REMOTE HEALTH MONITORING: A REVOLUTIONARY SOFTWARE FOR AUTONOMOUS DETECTION OF PULMONARY AND CARDIAC ABNORMALITIES A CUSTOMISED DIETERY PLAN

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February 2024

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Project Proposal Report

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DECLARATION

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

Signature of Supervisor
(Dr. Dilshan De Silva)

Date

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29/2/2024

ABSTRACT

Maintaining optimal health requires a personalized approach to nutrition. This research proposal aims to develop a system for generating customized dietary plans tailored to an individual’s unique needs. The proposed system will utilize a person’s age, gender, height, weight and blood oxygen saturation, glucose levels, cholesterol levels, ECG readings and pulse rate as inputs.

This comprehensive data will be processed and analyzed using machine learning algorithms to identify unique dietary requirements and potential health risks. Subsequently, the system will generate a personalized dietary plan based on these factors, accessible through a user-friendly mobile application. Based on the identified diagnosis from the inputs, the system tends to generate a dietary plan that addresses these factors designed to promote overall health and wellbeing.

This research holds the potential to revolutionize the approach to personalized nutrition, enabling individuals to make informed dietary choices based on their specific health profile.

Keywords: Dietary plan, health optimization, machine learning, mobile application, Electrocardiogram

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Abbreviation	Description
Spo2	Blood oxygen saturation
ECG	Electrocardiogram
NCD	Non-Communicable diseases
GDP	Gross Domestic Production
US	United States

1. INTRODUCTION

Maintaining optimal health is a crucial aspect of well-being, and a key factor in achieving this is a personalized approach to nutrition. However, navigating the vast landscape of dietary advice and recommendations can prove challenging for individuals seeking to optimize their health through tailored dietary strategies, specially for individuals who have busy lifestyle choices.

This research proposal outlines the development of a novel software solution aimed at addressing this gap. The proposed system will leverage the power of technology and machine learning algorithms to generate personalized dietary plans tailored to individual health profiles.

The rationale behind this research stems from the limitations of existing dietary approaches which only consider one or few essential components but not all that is required. These approaches often fail to consider individual differences in age, gender, body composition, metabolic needs, and potential health conditions. This can lead to suboptimal dietary choices and potentially hinder individuals in achieving their health goals.

The proposed software solution will address these limitations by collecting and analyzing various health metrics from individuals. These metrics include demographic data (age, gender), anthropometric data (weight, height), physiological data (SpO2, glucose, cholesterol levels), and additional data points (potentially ECG readings, pulse rate, activity level)

Once collected, the data will be anonymized and pre-processed to ensure quality and suitability for analysis. Subsequently, machine learning algorithms will be used to identify patterns and relationships between the various health metrics and optimal dietary recommendations.

Based on these analyses, the proposed software solution will generate personalized dietary plans for everyone, providing recommendations tailored to their unique needs and health goals.

This research holds significant potential to revolutionize the approach to personalized nutrition. By harnessing the power of technology and data analysis, the proposed solution offers the potential to empower individuals to make informed dietary choices, thereby promoting overall health and well-being.

1.1 Background & Literature Survey

Consuming a healthy diet throughout the life-course helps to prevent malnutrition in all its forms as well as a range of noncommunicable diseases (NCDs) and conditions. However, increased production of processed foods, rapid urbanization and changing lifestyles have led to a shift in dietary patterns. People are now consuming more foods high in energy, fats, free sugars and salt/sodium, and many people do not eat enough fruit, vegetables, and other dietary fiber such as whole grains [1].

The increasing focus on health in the modern era has led to a growing trend of individuals seeking to improve their dietary habits. This often involves adopting healthier practices like reducing sugar and carbohydrate intake or increasing physical activity. However, adhering to rigid, unguided dietary changes can be detrimental to an individual's well-being. For instance, while reducing sugar consumption is generally beneficial, eliminating it can disrupt metabolic processes. Therefore, individualized, and well-informed approaches to healthy eating are crucial [2].

To cater to this demand, a multitude of software applications offering dietary plans have emerged. However, these applications often fail to address several key concerns:

1. Lack of personalization: Most applications propose generic recommendations, neglecting individual differences like health conditions, dietary preferences, and activity levels. This leads to suboptimal outcomes as individual needs are not adequately considered [3].
2. Comprehensiveness: Many applications lack comprehensiveness in their approach. This can manifest in various ways, including:
    a. Data Collection: They may not collect a comprehensive range of data points, such as individual health metrics, dietary habits, and physical activity levels, resulting in incomplete assessments [4].
    b. Inadequate personalization methods: Current personalization techniques often rely on generic algorithms or pre-defined categories, failing to account for the complex and unique needs of everyone.
    c. The methodologies employed by some applications lack transparency and scientific rigor, raising concerns about their effectiveness and reliability [3].

The limitations of existing dietary applications necessitate a shift towards more personalized and data-driven approaches. By addressing these concerns and leveraging advancements in technology, we can create effective and evidence-based tools that empower individuals to make informed dietary choices and achieve their health and wellness goals.

1.2 Research Gap

While existing dietary applications offer various meal plans and recommendations, they often fall short in addressing the specific needs of diverse communities. This research aims to bridge this gap by focusing on the Sri Lankan community and considering the individuals age, height, weight, gender, and other factors such as ECG, Heart rate, Spo2, glucose level and cholesterol level.

Lack of Cultural Sensitivity - Existing applications primarily cater to a general audience, neglecting the unique dietary needs, preferences, and cultural constraints specific to the Sri Lankan community, which includes factors like:

   a. Traditional ingredients and culinary practices
   b. Religious dietary restrictions (e.g., vegetarianism, specific food avoidance)
   c. Cultural preferences for taste and texture

2. Limited data integrations - Most applications rely solely on user-reported data, which can be prone to errors and biases. This research proposes incorporating real-time physiological data from smartwatches, such as:
   a. Heart rate
   b. Blood glucose level
   c. Spo2
   d. Cholesterol level
3. 12 lead ECG pattern is also considered unlike any other diet planning application. This broader data scope will enable a more comprehensive understanding of individual health and lifestyle, leading to more accurate and personalized recommendations.
4. Lack of personalized methodologies: Existing personalization methods often employ generic algorithms or predefined categories, failing to capture the complex and unique needs of individual users. This research proposes exploring the development of machine learning algorithms specifically trained on:
   a. Comprehensive user data (including smartwatch data)
   b. Established Sri Lankan dietary guidelines.
   c. Cultural food preferences and restrictions

With the use of this diverse dataset, it is expected to train an accurate algorithm which could learn patterns and generate personalized dietary plans that are tailored to individual health goals and cultural context.

By addressing these gaps and limitations, this research proposes a novel and culturally sensitive approach to personalized dietary recommendations within the Sri Lankan community, ultimately promoting healthier dietary habits and contributing to overall well-being.

1.3 Research Problem

Eating and Food provides a crucial impact when it comes to a person`s health. Even thinking about food and longing for food plays a key role in our lives with people making more than 200 food decisions daily. [5] During the modern era, most people have come to state that eating is essential for survival and consume that is only required for it. A person's food consumption has an impact from external factors such cultural behaviors, geographical variations, and various personal targets.

However, food is not the only source of pleasure and enjoyment of manhood today. But due to its rapid increase in concern because of its substantial consequences of ill health. The growing epidemic of overweight resulting from obesogenic environment with plenty of cheap high caloric non hygienic food available at any plenty of time had made a vital importance as to why we food should be a key concern [6]. A substantial proportion of the world population, which includes both children and adolescents, are at the risk of being overweight with consequences in terms of increased risk of chronic illness [7]. The overweight epidemic has spurred research into the health consequences of overeating and overweight, and information about this has found its way to the public that now tends to associate eating with health, especially in the US.[6]

When it comes to food intake analysis of Asian region both overweight and underweight aspects need to be considered. Specially in countries like Sri Lanka the malnutrition rate increased to 15.3 per cent in 2022 from 12.2 per cent in 2021 [10]. Key major factors that cause unhealthy food intake patterns in Asian countries are mainly because of its demographical and socio-economic factors of nutrition transition. In Sri Lanka the income level, female labor force participation rate, urbanization and prevalence of processed food coupled with low quality cheap unhealthy fruits and vegetables available in market are in favor of a nutrition transition [8]. During the 1963 to 2016 period, there has been a marked increase in the income levels of people. Per capita GDP has increased from 147 US$ to 3,835 US$. More women have entered the workforce (the female labor force participation rate has improved from 14.2% to 35.9%) [9].

Food Category	1961	1970	1980	1990	2000	2010	2011	2012	2013
Alcoholic beverages	1.18	1.06	1.03	0.84	1.96	3.64	5.17	6.75	6.51
Sugar crops	7.90	5.46	7.95	17.01	25.31	29.52	18.93	16.88	30.10
Cereals	121.44	139.43	129.5	140.84	137.18	148.08	149.83	152.35	152.26
Eggs	0.92	1.40	1.86	2.45	2.38	2.61	2.72	2.75	4.57
Vegetables	19.70	16.44	25.72	31.28	32.83	38.46	40.34	41.59	46.24
Milk	17.49	20.9	27.72	28.22	32.61	36.07	40.61	39.98	34.98
Pulses	7.17	5.91	4.01	4.88	6.92	8.94	10.03	8.02	9.29
Vegetable oil	3.23	3.94	3.92	2.80	2.66	2.98	2.87	3.46	3.17
Animal fats	0.45	0.37	0.21	0.25	0.24	0.13	0.13	0.13	0.13
Fish	16.43	14.11	14.71	15.16	22.34	24.14	26.08	25.86	25.65
Fruits	38.40	38.21	121.48	37.16	39.54	35.15	36.70	36.61	36.15
Meat	3.97	4.46	3.53	3.17	5.38	6.60	6.34	6.45	6.48
Oil crops	67.07	76.52	67.31	66.67	66.9	63.87	66.95	70.43	72.44
Spices	5.15	3.62	3.25	2.53	3.65	4.65	5.21	4.72	4.61
Starchy roots	30.73	26.27	32.38	22.07	19.03	18.11	19.13	18.52	19.87
Sugar (raw equivalent)	17.60	24.65	17.29	18.47	30.68	28.49	27.03	26.71	26.34

Figure 1: Changes in Food Supply in Sri Lanka by selected years (kg/capita/year)

Source: [8]

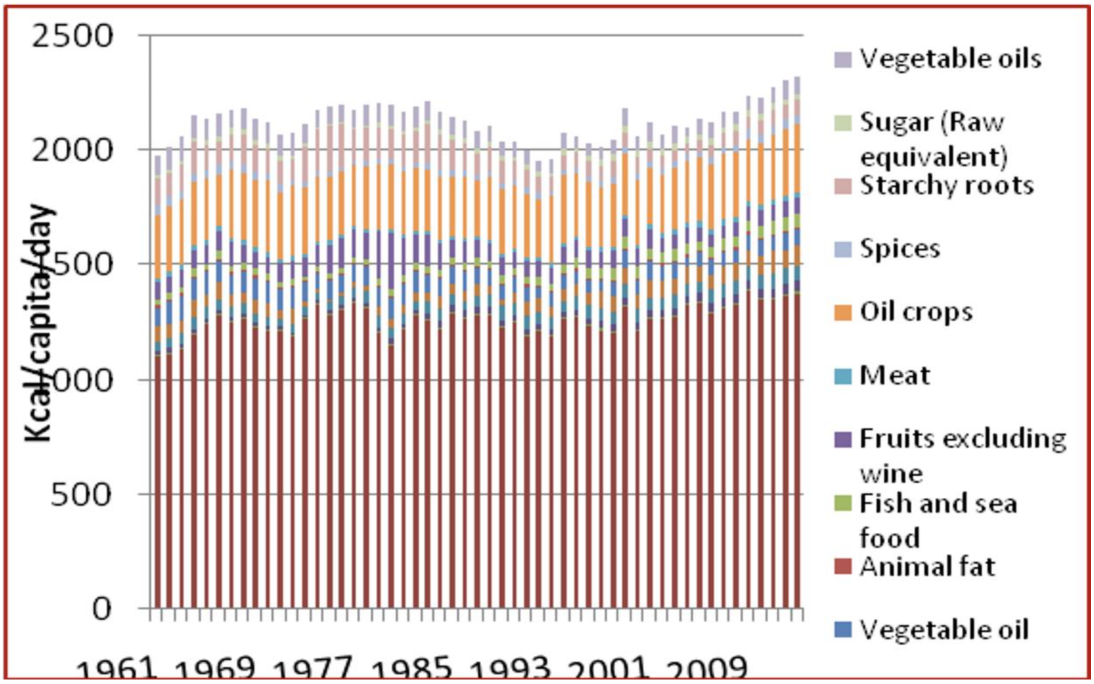

Figure 2: Changes in Total Energy Supply (Kcal/capita/day) from selected aggregated food items.

Source: [8]

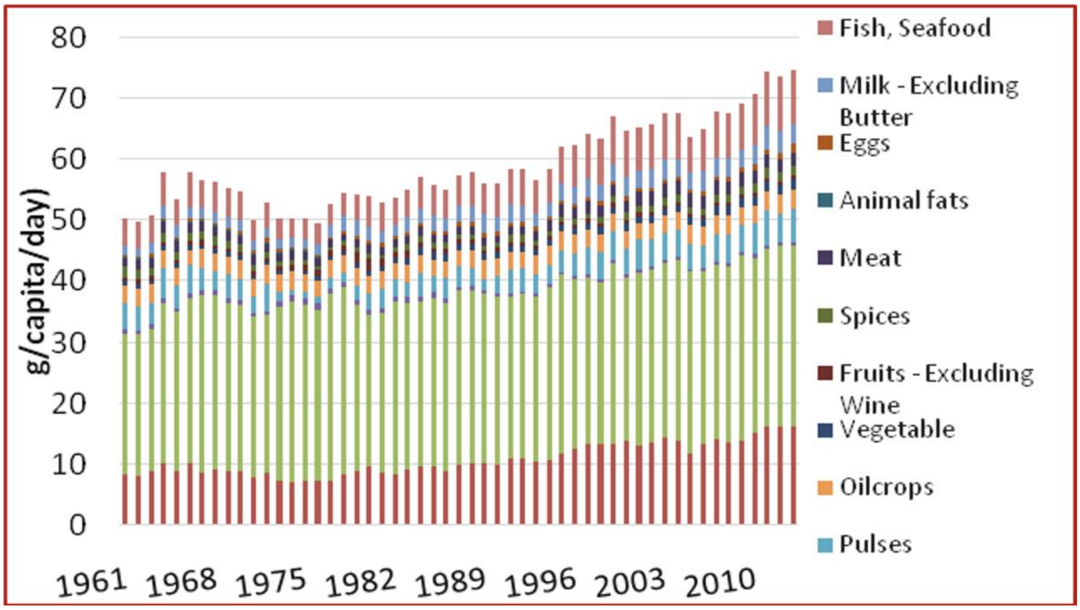

Figure 3: Changes in Protein Supply (g/capita/day) from selected aggregated food items.

Source: [8]

The above diagrams represent the consumption patterns of the citizens in Sri Lanka, due to its economic and social status with the competitive and hectic human lifestyle in modern era.

With the rapid growth of non-communicable diseases and interest in maintaining healthy diet, a variety of dietary plans are followed by people to battle the impacts triggered by the ill effects caused by harmful consumption. Out of all the methodologies followed many tend to use mobile apps which guide them to consume healthy diet by suggesting food items matching to the persons demographics entered such as age, height, weight, and gender. The main limitation behind these approaches is its inefficiency in proposing an accurate diet plan matching the person's physiological factors such as pulse rate, Spo2, blood glucose level, cholesterol level and ECG readings. Due to this reason, there is a tendency that a person who consumes a proposed diet plan from an application which only focuses on demographic data leads to surge in non-communicable disease even when they believe they consume healthy diet. This provides the importance of building an application which could predict a personalized diet plan to people considering not just demographic data (age, gender) and anthropometric data (weight, height) but also physiological data (SpO2, glucose, cholesterol levels), and additional data points (potentially ECG readings and pulse rate).

2. OBJECTIVES

2.1 Main Objectives

Provide a personalized diet plan for Sri Lankan Community by considering collection of personalized factors for accurate healthy effective diet plan prediction.

2.2 Specific Objectives

1. Collect dataset which contain demographic data (age, gender), anthropometric data (weight, height), physiological data (SpO2, glucose, cholesterol levels)
2. Identify and classify current dietary patterns and specific food groups. With suitable examples.
3. Validate the generated diet plan with persons food allergies and intolerances, cultural dietary preferences, and restrictions.
4. Explore how to map the generated diagnosis results with an accurate diet plan using suitable machine learning algorithm.
5. Conduct pilot studies to test the accuracy of the software.

3. METHODOLOGY

The first crucial step in building this personalized dietary recommendation system involves collecting comprehensive user data. Surveys will be conducted to gather information on demographics, dietary habits, health conditions, and cultural preferences specific to the Sri Lankan community. Additionally, with user consent and adherence to ethical guidelines and data privacy regulations, the system will integrate with compatible smartwatches to collect real-time physiological data like heart rate, sleep patterns, and activity levels. Based on the input data it is expected to recognize patterns in food that could be recommended for individuals who tend to have similar abnormalities.

Once collected, this data will undergo careful preprocessing. This involves cleaning the data by identifying and addressing missing values, outliers, and inconsistencies. Additionally, standardizing data units and formats ensures consistency for further analysis. Feature engineering may also be employed to create new features relevant to the analysis and personalization process.

Moving forward, a culturally sensitive framework will be developed in collaboration with Sri Lankan nutritionists and culinary experts. This collaboration will involve analyzing traditional Sri Lankan recipes and ingredients, identifying culturally significant food preferences and restrictions, and establishing a database of culturally appropriate and readily available ingredients. Importantly, the framework will also encompass guidelines and recommendations that align with existing Sri Lankan dietary guidelines and cultural context. Also, it is essential to identify the food recommendations are fully personalized so that if an individual is having food poison when consuming a relevant product, a few alternative dietary plans should also be recommended.

The core of the system lies in machine learning model training. Here, user data, smartwatch data, and information from the culturally sensitive framework will be combined into a comprehensive dataset. This dataset will then be split into training, validation, and testing sets to facilitate model development and evaluation. Open-source algorithms suitable for personalized recommendation systems will be explored and compared. These potential algorithms include Collaborative Filtering (CF) for recommending items based on similar user preferences, Content-Based Filtering (CBF) for recommending items like previously liked items based on their features, and Hybrid Recommendation Systems that combine both CF and CBF techniques. After selecting the most suitable algorithm, it will be trained on the prepared dataset, with hyperparameters adjusted for optimal performance. The model's performance will be evaluated using metrics like precision, recall, and recommendation accuracy on the validation set. Based on these results, the model will be fine-tuned to ensure its effectiveness.

The final stages involve software development and user interface design. A user-friendly and culturally sensitive mobile application or web interface will be created for user interaction. This interface will incorporate features for user registration and login, secure data collection and storage, user profile management and goal setting, visualization of data, display of personalized dietary recommendations tailored to individual needs and cultural preferences, and access to educational resources on healthy eating and Sri Lankan cuisine.

To ensure user trust and refine the system, a pilot study will be conducted with a representative sample of the Sri Lankan community. This pilot study will gather valuable feedback on the application's usability, cultural sensitivity, and effectiveness. Based on this feedback, the system will be further refined to address any identified issues before its wider launch within the community.

3.1 Component Diagram

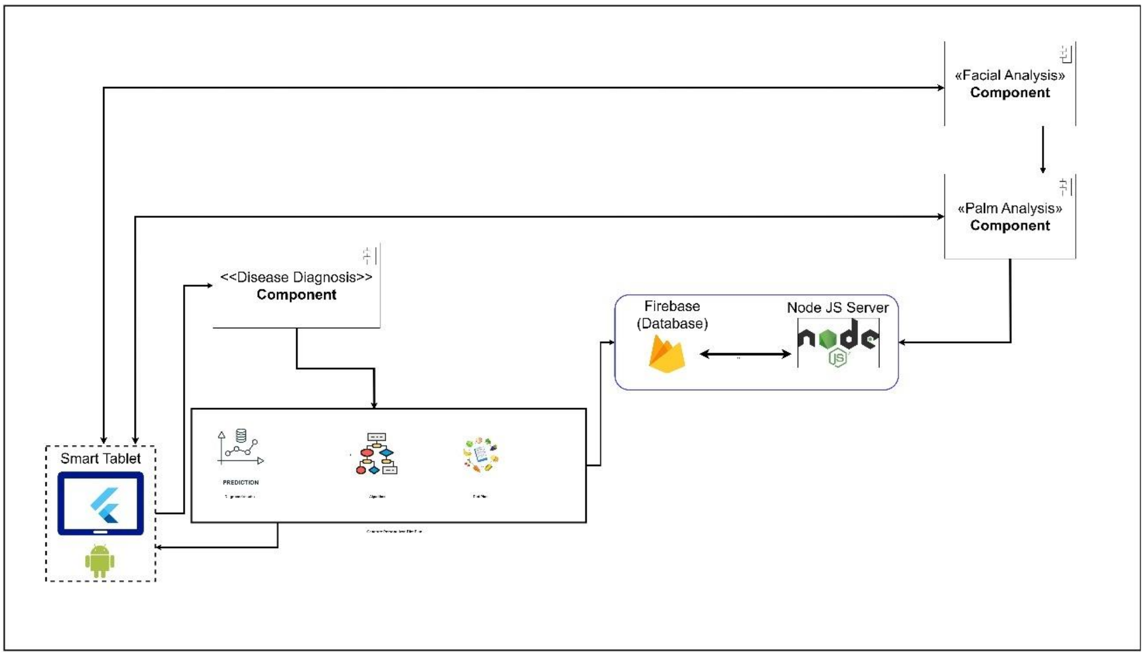

Figure 4: Component Diagram for Personalized Dietary Plan

In this research component I intend to provide a mobile device which would be a tablet device for the end users to view their dietary information and reporting. As inputs I intend to gather individuals’ demographic information.

With the demographic information and predicted abnormalities of the individual based on physiological factors, I aim at mapping the best dietary plan that could be suggested to the individual with a set of alternatives. Here my special focus is to customize the generated output which matches the cultural and social preferences of individuals in Sri Lanka.

Further as the database, Firebase is expected to be used along with Node JS Server which could aid in getting the optimum usage of variety of machine learning algorithms to do the predictions. The expected framework to be used is flutter, flutter is selected due to its inherent ability to used as a cross platform and screen responsive capability.

4. PROJECT REQUIREMENTS

4.1 Functional Requirements

1. Predict an accurate diet plan matching the person’s diagnosis.
2. Store user demographics such as age, gender, weight, and height effectively.
3. Build a user-friendly mobile application which has smooth navigation and high usability.
4. Ensure personal details of users are secure.
5. Provide a reporting interface for the users to track the diet patterns and health conditions in an attractive manner.

4.2 Non-functional Requirements

1. Performance - Responsive and fast loading, even on various devices and internet speeds.
2. Scalability - Ability to handle a growing user base without compromising performance.
3. Usability - Intuitive and easy to navigate for users with varying technological expertise.
4. Availability - Highly available with minimal downtime to ensure user access.
5. Maintainability - Well-documented and easy to maintain and update.

4.3 System Requirements

1. The mobile application is expected to be built using flutter technology. Therefore, the machine learning libraries should support flutter farmwork, the mobile devices used by the user should have minimum SDK version 21 to 34 in android and 17 in IOS.
2. Reliable network connection, for seamless data creation, retrieval, update and deleting.

4.4 User Requirements

1. Users should be able to capture access to the internet connection to their devices.
2. Users need to have a smart watch.
3. Users are expected to have a basic technical literacy on how to use a smart phone and a smartphone.
4. Willingness to provide accurate data.

4.5 Use Cases

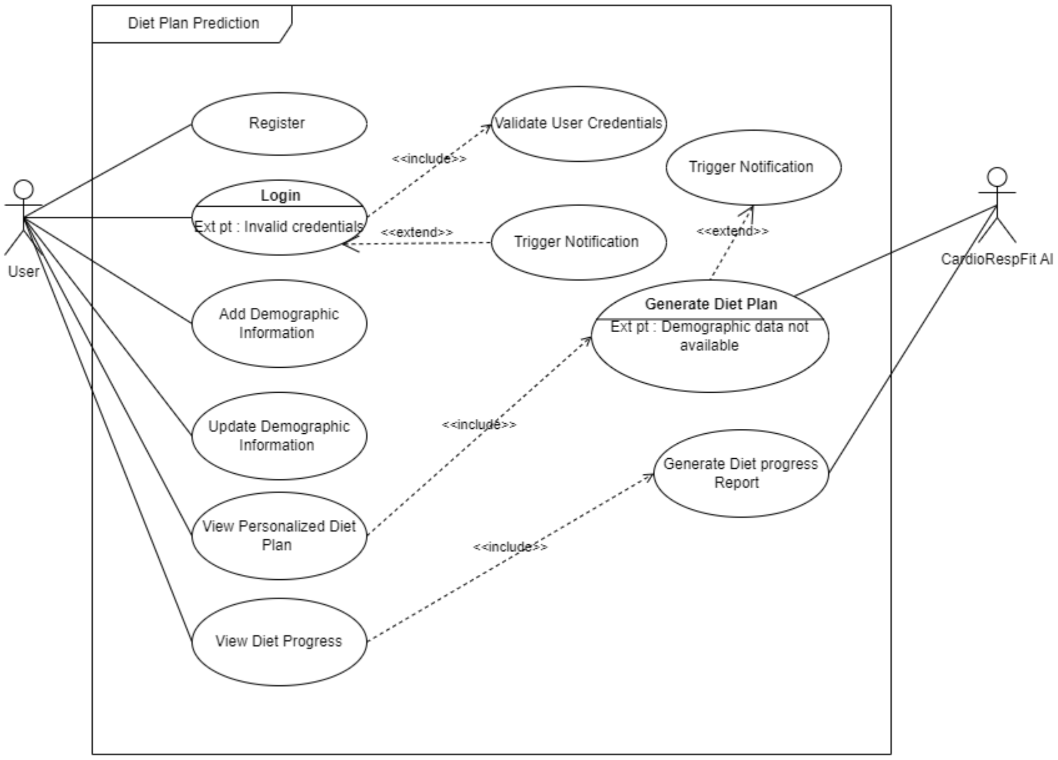

Figure 5: Use Case Diagram for personalized Dietary plan component.

1. When the user enters their registration information (name, email, and password) the system validates the information and creates a new user account if the user has not logged in previously.
2. The system must validate User login credentials when an existing user logs in to the system.
3. The System must generate personalized diet information to the user based on the predicted diagnosis.

4. A user should have the facility to add and update demographic information such as weight, height, and age.
5. Users should have the facility to view a progress report on their diet plan.
6. The system is obliged to generate meaningful notifications when the user fails to enter expected inputs.

4.6 Test Cases

Table 1: Test Cases

Id	Name	Scenario	Expected Output
1.	User Login Test	Enter invalid credentials and login to the system	The system should trigger an error message
2.	New User sign up Test	Enter credentials of an existing user and click sign in	The system should trigger an error message, "Stating that the user already found"
3.	Sign up form Validation test	Enter incorrect email format and numbers in the name field	System should show inline validations and should not allow the user to submit the sign-up form.
4.	Check Form Validations in demographic data enter form	Enter inappropriate values in the text input fields like type a word in the age field where numbers are expected	The system should trigger error messages and should not allow the use to submit the demographic data
5.	Generate diet plan when demographic data not entered	If the user request to generate a diet plan when demographic data are blank	Notify the user with a warning message stating that the generated diet plan may not be accurate due to lack of demographic data.

4.7 Wireframes

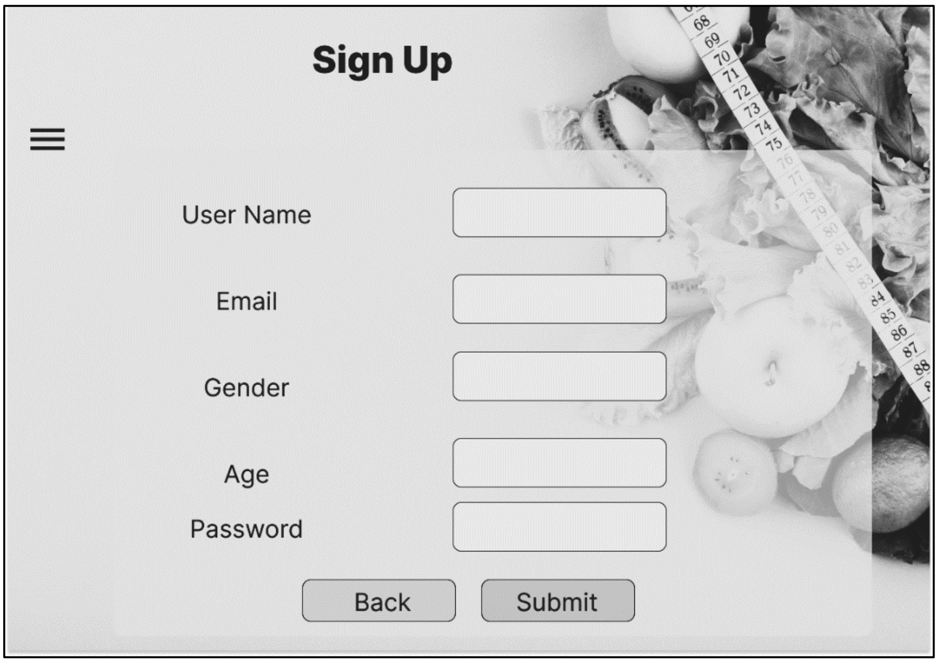

Figure 6: High Fidelity Wireframe - Sign up page.

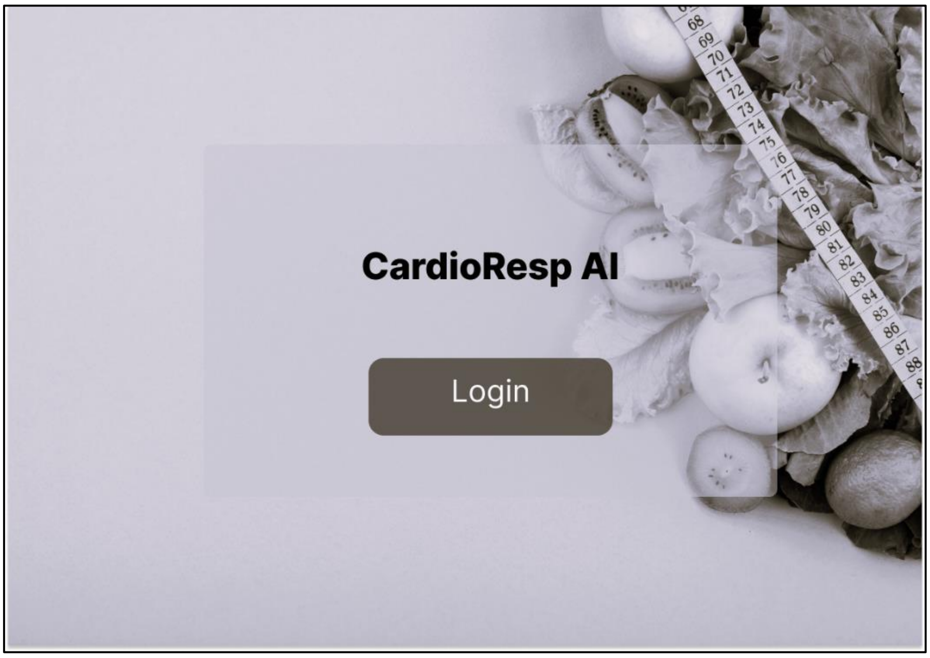

Figure 7: High Fidelity Wireframe - Login Screen

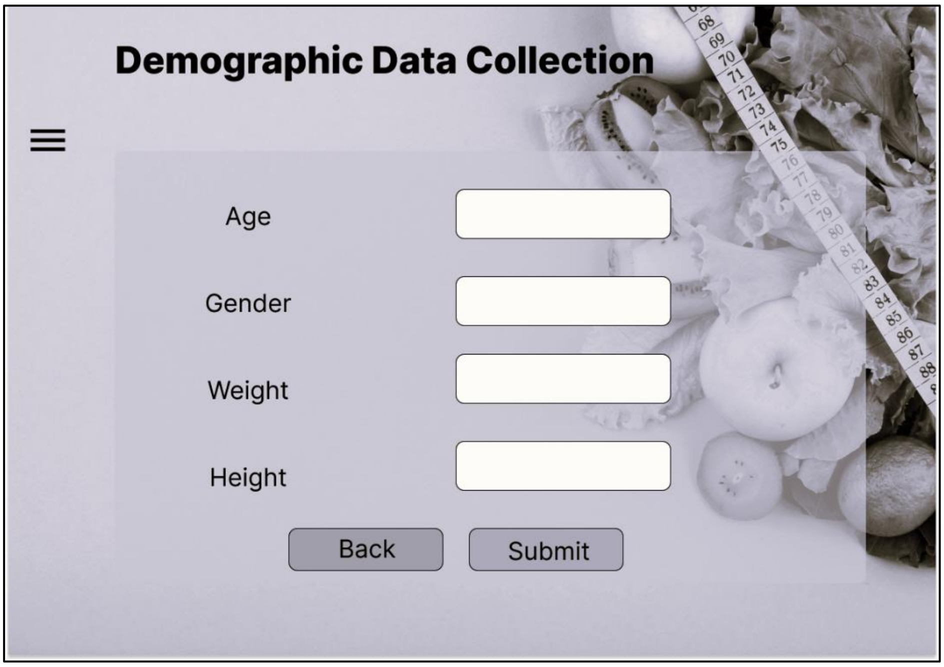

Figure 8: High Fidelity Wireframe - Collecting Demographic Data

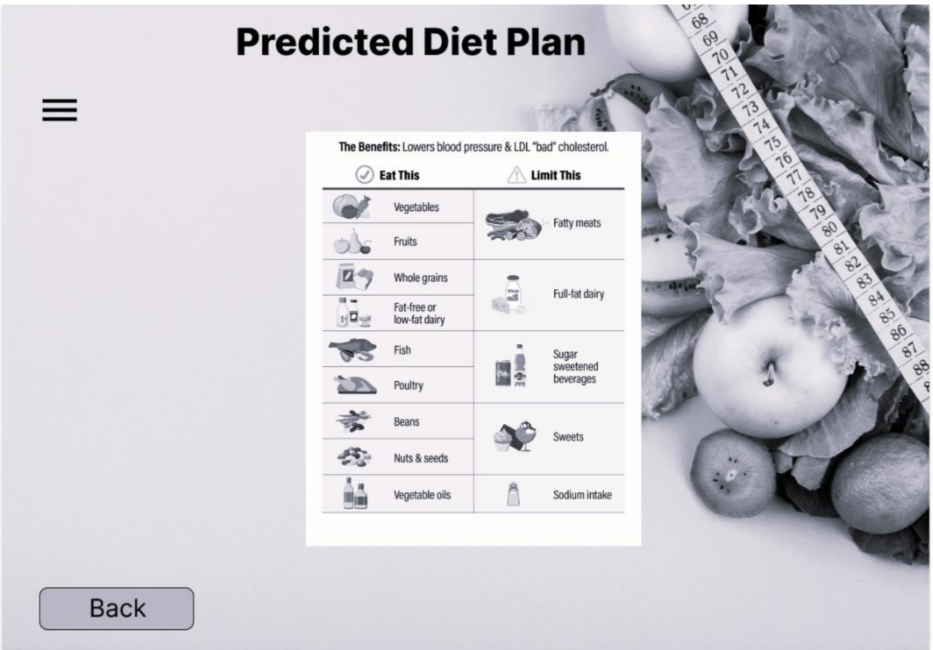

Figure 9 : High Fidelity Wireframe - Proposed Diet Plan

Figure 10 : High Fidelity Wireframe - Diet Progress Report

5. WORK BREAKDOWN STRUCTURE (WBS)

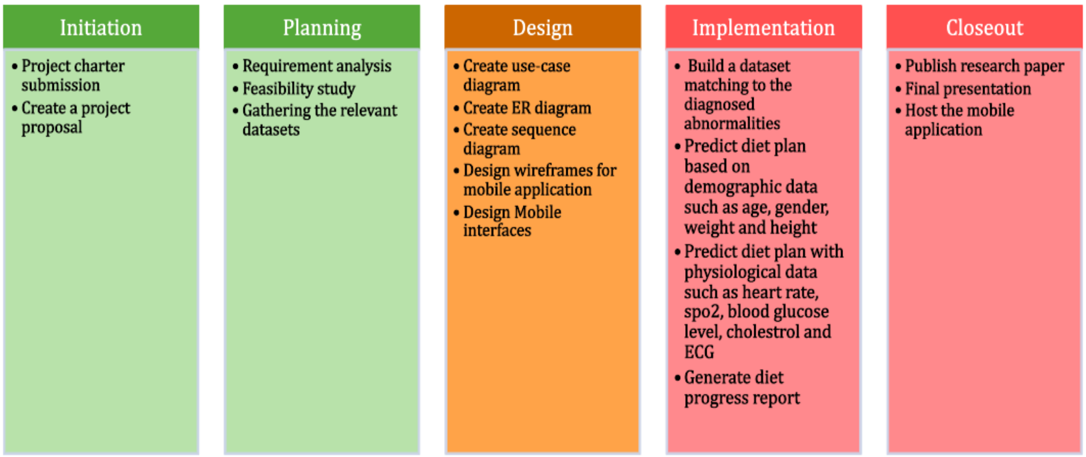

Figure 11: Work Break Down Structure

6. BUDGET AND BUDGET JUSTIFICATION

Table 2 shows the overall budget for the entire proposed system roughly.

Table 2 : Expenses for the proposed system

Expenses	
Requirement	**Cost**
Telemedicine kit	500 USD
Subscription fee	29 USD / month
Doctor consultation fee	49 USD / month
Research & development	150,000 LKR per annum
Cloud hosting	25,000 LKR per annum
Other costs	30,000 LKR per annum

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APPENDICES

Appendix A: Turnit in Plagarism Check