the "Feed" and "Active Challenges."
- **AI Scanner Result:** Accessed via the bottom "Recognize" button. Displays the photo taken and the AI-analyzed calorie data.
- **Chat Interface:** Accessed via the bottom "Chat" button. A conversational screen for interacting with the Motivational Assistant.



Figure 3.7. Sample user interface screens of the application

#### 4. Glossary

**AI (Artificial Intelligence):** The simulation of human intelligence processes by computer systems. In NutriGame, this refers to the Food Recognition engine and the Motivational Chatbot.

**API (Application Programming Interface):** A set of protocols and tools that allows the mobile application to communicate with the backend server to retrieve data and process requests.

**bcrypt:** A password-hashing function designed to secure user passwords by preventing them from being stored in plain text.

**Gamification:** The integration of game mechanics—such as points, streaks, and leaderboards—into the non-game environment of the app to encourage user engagement and motivation.

**GDPR (General Data Protection Regulation):** A legal framework that sets guidelines for the collection and processing of personal information from individuals who live in the European Union.

**HTTPS (Hypertext Transfer Protocol Secure):** The encrypted version of HTTP used to ensure secure communication between the user's device and the system servers.

**KVKK (Kişisel Verilerin Korunması Kanunu):** The Law on the Protection of Personal Data, which regulates the processing of personal data in Turkey.

**Macronutrients (Macros):** The three major nutrient categories found in food: carbohydrates, proteins, and fats, which the system tracks alongside calories.

**NLP (Natural Language Processing):** A branch of AI that enables the system to understand and process human language, used by the chatbot to generate contextual responses.

**NMS (Non-Maximum Suppression):** A computer vision technique used in the food recognition process to eliminate redundant overlapping bounding boxes and select the most accurate identification of a food item.

**TLS (Transport Layer Security):** A cryptographic protocol that provides end-to-end communications security over networks, required for all client-server data transfer.

## 5. References

- [1] K. R. Schneider, J. J. Liu, and A. A. Volda, "Retention and Engagement in Mobile Health Apps: A Longitudinal Study of User Behavior," *Journal of Medical Internet Research*, vol. 26, no. 1, p. e56897, Jan. 2024. [Online]. Available: <https://www.jmir.org/2024/1/e56897>
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