

FITSHIELD: PERSONALIZED FITNESS AND NUTRITION RECOMMENDATION MOBILE APPLICATION

HEALTH-AWARE DIETARY SAFETY AND FOOD-DRUG INTERACTION DETECTION

R26-IT-099

Project Proposal Report

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DECLARATION

I declare that this is my own work, and this proposal does not knowingly incorporate any material previously submitted for a degree or diploma at any other university or higher education institution, nor does it contain any material that has been previously published or written by another person apart from where proper acknowledgment is given in the text.

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ABSTRACT

Sri Lankan individuals often face challenges in selecting safe and suitable food due to the presence of food allergies and potential food-drug interactions. Many existing dietary applications provide general meal recommendations but fail to consider critical safety factors such as allergic reactions and interactions between food and medications. As a result, users may unknowingly consume harmful foods, leading to adverse health effects and unsafe dietary practices.

This research proposes a Health-Aware Personalized Dietary Recommendation and Safety Advisory System that generates customized meal suggestions while ensuring user safety. The system collects user-specific information including dietary preferences, allergies, and current medications, and evaluates each recommended food item against structured datasets to identify potential risks. It provides real-time alerts when unsafe food choices are detected and suggests safer alternatives to the user.

No existing Sri Lankan or global system effectively integrates personalized food recommendation, food allergy detection, and food-drug interaction analysis into a single platform tailored to local dietary patterns. Additionally, most systems rely on generic international datasets, lacking adaptation to Sri Lankan food habits. Addressing this gap is the key contribution of this research.

Core technologies include Python-based recommendation models, rule-based filtering for allergy and interaction detection, FastAPI for backend integration, and a React Native mobile application for user interaction. The system utilizes datasets such as Sri Lankan food composition data and publicly available food-drug interaction resources to perform accurate and context-aware analysis.

Expected outcomes include improved accuracy of dietary recommendations and enhanced user safety through early detection of harmful food combinations. The system enables users to make informed food choices and reduces the risk of adverse reactions. This research supports safer digital health solutions and promotes responsible dietary decision-making.

Keywords

personalized dietary recommendation, food-drug interaction detection, food allergy advisory, health-aware system, Sri Lankan food dataset, mobile health application

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TABLE OF CONTENTS

1. INTRODUCTION	10
1.1 Background and Context	10
1.2 Literature Review	12
1.3 Research Gap	14
2. OBJECTIVES	15
3. METHODOLOGY	16
4. HIGH-LEVEL SYSTEM ARCHITECTURE	23
5. USER REQUIREMENTS	29
6. COMMERCIALIZATION PLAN	32
7. BUDGET AND JUSTIFICATION	35
8. WORK BREAKDOWN STRUCTURE (WBS)	36
9. GANTT CHART	38
REFERENCES	39
11. APPENDICES	40

LIST OF TABLES

Table 1-Abbreviations	8
Table 2-Literature Review	13
Table 3-Research Gap	14
Table 4-Specific Objectives	16
Table 5-Tools and Technologies	21
Table 6-Component Interactions and Data Flow	24
Table 7-Component Description	26
Table 8-Stakeholder Identification	29
Table 9-Functional Requirements	30
Table 10-Non-Functional Requirements	31
Table 11- Pricing Strategy	33
Table 12-Budget and Justification	35
Table 13-Work Breakdown Structure Table	36
Table 14-Risk Analysis	41

LIST OF FIGURES

Figure 1-System Diagram	25
Figure 2- Individual Component Diagram	27
Figure 3-WBS	37
Figure 4-Gantt chart	38
Figure 5-Survey Instruments	40
Figure 6-Food Safety Check Screen	42
Figure 7-Health Safety Dashboard UI	42
Figure 8-Food Allergy Detection Screen	42
Figure 9-Drug-Food Interaction Warning Screen	42

LIST OF ABBREVIATIONS

AI: Artificial Intelligence

ML: Machine Learning

BMI: Body Mass Index

WHO: World Health Organization

SLIIT: Sri Lanka Institute of Information Technology

FR: Functional Requirement

NLP: Natural Language Processing

API: Application Programming Interface

UI: User Interface

DSR: Design Science Research

SDG: Sustainable Development Goal

LIST OF APPENDICES

Appendix A: Survey Instruments

Appendix B: System Diagram

Appendix C: Ethical Considerations

Appendix D: Risk Analysis

Appendix E: Sample UI Designs

1. INTRODUCTION

1.1 Background and Context

Maintaining a healthy and safe diet has become increasingly challenging in modern society due to unhealthy eating habits, lack of nutritional awareness, and the growing consumption of processed foods. In the Sri Lankan context, dietary patterns are highly diverse and culturally specific, with rice-based meals, coconut-based preparations, and traditional foods playing a major role in daily consumption. Existing studies have developed localized food composition databases but lack intelligent personalization or food safety validation mechanisms.

One of the major overlooked issues in dietary recommendation systems is food-drug interaction. Certain foods affect the absorption and efficacy of medicines. In addition, food allergies present another critical risk. Most apps rely on generic Western datasets that lack adaptation to Sri Lankan food habits.

1.1 Background and Context (Cont.)

There is currently no unified system that integrates personalized dietary recommendation, food-drug interaction detection, food allergy detection, and risk-based safety evaluation using localized Sri Lankan data.

This research proposes a Risk-Aware Personalized Dietary Recommendation and Food Safety System that classifies foods into Safe, Moderate, and Dangerous categories. It aligns with UN SDG 3 (Good Health and Well-being), SDG 9 (Innovation), and SDG 12 (Responsible Consumption).

1.2 Literature Review

Research covers four areas: Sri Lankan dietary datasets, AI dietary systems, food-drug interaction analysis, and allergy detection. Studies by Jayawardena et al. (2022) developed food composition databases and atlases. Machine learning models by Jayarathna & Weerakoon (2023) and Yang et al. (2023) improved personalization but ignored medical contraindications and food safety.

1.2 Literature Review (Cont.)

Table 2 reviews work across clinical pharmacology and dietary AI: Jayawardena et al. (2022), Jayarathna & Weerakoon (2023), Yang et al. (2023), Chen et al. (2023), Freyne & Berkovsky (2023), Smith & Kumar (2024), Schmidt & Dalhoff (2024), Bushra et al. (2023), Lacruz-Pleguezuelos et al. (2023), and Patel et al. (2024).

1.3 Research Gap

Identified Gaps (Table 3): G1: Dietary recommendation systems focus on personalization but ignore medical safety; G2: Food-drug interaction studies remain clinical datasets; G3: Allergy detection operates standalone; G4: Lack of risk severity classification; G5: Limited use of localized Sri Lankan food datasets; G6: No unified platform combining recommendation, safety validation, and explainable outputs.

2. OBJECTIVES

2.1 Main Objective

To develop an AI-based personalized dietary recommendation system with integrated food safety analysis and risk scoring, providing context-aware food recommendations based on health conditions, medications, and allergies.

2.2 Specific Objectives

SO1: Analyze user health profiles with personalization accuracy $\geq 80\%$; SO2: Detect food-drug interactions with precision ≥ 0.90 and recall ≥ 0.85 ; SO3: Implement allergy detection with accuracy $\geq 90\%$; SO4: Classify safety levels into Safe, Moderate, and Dangerous with accuracy $\geq 85\%$.

2.2 Specific Objectives (Cont.)

SO5: Provide real-time alerts and safer alternative food recommendations within < 5 seconds during usability testing.

SO6: Integrate all modules into a unified system with response time < 3 seconds and SUS score >= 70.

3. METHODOLOGY

This study follows Design Science Research (DSR). Components include: User Profile Management, Dietary Recommendation Engine, Food-Drug Interaction Detection Module, Food Allergy Detection Module, Risk Scoring and Safety Evaluation Module, Alert and Alternative Recommendation Module, and User Interface Delivery.

3.1 Data Collection

Primary data collected via user surveys, nutritionist interviews, and app logs. Secondary data includes Sri Lankan food composition tables, FooDrugs interaction database, and allergen ontologies.

3.2 Technical Methods and Algorithms

Random Forest Classification is selected for dietary recommendation due to strong performance on mixed categorical and continuous tabular health vectors. Rule-based interaction screening checks candidate ingredients against medications using if-then production rules. Ingredient matching detects allergens.

3.2 Technical Methods (Cont.)

Content-based similarity filtering refines meal suggestions using cosine similarity. Risk scoring engine aggregates interaction weights and classifies items into Safe, Moderate, and Dangerous with real-time substitution recommendations.

3.5 Tools and Technologies

Table 5 outlines stack selection: Frontend: React / React Native for cross-platform mobile delivery; Backend: Django / FastAPI for secure health data APIs; Database: PostgreSQL for relational meal and interaction rules; Machine Learning: Scikit-learn with Random Forest.

3.6 Validation Strategy

5-fold cross-validation targeting $F1 \geq 0.75$ for recommendations. Interaction detection evaluated against curated medical benchmarks targeting precision ≥ 0.90 . System usability evaluated with 20 participants targeting SUS ≥ 70 .

3.7 Ethical Considerations

All health data anonymized and encrypted using AES-256. Informed consent acquired under SLIIT Research Ethics Committee guidelines. Recommendations display non-prescriptive advisory disclaimers.

4. HIGH-LEVEL SYSTEM ARCHITECTURE

FITSHIELD combines 4 integrated modules: AHEE Habit Evolution Engine (IT22621542), Posture Recognition System (IT22248176), Smart Supplement Advisory (IT22169044), and Dietary Recommendation & Food-Drug Interaction System (IT22065476).

Table 6: Component Interactions

Table 6 details data flow between profiling, computer vision, supplement screening, and dietary safety layers without functional duplication.

Figure 1: System Diagram

Figure 1 illustrates end-to-end data pipelines connecting mobile users, food databases, interaction rule engines, and safety alert dispatchers.

4.3 Component Description

Table 7 breaks down Health Profile Onboarding, Nutrition Analysis, Interaction Detection, Allergy Matching, Risk Scoring, and Alert Generator modules with assigned technologies.

Figure 2: Component Flowchart

Flow diagram mapping user onboarding input through ML scoring, drug checking, and safety alert rendering.

4.4 Scalability and Security

Horizontal cloud scaling, API caching, encrypted transit (TLS 1.3), AES-256 rest encryption, and strict role-based access control.

5. USER REQUIREMENTS

Table 8 identifies primary end users, medical-sensitive cohorts, dietitians, and system administrators with respective functional priorities.

Table 9: Functional Requirements

FR01 to FR10 specify health profile storage, food ranking, allergy detection, food-drug interaction alerts, alternative meal suggestions, and admin database updating.

Table 10: Non-Functional Requirements

NFR01 (Response time < 3s), NFR02 (Accuracy $\geq 80\%$, Precision ≥ 0.90), NFR03 (SUS ≥ 70), NFR04 (AES-256 security), NFR05 (99% uptime), NFR06 (5,000 users scalability), NFR07 (Maintainability), NFR08 (Accessibility).

6. COMMERCIALIZATION PLAN

Target Market: Health-conscious adults and individuals managing chronic medical conditions in urban Sri Lanka.
Customer personas: "Nadeesha" (working professional) and "Kavindu" (diabetic patient on medication).

6.3 Revenue Model & Pricing

Tiered freemium subscription: Free Tier (basic meals), Basic Tier, Premium Tier (full food-drug safety & risk scoring), and Advanced Tier (chronic care integration).

6.6 Competitive Advantage & IP

First localized platform incorporating Sri Lankan food habits, ingredient-level allergy analysis, and 3-tier risk scoring. Intellectual property protected via copyright and proprietary risk algorithms.

7. BUDGET AND JUSTIFICATION

Table 12 Budget: Cloud Servers (20,000 LKR), Cloud Database (12,000 LKR), Domain & API Services (8,000 LKR), Google Play Account (9,000 LKR), Dataset Preparation (7,000 LKR), Device Testing (10,000 LKR), Internet (6,000 LKR), Operations (10,000 LKR). Total: 82,000 LKR.

8. WORK BREAKDOWN STRUCTURE (WBS)

Table 13 details Work Packages WP1 (Data Collection), WP2 (Feature Engineering), WP3 (Model Development), WP4 (Safety System), WP5 (Backend API), WP6 (Mobile App), WP7 (Database Integration).

Figure 3: WBS Structure

Visual breakdown of work packages across preprocessing, model training, safety verification, and mobile testing.

9. GANTT CHART

Figure 4 illustrates timeline across the two academic semesters leading to final viva defense.

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11. APPENDICES

Appendix A: Survey Instruments for dietary habits and allergy awareness in Sri Lanka.

Appendix B: Ethical compliance statement.

Appendix C: Risk analysis table (insufficient datasets, model overfitting, API downtime).

Appendix D: Sample UI Designs

Figure 6: Food Safety Check Screen

Figure 7: Health Safety Dashboard UI

Figure 8: Food Allergy Detection Screen

Figure 9: Drug-Food Interaction Warning Screen

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