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SNACKTRACK: nutritional tracking in the era of LLMs and AI

SÃO PAULO

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Resumo

Este trabalho apresenta a SnackTrack, uma plataforma de acompanhamento nutricional que reduz o atrito do registro alimentar ao integrar uma assistente conversacional via WhatsApp com inferência automatizada baseada em modelos de linguagem e visão computacional. O problema central investigado é a baixa adesão à diários alimentares causada pelo alto custo cognitivo do “logging” manual, bem como a baixa confiabilidade de auto relatos retrospectivos usados por profissionais de nutrição. Para endereçar essa lacuna, desenvolveu-se um MVP composto por: (i) interface conversacional multimodal para registro por texto e imagem; (ii) pipeline de inferência para estimativa de calorias e macronutrientes e persistência de registros; e (iii) aplicação web para visualização histórica e insights de consumo. A validação ocorreu em ambiente real de uso, com métricas de adoção e viabilidade econômica. Durante o período observado, registraram-se mais de 1.800 entradas alimentares e 27 assinantes ativos, com aquisição predominantemente orgânica e custo de aquisição por cliente abaixo do limite definido, além de margem bruta superior ao patamar mínimo estabelecido. Os resultados indicam que a abordagem de baixo atrito via WhatsApp aumenta a recorrência do registro e sustenta um modelo de assinatura acessível no contexto brasileiro. Conclui-se que a SnackTrack atende ao objetivo de validar a solução computacional e sua viabilidade inicial, permanecendo como trabalhos futuros o aprimoramento da acurácia de inferência, o fortalecimento de mecanismos de retenção e a expansão para integrações profissionais.

Palavras-Chave: acompanhamento nutricional; whatsapp; modelos de linguagem; visão computacional; saúde digital.

ABSTRACT

This work presents SnackTrack, a nutritional tracking platform that reduces food-logging friction by integrating a WhatsApp-based conversational assistant with automated inference supported by large language models and computer vision. The core problem addressed is long-term non-adherence to manual food diaries due to high cognitive effort, alongside the limited reliability of retrospective self-reporting commonly used in nutritional follow-up. To bridge this gap, an MVP was implemented comprising: (i) a multimodal conversational interface for text- and image-based logging; (ii) an inference pipeline to estimate calories and macronutrients and persist structured records; and (iii) a web application for historical visualization and consumption insights. Validation was conducted under real usage conditions using adoption and economic feasibility metrics. During the observation period, over 1,800 food entries were logged and 27 active subscribers were recorded, with predominantly organic acquisition, customer acquisition cost below the defined threshold, and gross margin above the minimum target. Results suggest that low-friction WhatsApp interaction increases logging consistency and supports an affordable subscription model in the Brazilian context. The project concludes that SnackTrack meets its objectives of validating both the computational solution and its initial market viability; future work includes improving inference accuracy, strengthening retention mechanisms, and expanding professional integrations.

Keywords: nutritional tracking; WhatsApp; large language models; computer vision; digital health.

List of Abbreviations and Acronyms

AI Artificial Intelligence

CAC Customer Acquisition Cost

CDN Content Delivery Network

CAGR Compound Annual Growth Rate

CI/CD Continuous Integration / Continuous Delivery

CV Computer Vision

FFQ Food Frequency Questionnaire

KPI Key Performance Indicator

LLM Large Language Model

MVP Minimum Viable Product

NCD Non-Communicable Disease

PoC Proof of Concept

RAG Retrieval-Augmented Generation

SAM Serviceable Available Market

SOM Serviceable Obtainable Market

TAM Total Addressable Market

UX User Experience

B2B Business-to-Business

B2C Business-to-Consumer

B2B2C Business-to-Business-to-Consumer

Summary

1 Introduction

1.1 Context and Motivation

The global public health landscape is currently navigating a profound epidemiological transition, shifting from infectious pathologies to a prevalence of Chronic Non-Communicable Diseases (NCDs). Conditions such as obesity, type 2 diabetes mellitus, and cardiovascular diseases have reached endemic proportions, with the World Health Organization identifying inadequate diet as a primary, yet modifiable, risk factor driving these comorbidities (WORLD HEALTH ORGANIZATION, 2025). In parallel to this health crisis, the Brazilian market has witnessed a robust expansion in the fitness and wellness sectors, reflecting a societal pivot toward preventive health behaviors and lifestyle management. The Brazilian fitness market moved approximately BRL 12 billion in 2024 (FECOMERCIO-SP, 2025), signaling a mature economic ecosystem ripe for technological disruption.

Concurrently, the digitalization of health, or digital health, has carved out a significant economic niche. Grand View Research estimates that the Brazil virtual fitness market generated USD 1 billion in 2024 (GRAND VIEW RESEARCH, 2024), with projections indicating a compound annual growth rate (CAGR) exceeding 9% in subsequent years. This burgeoning market suggests that while the physical infrastructure for health (gyms, studios) is well-established, the digital layer responsible for behavioral tracking and nutritional management remains an area of aggressive growth and innovation.

Despite this economic buoyancy, a critical disconnect persists in the daily execution of dietary management for the average Brazilian. The primary customer segment identified for this project consists of working adults from the middle-income bracket, with a monthly income ranging approximately between BRL 3,000 and BRL 5,000. This demographic exhibits a high intent to improve physical condition, evidenced by gym memberships and supplement consumption, but faces structural barriers to consistency. These individuals are characterized by extreme time scarcity, high cognitive load from professional demands, and limited financial resources to sustain continuous, high-touch professional nutritional coaching. Consequently, they resort to self-managed solutions for tracking food intake, which are currently fragmented and technologically archaic.

Current practices for food tracking within this segment are largely inefficient.

Many individuals resort to manual methods such as handwritten notes, personal WhatsApp messages sent to themselves, or generic note-taking applications. While digital food tracking applications exist, the dominant market solutions require extensive manual interaction: searching food databases, selecting items from predefined lists, and visually estimating portion sizes. This process introduces significant friction. Behavioral science literature indicates that this "logging fatigue" is the primary cause of abandonment in dietary interventions. The cognitive cost of calculating the caloric density of a complex Brazilian dish using a text-based search is prohibitively high for a user with limited nutritional literacy. Evidence from self-monitoring research shows that burden and low usability are major drivers of attrition in digital lifestyle interventions (BURKE et al., 2009).

In Brazil, an additional barrier is contextual mismatch: international databases and interfaces frequently fail to represent local foods and preparation patterns, reducing the perceived usefulness of the data for both users and nutritionists. Given the high adoption of WhatsApp as a communication channel in Brazil, and its large user base, integrating meal logging into messaging flows offers a promising path to reduce friction (DATAREPORTAL, 2025).

The motivation for this work, therefore, arises from the intersection of a massive market opportunity (BRL 12 billion) and a clear technological gap: the lack of a low-friction, culturally adapted, and automated nutritional tracking system. By leveraging recent advances in Artificial Intelligence, specifically Computer Vision (CV) for automated recognition and Large Language Models (LLMs) for contextual reasoning, this project seeks to bridge the gap between intent and adherence.

1.2 Problem Definition and Value Proposition

The problem addressed in this project is systemic and affects two stakeholders: end users and nutrition professionals. For users, most existing tools rely on high-frequency manual interaction and demand a level of nutritional literacy that many do not have, leading to incomplete logs and eventual abandonment. For professionals, dietary monitoring is often based on retrospective self-reporting methods (e.g., 24-hour recall, food frequency questionnaires), which are susceptible to memory and social desirability bias. Classic validation work shows that self-reported energy intake can substantially underestimate actual intake, compromising clinical decision-making (SCHOELLER, 1995), and later analyses reiterate the limitations of self-report dietary data in practice (ARCHER; BLAIR, 2015).

SnackTrack's value proposition is to reduce the cognitive and operational cost of logging by enabling multimodal inputs (images and natural language messages) through WhatsApp, a channel users already access daily. For users, this shifts logging from a data-entry task to a lightweight action, supported by automated estimation and immediate feedback. For nutritionists, the platform offers structured records, aggregated dashboards, and automated analysis that reduce manual interpretation and support scalable follow-up.

1.3 Objectives of the Work

The execution of this project is guided by a structured set of general and specific objectives designed to validate both the technological feasibility and the business viability of the solution.

- General Objective: Design, implement, and validate a computational nutritional tracking platform that leverages artificial intelligence to infer dietary intake from user inputs, while simultaneously developing and evaluating a business plan for its viable introduction into the market.
- AI Pipeline Development: Design and implement an artificial intelligence pipeline capable of performing instance segmentation on food images using state-of-the-art architectures and other computer vision APIs, classifying items based on a public dataset of Brazilian cuisine (TACO table).
- Conversational Interface: Develop an AI-powered conversational assistant integrated with the WhatsApp Business API, enabling low-friction meal logging through text and image-based interactions and utilizing Retrieval-Augmented Generation (RAG) to provide contextualized nutritional advice.
- Platform Implementation: Implement a web-based platform for nutritional data visualization and management, supporting both individual users (B2C) and nutrition professionals (B2B), ensuring secure authentication and data privacy compliance.
- MVP Validation: Develop a functional Minimum Viable Product (MVP) and validate it through real user interaction involving at least 50 participants

including subscribers and non-subscribers. This validation aims to assess usability, engagement metrics, and the perceived value of the automated logging feature.

- Business Model Verification: Evaluate alternative business and monetization strategies, specifically testing the viability of direct-to-consumer subscriptions versus professional-mediated access, and defining the Unit Economics (CAC, LTV) required for sustainability.

1.4 Justification and Contributions

From a market and social standpoint, SnackTrack targets a structural limitation in how dietary habits are currently monitored and supported. Personalized nutritional tracking and continuous dietary guidance are typically associated with high-cost services or manual professional follow-up, making them inaccessible to a large portion of the population. Automated alternatives, when available, often lack personalization or require excessive manual effort, which compromises long-term adherence. By proposing a system that reduces friction in food logging while enabling personalized interventions, this work contributes to expanding access to nutritional support, particularly within the Brazilian context, where the fitness and health sector has experienced sustained growth. Given the central role of food consumption in preventive health, improving accessibility to structured dietary monitoring represents a relevant contribution to individual well-being and broader health practices.

From a technological perspective, this project explores the integration of contemporary artificial intelligence techniques into a real-world, user-facing system. The solution combines large language models with retrieval-augmented generation mechanisms to contextualize nutritional information, alongside computer vision approaches for food recognition and intake estimation from images. Rather than relying exclusively on pre-packaged solutions, the project investigates the design and integration of custom pipelines, addressing challenges related to data processing, inference accuracy, and system orchestration. Additionally, by focusing on a localized application tailored to Brazilian users, the project contributes to the practical adoption of AI technologies beyond globally dominant platforms, fostering technological autonomy and contextual relevance within the national ecosystem.

From an economic perspective, the proposed solution aims to reduce the cost barriers associated with maintaining healthy dietary habits. Nutritional follow-up and personalized guidance are often financially restrictive, limiting access to consistent support. By automating data collection, analysis, and feedback processes, the platform has the potential to lower operational costs for nutrition professionals while simultaneously offering affordable access to users. This efficiency gain enables scalability, allowing professionals to support a larger number of individuals without proportional increases in workload. Furthermore, the exploration of alternative revenue and pricing models contributes to assessing the economic feasibility of AI-driven nutritional services within the Brazilian market, supporting sustainable business practices aligned with local socioeconomic conditions.

Taken together, these contributions justify the relevance of the project by demonstrating its potential impact on market accessibility, its technological innovation within a localized context, and its economic viability as a scalable digital health solution.

1.5 Work Structure

This work is structured into three main chapters. Chapter 1 (Introduction) presents the context and motivation for the project, defines the problem and value proposition, states the objectives, and justifies the relevance of the proposed solution from market, technological, and economic perspectives. Chapter 2 (Solution Development) details the assumptions and hypotheses that guided the project, presents market sizing and customer profiling, analyzes competitors and differentiators, and describes the technological solution, including requirements, architecture, MVP development, testing, and the business plan. Chapter 3 (Conclusion) synthesizes the outcomes, assesses whether the objectives were achieved, and outlines future directions based on the validation results and identified constraints.

2 Solution Development

2.1 Definition of Market Assumptions and Hypotheses

2.1.1 Problem Hypothesis

Individuals who seek to improve or maintain their health experience significant difficulties in monitoring dietary intake in a precise, convenient, and consistent manner. Manual food logging methods introduce excessive friction, leading to incomplete records, low engagement, and abandonment over time. In addition, existing digital solutions provide predominantly generic feedback, failing to adapt to personal routines, cultural habits, financial constraints, and dietary restrictions, such as vegetarianism, veganism, diabetes, or other health-related conditions. These limitations reduce the effectiveness of dietary monitoring and negatively impact long-term adherence.

A complementary hypothesis addresses the professional context of nutritionists. It is assumed that nutrition professionals lack access to high-quality, structured, and continuous data regarding patients' real dietary behavior. Current practices rely heavily on retrospective self-reporting, which is often imprecise and biased. This data limitation increases manual workload, constrains personalization, and contributes to reduced patient engagement and higher churn, ultimately affecting the effectiveness and scalability of nutritional follow-up.

2.1.2 Solution Hypothesis

An artificial intelligence–driven platform that enables low-friction meal logging through images, text, and conversational interaction can significantly improve the accuracy, consistency, and usability of dietary tracking. By allowing users to record meals through simple actions, such as taking a photograph or sending a message, the system reduces cognitive and operational effort, increasing the likelihood of sustained use.

It is further assumed that contextualized AI models, trained and adapted to regional food data, can provide more accurate and relevant nutritional inferences than generic international databases. The integration of conversational AI enables personalization by incorporating user-specific goals, preferences, and restrictions into the interaction flow. From the professional perspective, providing nutritionists with structured dashboards, automated analysis, and optimization tools, such as algorithmic meal plan generation that considers nutritional and cost constraints, can enhance decision-making, reduce manual workload, and improve the quality of patient guidance.

2.1.3 Value Hypothesis

The value hypothesis assumes that both end users and nutrition professionals are willing to pay for a solution that demonstrably reduces effort, increases personalization, and improves outcomes. For end users, the ease of use and immediacy of feedback provided by AI-assisted tracking are expected to justify subscription-based access, as they lower the barrier to consistent dietary monitoring. For nutrition professionals, access to high-quality data, automated analysis, and scalable tools is assumed to translate into higher patient engagement, improved retention, and the ability to serve more patients effectively. These perceived gains form the basis for the economic viability of the proposed platform across different market configurations.

2.2 Market Sizing and Analysis

2.2.1 Market Size (TAM, SAM, SOM)

Although the project explored different market configurations during its development, the market sizing and customer profiling presented in this section focus on the direct-to-consumer (B2C) perspective, which was adopted for the final MVP and validation stage

In order to evaluate the economic potential of the proposed solution, a market sizing analysis was conducted using the Total Addressable Market (TAM), Serviceable Available Market (SAM), and Serviceable Obtainable Market (SOM) framework.

The Total Addressable Market (TAM) represents the total demand for fitness and health-related services in Brazil, assuming no constraints on the type of solution or distribution channel. For this estimation, the Brazilian fitness market was used as a reference, based on data reported by FecomercioSP (FECOMERCIO-SP, 2025), which estimates the sector’s size at approximately USD 2.2 billion annually in 2024.

The Serviceable Available Market (SAM) refines this scope by focusing on the portion of the market that can be reached through digital solutions. In this case, the digital fitness and health segment in Brazil was considered, as it more closely aligns with the nature of the proposed platform. According to Grand View Research (2024), the Brazilian digital fitness market is estimated at approximately USD 1.0 billion annually. This segment includes mobile applications, digital platforms, and technology-enabled services aimed at health monitoring, fitness engagement, and lifestyle management.

The Serviceable Obtainable Market (SOM) represents the fraction of the SAM that the project could realistically capture in its initial stages. To estimate the SOM, a bottom-up approach was adopted, incorporating demographic targeting and pricing assumptions derived from real user data collected during the project. Internal usage data indicated that a significant portion of early users fell within the 25 to 34 age range, which accounted for over 40% of the active user base. This age group was therefore selected as the primary initial target segment.

Public demographic data on the Brazilian population distribution by age were used to estimate the proportion of individuals within this range who are engaged in fitness-related activities, particularly gym memberships, as reported by InvestNews. From this population, a conservative market capture rate of 10% was assumed for the initial phase of adoption. The pricing model considered a monthly subscription fee of BRL 30 per user, resulting in an estimated annual recurring revenue per user. Based on these assumptions, the Serviceable Obtainable Market was estimated at approximately USD 26 million annually.

2.2.2 Customer Segmentation and Profiling

Although the project explored different market configurations during its development, including professional-mediated and hybrid approaches, the customer segmentation and profiling presented in this section focus primarily on the direct-to-consumer (B2C) perspective. This choice reflects the analytical scope adopted for the final MVP and validation phase, while still acknowledging the relevance of nutrition professionals as complementary stakeholders within the broader solution ecosystem.

From the professional perspective, the initial target segment consisted of recently established or early-career nutritionists seeking to expand their patient base and improve the efficiency of their practice. These professionals typically operate with limited resources and rely heavily on manual processes to collect, analyze, and interpret patient dietary data. The project assumed that this group would benefit from tools that reduce operational workload, improve data quality, and support more structured and scalable follow-up. In particular, nutritionists working with patients who require restrictive or highly personalized diets, such as those involving dietary preferences, health conditions, or budget constraints, were identified as potential early adopters of automated optimization and monitoring tools. However, due to limited empirical data collected from this segment during the validation phase, nutritionists are not treated as the primary customer profile in the market analysis presented here.

The primary customer segment analyzed corresponds to individual users seeking to improve or maintain their health through better dietary management. Based on usage data collected during the project, the most representative age group was between 25 and 34 years, which accounted for approximately 40% of the active user base. This demographic was therefore defined as the core target segment for the B2C offering. Gender distribution within this group was relatively balanced, with approximately 54% male and 46% female users, indicating broad appeal across genders.

Behaviorally, these users can be characterized as health-conscious but time-constrained working adults. They typically maintain busy routines involving professional responsibilities and commuting, which limits their ability to engage with complex or time-intensive tracking tools. Many had previously attempted to monitor their diet using existing applications or informal methods, such as notes or messaging platforms, but discontinued usage due to excessive manual effort and lack of sustained engagement. Despite these challenges, this segment demonstrates a clear motivation to improve lifestyle habits, particularly in relation to fitness, weight management, and general well-being.

From a needs and constraints perspective, this customer profile values convenience, speed, and personalization. Solutions that require minimal interaction, provide immediate feedback, and adapt to personal preferences and restrictions are more likely to be adopted and maintained over time.

2.3 Competitive Analysis and Differentials

The market for nutritional tracking is saturated but polarized, creating an opportunity for a localized, automated solution.

Table 1 – Competitor landscape and observed gaps

Competitor Type	Examples	Strengths	Weaknesses
Direct (AI-Based Global)	Foodvisor, Bite AI	Advanced algorithms, wearable integration.	Lack of cultural adaptation (fail to recognize Brazilian foods); Dollarized pricing; English-first interfaces.
Direct (AI-Based Local)	MyFood, Dieta.ai	Localized databases; WhatsApp integration.	Limited volume estimation capabilities (often require manual portion entry); Lower recognition accuracy for complex dishes; High cost subscriptions.
Indirect (Manual)	MyFitnessPal, FatSecret	Massive databases; Strong brand recognition.	High Friction: Rely entirely on manual entry; High abandonment rates.
Professional Platforms	Dietbox, WebDiet	Robust clinic management; Telemedicine features.	No automated tracking for patients; Merely digitize the manual diary process; High cost for professionals.

Source: The authors, based on exploratory analysis of market offerings (2025).

Direct competitors include widely adopted food tracking applications that allow users to manually log meals and monitor calorie and macronutrient intake. Examples of this category include platforms such as MyFitnessPal, Yazio, FatSecret, and similar applications with global reach. These solutions are well-established and benefit from extensive food databases and brand recognition. However, they rely predominantly on manual interaction, requiring users to search for food items, estimate portions, and input data repetitively. This interaction model introduces friction, particularly for time-constrained users, and often leads to reduced engagement and long-term abandonment.

In addition to traditional applications, a new category of AI-driven nutritional tracking platforms has emerged, primarily developed and operated by international companies. These solutions attempt to automate food recognition and dietary analysis using artificial intelligence. While technologically advanced, they often lack localization, relying on generic international food datasets that do not fully reflect regional eating habits, ingredient variations, or cultural patterns. This limitation reduces accuracy and relevance for Brazilian users. Furthermore, many of these platforms operate with higher pricing structures, creating accessibility barriers for a broader segment of the market.

The Brazilian market also includes emerging AI-based nutritional tracking solutions. Although these platforms demonstrate growing technological capability, they frequently present higher subscription costs compared to the proposed solution and tend to focus on narrower use cases. As a result, affordability and scalability remain challenges for widespread adoption, particularly among middle-income users.

Indirect competitors include non-specialized tools and professional software that partially address dietary monitoring without focusing on continuous, user-centered tracking. On the consumer side, informal methods such as note-taking applications, spreadsheets, or messaging platforms are commonly used to record meals. While flexible, these approaches lack structure, automation, and analytical capabilities, limiting their usefulness over time.

From the professional perspective, nutritionists often rely on meal planning and patient management software acquired during or shortly after academic training. These tools typically emphasize static meal plan creation rather than dynamic monitoring of real consumption behavior. Additionally, data portability and platform lock-in represent significant barriers, as migrating patient information between systems is complex and time-consuming. This discourages experimentation with newer solutions, even when existing tools fail to provide adequate tracking or engagement capabilities.

SnackTrack differentiates itself by addressing limitations observed across both traditional and emerging solutions. Its primary competitive advantage lies in the combination of low-friction user interaction, contextualized artificial intelligence, and adaptability to local needs. By enabling meal logging through images and conversational inputs, the platform significantly reduces the effort required from users, directly targeting one of the main causes of disengagement in existing applications.

The use of AI models adapted to regional food data enhances accuracy and cultural relevance, distinguishing the solution from international platforms that rely on generalized datasets. Additionally, the integration of personalization mechanisms allows dietary guidance to account for individual preferences, restrictions, and constraints, moving beyond generic recommendations.

From a strategic perspective, the platform's design supports both individual use and professional integration, enabling future expansion into professional-mediated models without compromising the core consumer experience. Combined with a pricing strategy aimed at accessibility, these differentiators position SnackTrack competitively within the Brazilian digital health and fitness ecosystem.

2.4 Technological Solution

2.4.1 Requirements and Specifications

The functional requirements describe the core capabilities that the system must provide in order to support nutritional tracking, personalization, and user interaction. The main functional requirements identified for the platform are as follows:

- FR1 – Meal Logging via Multimodal Input:
  The system shall allow users to register meals using images, text messages, or a combination of both, enabling flexible and low-friction interaction.
- FR2 – Nutritional Intake Estimation:
  The system shall process user inputs to estimate calorie and macronutrient intake using artificial intelligence models, including computer vision and natural language processing techniques.
- FR3 – Conversational Interaction:
  The system shall provide an AI-driven conversational assistant, accessible via

WhatsApp, capable of guiding users through meal logging, clarifying inputs, and responding to basic nutritional queries.

- FR4 – Personalization and Dietary Constraints:
  The system shall support personalized dietary guidance by incorporating user-specific preferences, goals, and restrictions, such as dietary patterns or health-related constraints.
- FR5 – Data Visualization and History:
  The system shall provide a web-based interface that allows users to visualize historical consumption data, summaries, and trends over time.
- FR6 – Professional Access and Monitoring:
  The system shall support access for nutrition professionals, enabling them to monitor aggregated patient data, analyze adherence patterns, and review nutritional metrics when applicable.
- FR7 – User Management and Authentication:
  The system shall support user registration, authentication, and profile management, ensuring that personal and dietary information is associated with the correct user.
- FR8 – Subscription and Payment Management:
  The system shall support subscription-based access models, including payment processing and plan management, enabling controlled access to platform features.

The non-functional requirements define quality attributes and operational constraints that ensure the system's reliability, usability, and scalability. The primary non-functional requirements identified are:

- NFR1 – Usability:
  The system shall minimize user effort during meal logging, prioritizing intuitive interaction flows and reducing the number of required actions per entry.
- NFR2 – Performance:
  The system shall provide nutritional estimations and conversational responses within acceptable response times, ensuring a smooth user experience during interaction.

- NFR3 – Scalability:
  The system architecture shall support growth in the number of users and interactions without requiring fundamental redesign, allowing incremental scaling of services.
- NFR4 – Availability:
  The system shall maintain high availability for core functionalities, particularly the conversational assistant, which operates in real-time user contexts.
- NFR5 – Security and Data Privacy:
  The system shall ensure the protection of user data through secure authentication, controlled access, and appropriate data handling practices, given the sensitivity of health-related information.
- NFR6 – Modularity and Maintainability:
  The system shall be designed using modular components, enabling independent updates, maintenance, and future extensions of individual services.
- NFR7 – Integration Capability:
  The system shall support integration with external services, such as messaging platforms and payment providers, through well-defined interfaces and APIs.

Based on the defined requirements, the primary use cases supported by the system include:

- UC1 – User logs a meal via WhatsApp using an image or text input.
- UC2 – System processes the input and returns an estimated nutritional breakdown.
- UC3 – User receives personalized feedback or reminders based on consumption patterns.
- UC4 – User accesses historical dietary data through the web platform.
- UC5 – Nutritionist reviews aggregated dietary data for supported users.
- UC6 – User subscribes to or manages an active plan through the platform.

2.4.2 Architecture and Technology

The proposed solution was designed using a modular and scalable cloud-based architecture, with the objective of supporting real-time interaction, computationally intensive AI inference, and future growth in user volume. The system follows a distributed client–server model, with clear separation between presentation, application, intelligence, and data layers.

Infrastructure:

- The infrastructure is deployed on a cloud environment using managed services to ensure scalability, availability, and operational control. Containerized services are orchestrated using a managed container service backed by virtual machine instances, allowing fine-grained control over resource allocation and horizontal scaling. Multiple redundant application containers are deployed, with auto-scaling policies triggered by CPU and memory utilization metrics to handle variable workloads.
- A load balancer is positioned at the entry point of the backend services, distributing incoming traffic and providing an additional security layer. Static frontend assets are hosted on object storage and delivered through a content delivery network (CDN), reducing latency and minimizing direct access to backend resources. This configuration improves performance while lowering infrastructure costs.

Frontend Layer:

- The frontend applications, including the landing page and the main user interface, are implemented using a modern JavaScript framework based on React. These applications are deployed as static assets in object storage and served through the CDN. The landing page operates independently of backend services, while the main application communicates with backend APIs for authentication, data visualization, and subscription management.

Backend and Application Layer:

- The core backend services are implemented in Python using the FastAPI framework, chosen for its performance, asynchronous support, and suitability for AI-driven workloads. These services expose RESTful endpoints responsible for user management, meal logging, data processing, and integration with external platforms.

- An internal orchestration layer coordinates interactions between backend services, AI models, and external providers. This layer manages intent detection, action routing, and the sequencing of AI calls, enabling flexible composition of language models, retrieval mechanisms, and domain-specific logic.

Conversational and Messaging Integration:

- User interaction is primarily conducted through a messaging platform using an official business integration. Incoming messages—text, images, or audio—are received via webhooks and forwarded to the backend for processing. The system supports asynchronous message handling, ensuring responsiveness even under high interaction volume. Outgoing responses, confirmations, and notifications are sent back to users through the same messaging channel.

Artificial Intelligence and Inference Layer:

- The AI layer integrates multiple providers and techniques to support different inference tasks. Large language models are used for conversational interaction, intent detection, and contextual reasoning. Retrieval-augmented generation mechanisms are employed to enrich model responses with structured nutritional data. In parallel, computer vision models are used to analyze food images and estimate portion sizes and nutritional intake.
- The architecture supports both third-party AI services and internally tested models, allowing flexibility in experimentation and optimization. This hybrid approach enables balancing performance, accuracy, and operational cost.

Data Storage and Management:

- User data, nutritional records, and system metadata are stored in a relational database management system, selected for consistency, reliability, and structured querying capabilities. Data transmission is secured, and sensitive information is handled following standard data protection practices. Nutritional entries generated through AI inference are persistently stored to support historical analysis, visualization, and professional review.

Payment and Subscription Services:

- Subscription management and payment processing are handled through integration with an external payment service provider. Event-driven mechanisms are used to process payment confirmations, subscription state changes, and billing updates. Serverless functions implemented in a compiled language are triggered by payment events to update user access rights and maintain consistency across system components.

Background Processing and Automation:

- Scheduled background jobs are used to perform periodic computations, such as aggregating daily and weekly consumption summaries. These jobs generate personalized reports and insights, which are automatically delivered to users through the messaging platform. This asynchronous processing model reduces load on real-time services while enabling continuous user engagement.

Development and Deployment Pipeline:

- The system development lifecycle follows a continuous integration and continuous delivery (CI/CD) approach. Source code is managed through a version control platform, with automated pipelines triggered by pull request merges and version tagging. These pipelines build, test, and deploy frontend and backend components independently, supporting rapid iteration and controlled releases.

2.4.3 Development and Implementation (MVP)

The development and implementation of the proposed solution followed an iterative and incremental approach based on the Scrum methodology. Scrum was adopted not only as a software development framework but also as a broader project management strategy, supporting technical development, exploratory analysis, and interaction with potential users and stakeholders. This approach enabled continuous feedback, rapid iteration, and informed decision-making throughout the project lifecycle.

The project was structured across four academic modules over the course of one year, each corresponding to a distinct phase in the maturation of the solution. Within each module, development activities were organized into sprints, totaling approximately five sprints per module. These sprints combined technical implementation tasks with market exploration, validation activities, and business analysis, reflecting the interdisciplinary nature of the project.

The initial phase focused on conceptualization and technical feasibility. During this stage, the primary objective was to assess whether artificial intelligence techniques—particularly computer vision and language models—could be effectively applied to estimate nutritional intake from user-generated inputs. A proof of concept (PoC) was developed to validate the feasibility of food recognition, portion estimation, and basic conversational interaction. This phase established the technical foundation for subsequent development.

The second phase emphasized early product development and initial market exploration, primarily from a direct-to-consumer perspective. Core system components were implemented, including the AI inference pipeline and the conversational interface. Early versions of the WhatsApp-based interaction flow were tested to evaluate usability, engagement, and logging accuracy. Feedback gathered during this phase informed refinements to interaction design and system responsiveness.

In the following phase, the project expanded to explore professional-mediated models, including B2B and B2B2C configurations. Additional features were developed to support nutrition professionals, such as patient data aggregation, analytical views, and an optimization algorithm for automated meal plan generation. This stage also included the implementation of subscription logic and revenue-sharing mechanisms, enabling preliminary testing of different monetization strategies. Market experiments conducted during this phase provided insights into adoption barriers, pricing sensitivity, and operational complexity.

The final phase consolidated the results of prior experimentation and incorporated strategic adjustments based on validation outcomes. The project refined its positioning, prioritized features aligned with observed user behavior, and stabilized the MVP for final evaluation and presentation. This stage also included preparation for demonstrations, documentation, and performance assessment, ensuring coherence between technical implementation and business objectives.

From a functional standpoint, the Minimum Viable Product implemented during the project included the following core features:

- A WhatsApp-based conversational interface allowing users to log meals through images, text, or audio messages.
- An AI pipeline capable of extracting nutritional information from user inputs and storing structured consumption records.
- Support for querying historical meal data and updating previous entries through conversational commands.
- Automated generation of daily and weekly nutritional summaries, delivered through messaging interactions.
- A web-based platform enabling users to visualize historical consumption data through charts and filtered views.
- User authentication, profile management, and subscription handling.
- A professional interface supporting patient connections, meal plan generation through optimization algorithms, and access to aggregated nutritional analytics.

2.4.4 Testing and Technical Evaluation

Testing and technical evaluation were conducted throughout the development process to assess the correctness, robustness, and usability of the system. Given the iterative nature of the project, testing activities were integrated into multiple stages of development, covering both technical components and user interaction flows.

From a software engineering perspective, unit tests were implemented for core backend services to validate individual components in isolation. These tests focused on critical functionalities such as data processing, input validation, user management, and integration points with external services. By isolating these components, unit testing helped identify implementation errors early and ensured the stability of fundamental system logic.

In addition to unit testing, integration tests were performed to evaluate the behavior of the system across interconnected components, particularly within the artificial intelligence processing pipeline. These tests validated the end-to-end flow of user interactions, including message reception, intent detection, AI inference, data persistence, and response generation. Special attention was given to the orchestration of AI services, ensuring that language models, retrieval mechanisms, and computer vision components interacted consistently and produced coherent outputs under different input conditions.

Functional and acceptance testing were carried out through structured demonstrations and hands-on usage by potential users and early adopters. These tests aimed to assess whether the system fulfilled its intended use cases in realistic scenarios. User testing sessions included guided interactions, in which participants were observed while using the platform, as well as blind tests designed to evaluate preference, ease of use, and comprehension without prior instruction. Feedback collected during these sessions informed adjustments to interaction design, messaging clarity, and feature prioritization.

Additional qualitative evaluation was conducted with nutrition professionals through remote sessions, during which the platform was used collaboratively to analyze dietary data and generate meal plans. These sessions provided insights into professional workflows, data interpretation needs, and usability considerations from a practitioner's perspective.

Regarding technical performance, experimental evaluations were conducted during the proof-of-concept phase to assess the accuracy of the proprietary food detection and portion estimation models. While detailed quantitative metrics are not disclosed due to the proprietary nature of the models, the results demonstrated a satisfactory level of accuracy in estimating relative portion sizes and nutritional proportions from user-submitted images. These findings supported the feasibility of the approach and guided further refinement of the inference pipeline.

2.5 The Business Plan

2.5.1 Market and Competitor Analysis

The primary target audience consists of health-conscious adults aged 22 to 34, living in urban areas and maintaining active or fitness-oriented lifestyles. This segment values health improvement but faces time constraints and low tolerance for manual food tracking. Market validation showed that this demographic represented the majority of active and paying users, with an average age of approximately 28.5 years and balanced gender distribution.

Users in this segment are digitally native, use WhatsApp daily, and have previously attempted to track diet using traditional applications or informal methods but abandoned them due to friction and lack of engagement. Although nutrition professionals were initially considered as intermediary customers, empirical validation indicated that direct-to-consumer adoption was more feasible within the project's scope.

2.5.2 SWOT Analysis

Strengths

- Low-friction meal logging via WhatsApp
- AI-based nutritional inference adapted to Brazilian dietary context
- Favorable unit economics and low customer acquisition cost
- Scalable, modular cloud architecture

Weaknesses

- Limited marketing reach and brand awareness
- Dependence on third-party AI and messaging services
- Small operational team

Opportunities

- Growth of digital health and fitness markets in Brazil
- Increasing acceptance of AI-driven personal assistants

- Expansion to professional ecosystems (nutritionists, trainers, wellness services)

Threats

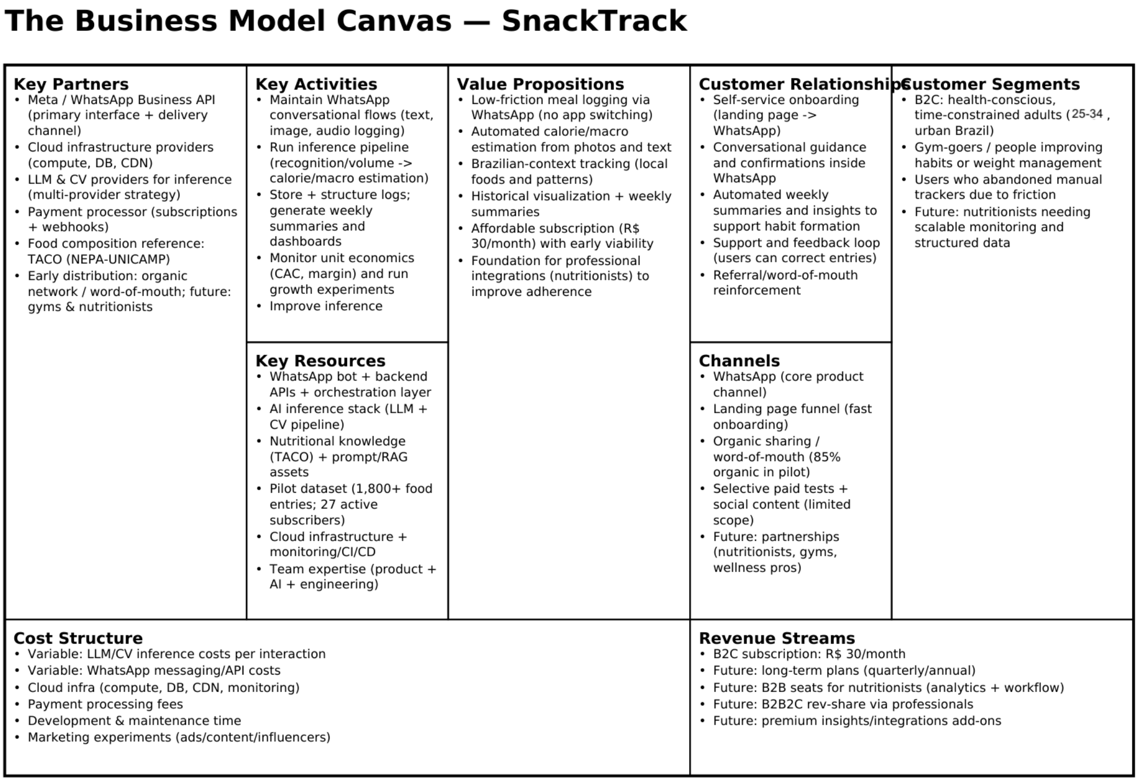
- High churn rates in consumer fitness applications
- Competition from established international platforms
- Rapid commoditization of generic AI solutions

Direct competitors include traditional food tracking applications that rely on manual data entry and database searches. These platforms provide structured tracking but impose high interaction costs, leading to low long-term adherence. Emerging AI-based solutions reduce some friction but often lack cultural localization and present higher subscription costs.

SnackTrack differentiates itself by combining automated meal recognition, conversational interaction, and local dietary contextualization. By embedding tracking into an existing daily communication channel, the platform minimizes behavioral barriers and reframes nutritional logging as a lightweight habit rather than a repetitive task.

2.5.3 Business Model (Business Model Canvas - BMC):

Figure 1 – Business Model Canvas (BMC) of SnackTrack (B2C-first)



Source: The authors (2025).

Key Partners:

- The platform depends on Meta’s WhatsApp Business API as the primary interface and delivery channel, enabling the low-friction conversational experience. In addition, cloud infrastructure providers support compute, database, and content delivery (CDN) operations required for availability and scalability. The inference layer relies on LLM and computer vision providers under a multi-provider strategy to preserve flexibility and reduce dependency risk. Payment processing providers enable subscription billing and webhook-based state synchronization. Finally, nutritional grounding is supported by the Brazilian food composition reference TACO (NEPA–UNICAMP), while early distribution is reinforced through organic network effects and, in future iterations, potential partnerships with gyms and nutritionists.

Key Activities:

- SnackTrack's core activities include maintaining WhatsApp conversational flows for multimodal logging (text, image, and audio), orchestrating the inference pipeline that transforms recognition and volume estimates into calorie and macronutrient outputs, and persisting structured logs that enable weekly summaries and dashboards. The operational model also includes monitoring unit economics (e.g., CAC and margin) and running controlled growth experiments to improve conversion and retention. Continuous improvement of inference quality remains an ongoing activity, as accuracy directly affects perceived value and long-term adherence.

Key Resources:

- The main resources include the WhatsApp bot, backend APIs, and an orchestration layer responsible for routing intents and coordinating inference steps. The AI inference stack (LLM + CV pipeline) is a critical technical resource, together with the nutritional knowledge base and prompt/RAG assets used to contextualize outputs. Pilot operational data accumulated during validation—such as the dataset of logged meals and the subscriber base—constitutes a practical asset for product refinement and retention strategy evolution. Cloud infrastructure, monitoring, and CI/CD pipelines support reliable delivery, while team expertise across product, AI, and engineering sustains iterative improvement.

Value Propositions:

- The central value proposition is low-friction meal logging via WhatsApp, eliminating the need for app switching and reducing the cognitive overhead of manual tracking. The platform provides automated calorie and macronutrient estimation from photos and text inputs, supported by Brazilian-context tracking aligned with local foods and consumption patterns. Users receive historical visualization and weekly summaries that reinforce continuity and reduce the perceived effort of dietary monitoring. The solution is positioned as an affordable subscription (R$ 30/month) with early viability demonstrated in the pilot. Additionally, the platform establishes a foundation for future professional integrations (nutritionists) aimed at improving adherence and enabling more structured follow-up.

Customer Relationships:

- The relationship model emphasizes self-service onboarding through a landing page that routes users directly into the WhatsApp experience, enabling immediate interaction. Within WhatsApp, conversational guidance and confirmations support logging clarity and reduce user uncertainty. Retention is reinforced through automated weekly summaries and insights that support habit formation, as well as a support and feedback loop that allows users to correct entries when needed, improving perceived reliability. Organic referral and word-of-mouth reinforcement is treated as a practical extension of the relationship model, as sharing behavior directly contributes to acquisition efficiency.

Channels:

- WhatsApp is the core product channel and the primary interface for logging and engagement. Acquisition is enabled by a landing page funnel designed for fast onboarding with minimal steps. Pilot acquisition occurred predominantly through organic sharing and word-of-mouth, supporting low CAC and early product acceptance. Selective paid tests and limited social content may be used to validate growth hypotheses without shifting the strategy away from controlled experimentation. In future stages, partnerships with nutritionists, gyms, and wellness professionals remain relevant distribution channels, particularly for professional-mediated retention strategies.

Customer Segments:

- The primary validated segment is B2C: health-conscious, time-constrained adults (25–34, urban Brazil). This group includes gym-goers and individuals focused on improving habits or weight management, and it is characterized by low tolerance for manual tracking friction. A key secondary segment consists of users who previously abandoned manual trackers due to effort and repetition, making them more responsive to low-friction conversational logging. As a future extension, nutritionists remain a strategic segment for scalable monitoring and structured data usage, although this was not the primary commercial focus of the MVP validation.

Cost Structure:

- Costs include variable inference expenses (LLM/CV costs per interaction) and variable WhatsApp messaging/API costs tied to usage volume. Infrastructure costs include cloud compute, database operations, CDN delivery, and monitoring. Payment processing fees and ongoing development and maintenance time represent additional structural costs. Marketing experiments (ads/content/influencers) are treated as controlled spending aimed at validating acquisition hypotheses rather than scaling prematurely.

Revenue Streams:

- The validated revenue stream is a B2C subscription priced at R$ 30/month. Future revenue mechanisms include long-term plans (quarterly/annual) to reduce churn and increase predictability. Professional monetization options include B2B seats for nutritionists (analytics and workflow) and B2B2C revenue-sharing models via professionals, contingent on partnerships and operational capacity. Additional premium streams may emerge through advanced insights and integration add-ons, aligned with professional ecosystem expansion.

2.5.4 Marketing and Sales Strategy

The go-to-market strategy prioritized fast validation over scale, adopting a B2C-first approach. The product was launched through a landing page connected directly to the WhatsApp-based experience, minimizing onboarding steps and enabling immediate interaction. This strategy allowed rapid testing of user behavior, engagement, and willingness to pay.

User acquisition relied primarily on organic channels, including word-of-mouth sharing and social exposure. This resulted in a low customer acquisition cost and a high proportion of organic conversions, indicating strong initial product acceptance. Retention strategies focused on habit formation and perceived value, including:

- Effortless daily interaction via WhatsApp
- Weekly nutritional summaries and historical insights
- Accumulation of personal data increasing switching costs

To mitigate the high churn typical of the fitness market, longer-term subscription models and future professional integrations were identified as strategic enhancements.

2.5.5 Financial Projection and Feasibility

The primary revenue model adopted for the MVP was a direct-to-consumer subscription model. Users were offered access to the platform through a monthly subscription priced at BRL 30.00. This pricing strategy was defined to balance affordability for middle-income users while sustaining operational costs and ensuring scalability.

Subscription revenue was generated directly through the platform, with users completing onboarding and payment prior to full access to the conversational assistant and nutritional tracking features. During the initial validation period, this model demonstrated practical viability, with multiple users converting from free access to paid subscriptions.

Operational costs were primarily driven by infrastructure usage, third-party AI services, messaging platform integration, and payment processing. Based on internal accounting during the MVP operation, the average operational cost per active user remained below BRL 11.00 per month, resulting in a gross margin exceeding 60%.

Customer acquisition costs (CAC) were notably low, with an average value of BRL 2.96 per acquired customer, largely due to organic traffic and word-of-mouth adoption. Lead generation costs (CPL) averaged BRL 20.00, reflecting selective marketing efforts during the validation phase. These figures indicate a favorable cost structure and strong early-stage efficiency.

Revenue collected during the validation period exceeded BRL 950.00 over approximately five months of operation, with 27 active paying users, of which 23 were acquired organically. These results suggest that the platform reached an early break-even threshold on a per-user basis, validating the sustainability of the pricing model under controlled growth conditions

The initial investment required for the project was primarily composed of development time, cloud infrastructure costs, and service subscriptions necessary to support AI inference and messaging integration. No external capital investment was required during the MVP phase, as development and deployment were executed using existing resources and academic infrastructure. This low initial capital requirement reinforces the feasibility of incremental scaling aligned with user growth.

2.6 Validation and Results

2.6.1 Validation Methodology

The validation of the proposed solution followed a qualitative and exploratory research-driven approach, inspired by principles of user-centered design and lean product discovery. In particular, the methodology was informed by practices described in *Talking to Humans* (CONSTABLE, 2014) and established UX research frameworks, emphasizing early interaction with stakeholders, hypothesis testing, and iterative learning.

From the outset, validation activities were conducted in parallel with technical development. Rather than treating validation as a final verification step, the project adopted an ongoing discovery process aimed at understanding real needs, constraints, and behaviors of both end users and professionals within the nutritional domain.

The initial validation stage focused on contextual and exploratory research. Semi-structured conversations were conducted with nutritionists, academic professionals, and university instructors to gain a broader understanding of current practices, limitations, and expectations within the field of nutrition. These discussions provided insights into professional workflows, data usage challenges, and the gap between theoretical nutritional planning and real-world patient behavior.

In parallel, direct interactions were carried out with practicing nutritionists to understand how dietary monitoring is performed in daily practice, how patients report food consumption, and which activities consume the most time and effort. These conversations informed the identification of core problems and helped formalize initial hypotheses regarding data quality, adherence, and personalization.

Based on these findings, the project adopted an iterative validation process aligned with the Double Diamond model (UXPIN, 2025). The first phase emphasized problem exploration and divergence, involving brainstorming sessions, hypothesis formulation, and qualitative research with potential users. The second phase focused on convergence through testing, where assumptions were validated or refuted using concrete artifacts such as early prototypes, conversational flows, and proof-of-concept implementations.

User validation methods included guided usability sessions, informal interviews, questionnaires, and observation of real interactions with the MVP. These methods were used to collect qualitative feedback on usability, perceived value, and friction points, as well as to identify behavioral patterns related to engagement and retention. Feedback was continuously incorporated into design and implementation decisions, enabling strategic adjustments when necessary.

This combination of qualitative research, iterative testing, and hypothesis-driven validation ensured that both the technical solution and the business assumptions were grounded in real-world evidence. The methodology supported informed decision-making throughout the project and provided a structured foundation for the market validation results presented in the following section.

2.6.2 Market Validation Results

The collected data indicates positive early-stage validation of the solution. Over 1,800 food entries were logged by users during the observation period, demonstrating consistent interaction with the platform. Demographic analysis showed that more than 40% of active users were between 25 and 34 years old, with a relatively balanced gender distribution (54% male and 46% female), aligning with the target customer profile defined earlier.

User feedback highlighted the convenience of WhatsApp-based interaction, the reduction in manual effort compared to traditional tracking applications, and the perceived usefulness of weekly summaries and historical insights. These findings support the original problem and solution hypotheses regarding friction reduction and engagement.

During the validation phase, the project explored alternative business configurations, particularly a B2B2C model in which nutrition professionals would act as intermediaries between the platform and end users. In this configuration, nutritionists would receive a percentage of the subscription revenue generated by patients onboarded through their practice. This approach was initially considered attractive due to its potential to reduce consumer churn and increase long-term retention through professional mediation.

However, empirical observation and exploratory interactions revealed significant structural barriers to adoption. One major limitation identified was platform lock-in within the nutritionist ecosystem. Many professionals already rely on established software solutions for meal planning and patient management, often adopted early in their careers or during academic training. The difficulty of migrating historical patient data and workflows created resistance to switching platforms, even when alternative solutions offered technical advantages.

Additionally, it was observed that effective scaling of a professional-mediated model would likely require strategic partnerships with established institutions, clinical systems, or high-visibility influencers within the nutrition domain. Such partnerships could facilitate trust, distribution, and credibility, but their establishment demands time, financial resources, and negotiation capacity beyond the scope of the project's duration.

Given these constraints, and considering the limited timeframe and resources available, the project opted to persist with the direct-to-consumer (B2C) configuration for the MVP. This decision was supported by existing validation results, including organic user acquisition, subscription conversion, and sustained interaction through the conversational interface. Although the B2C fitness market is characterized by higher churn rates, this approach allowed the team to deliver a fully functional, validated solution aligned with the project's objectives. The professional-mediated strategy remains viable as a future extension, contingent on partnerships and further investment.

2.6.3 Key Performance Indicators (KPIs):

Table 2 – Pilot KPIs and targets

KPI	Target	Actual (pilot)	Status
Users	N/A	140+ users (27 subscribers)	Validated
Organic acquisition	> 50%	85%	Exceeded
CAC	< BRL 10.00	BRL 2.96	Exceeded
Gross margin	> 50%	> 60%	Exceeded
Analysis time reduction vs. manual	-40%	Self-reported (total time spent in meal logging when compared with paper and other apps that require manual input.)	Achieved

Source: The authors, based on pilot operational data (2025).

2.6.4 Risks and Mitigation Plan:

Several risks were identified throughout the development and validation of the project, spanning competitive, market, technological, and strategic dimensions.

From a competitive perspective, the presence of established national and international platforms represents a significant risk, particularly as larger players may introduce localized solutions over time. This risk is mitigated through regional contextualization, cost accessibility, and rapid iteration enabled by the platform's modular and scalable architecture.

Market-related risks include the inherently high churn associated with consumer-facing fitness and health applications. Irregular usage patterns and short subscription lifecycles may affect long-term revenue stability. As a mitigation strategy, alternative pricing models, such as discounted long-term or annual subscriptions, were identified as mechanisms to improve retention and predictability of revenue.

A key long-term strategic risk relates to dependence on a purely B2C growth model. To mitigate this risk, the project envisions a gradual transition toward a professional-oriented ecosystem, leveraging an established base of engaged B2C users. By consolidating a structured and high-quality database of dietary behavior and user engagement, the platform can reduce entry barriers when expanding toward B2B or hybrid models. In this scenario, the existing user base functions as market validation and demand generation for professional services.

This strategic evolution enables expansion beyond nutritionists to other stakeholders in the health and fitness domain, such as personal trainers, wellness professionals, and related service providers, who could benefit from structured behavioral data and AI-supported insights. Such an approach supports diversification of revenue streams and reduces reliance on a single market configuration.

Technological risks are primarily associated with dependency on third-party AI services and the accuracy of automated nutritional inference. These risks are mitigated through a multi-provider strategy, internal orchestration mechanisms, and continuous testing of inference pipelines. Finally, operational and financial risks were minimized during the MVP phase by maintaining low fixed costs, leveraging cloud scalability, and avoiding upfront capital investment, as demonstrated by the platform’s positive early-stage operational margins.

3 Conclusion

This project designed, implemented, and validated SnackTrack, an AI-enabled nutritional tracking platform that integrates WhatsApp conversation flows with multimodal meal logging, structured persistence, and a web dashboard. Pilot evidence supports the feasibility of a low-friction interaction model and an affordable subscription pricing strategy, with favorable early unit economics. Future work should focus on improving inference accuracy and transparency, expanding localization coverage for Brazilian dietary patterns, and strengthening retention mechanisms, including partnerships that enable professional-mediated distribution when appropriate.

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