KidniFy – A mobile based patient care application for Kidney Patients

2023-032

Project Proposal Report

Isurika W.B.M.A

B.Sc. (Hons) Degree in Information Technology specializing in

Data Science

Department of Information Technology

Sri Lanka Institute of Information Technology

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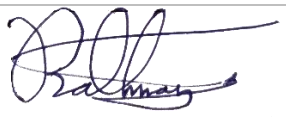
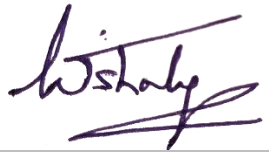
DECLARATION

We declare that this is our 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.

Name	Student ID	Signature
Isurika W.B.M. A	IT20785192	

The supervisor/s should certify the proposal report with the following declaration.

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the Supervisor:	2023.03.	
Signature of the Co-Supervisor:	2023.03.	

ABSTRACT

Chronic kidney disease (CKD) in Sri Lanka is attributed to various environmental, occupational, and lifestyle factors. However, patients often need more awareness about the importance of a personalized diet plan and tend to neglect it for various reasons, including lack of knowledge, inconvenience, and misinformation. In order to tackle this problem, we suggest an innovative approach that employs machine learning to provide customized diet plans for CKD patients, taking into account their blood potassium levels and medication usage, allergies, and dietary preferences. Our approach aims to improve patient compliance and increase awareness about the significance of a healthy diet in managing CKD.

The personalized diet plans are generated using machine learning algorithms that analyze large datasets of patient information, including medical records, laboratory results, and dietary guidelines. The machine learning model is trained to identify patterns and correlations between patient factors and optimal diet plans. The model considers the unique needs of each CKD patient, such as their stage of CKD, comorbidities, and individual dietary restrictions, to provide personalized and actionable diet recommendations. By utilizing machine learning, our approach aims to increase CKD patients' awareness of the importance of a healthy diet plan in managing their condition. Patients are empowered with personalized diet recommendations that consider their unique needs, which can lead to better adherence to dietary restrictions and improved health outcomes. Furthermore, the user-friendly mobile app helps to overcome barriers to dietary compliance and enhances patient engagement in their care. In conclusion, a personalized diet plan is crucial for CKD patients, and machine learning can significantly enhance awareness and adherence to such projects. Our mobile app, powered by machine learning, aims to improve the well-being of CKD patients by providing personalized diet recommendations and increasing awareness about the significance of a healthy diet in managing CKD.

Keywords: Chronic Kidney Disease, CKD, personalized diet plan, machine learning, mobile app, awareness, patient engagement, adherence, healthcare, dietary restrictions.

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LIST OF ABBREVIATION

AI - Artificial Intelligence

AUC - Area Under the Curve

App - Application

AWS - Amazon Web Services

CKD - Chronic Kidney Disease

CR - Conduct Sprint Reviews

CS - Conduct Sprint Retrospectives

DB - MongoDB

DT - Decision Trees

GFR - Glomerular Filtration Rate

JS - JavaScript

LR - Logistic Regression

LOC - Localization

ML - Machine Learning

NodeJS - Node JavaScript

PB - Prioritized Product Backlog

PI - Project Objectives and Scope

PRO - Proteinuria

QA - Quality Assurance

RBC - Red Blood Cells

RN - React Native

RNative - React Native

SVM - Support Vector Machines

T-CHO - Total Cholesterol

TF - TensorFlow

TG - Triglycerides

UPCR - Urine Protein and Creatinine Ratio

1 INTRODUCTION

1.1 Background and Literature Survey

Chronic kidney disease (CKD) in Sri Lanka is attributed to various environmental, occupational, and lifestyle factors. Kidney diseases can arise when the kidneys fail to function correctly, leading to complications in the body's ability to remove excess water and waste from the blood. If kidney damage and reduced function persist for over three months, it is called chronic kidney disease (CKD). The human body may experience complications when the kidneys cannot effectively filter out excess water and waste products from the blood, resulting in chronic kidney disease (CKD). The kidneys filter waste and excess bodily fluids and control other vital activities. When they fail, the consequences can be severe and life-threatening. CKD is becoming an increasingly severe public health issue in Sri Lanka, with thousands dying yearly. According to studies, kidney illness deaths have increased by more than 50% in the last decade, highlighting the importance of raising awareness and early detection initiatives. CKD can occur as a result of several reasons. In the north-central region of Sri Lanka, chronic kidney disease (CKD) is widespread, particularly among communities engaged in paddy farming, with a prevalence rate varying from 6% to 15%.

Machine Learning (ML) algorithms have been increasingly used in healthcare to predict outcomes and provide personalized treatment plans for patients. In the case of CKD patients, ML can be used to analyze large amounts of patient data, such as lab results, medical history, and dietary information, to develop a personalized diet plan tailored to the patient's needs. The use of ML in CKD diet planning has several potential benefits. First, it can assist in detecting patterns and associations in patient data that may not be readily discernible to human experts, resulting in improved accuracy in predictions and personalized recommendations. Secondly, ML can help to automate the process of diet planning, reducing the workload of healthcare professionals and allowing for more efficient and cost-effective care. ML in CKD diet planning can improve patient outcomes and quality of life by providing personalized,

data-driven dietary recommendations tailored to each patient's needs and medical history.

In 2019, Akash Maurya and his team devised an automated tool employing machine learning techniques to predict chronic kidney disease (CKD), aiming to assist physicians in enhancing patient treatment. The proposed system, designed to humanize the approach, aims to provide a personalized diet recommendation for CKD patients using classification algorithms. Akash Maurya and the team utilized blood potassium levels to calculate the potassium zone, which helps slow the progression of CKD. This diet plan recommendation based on the machine learning algorithm assists doctors in suggesting a suitable diet plan for CKD patients, taking into account the severity of the disease [1].

M.P.N.M. Wickramasinghe and his team conducted a research study with the objective of identifying appropriate diet plans for CKD patients by utilizing classification algorithms on medical records. The main aim of their research was to mitigate the progression of CKD through the implementation of tailored diet plans, determined using classification algorithms. The researchers focused on recommending diverse diet plans based on the predicted potassium zone, which was determined from blood potassium levels of CKD patients. The experiment involved the application of various algorithms for data analysis and classification. The results revealed that the Multiclass Decision Forest algorithm achieved the highest accuracy of 99.17% among the different classification algorithms. This study provides valuable insights into the utilization of machine learning techniques for identifying suitable diet plans for CKD patients, with the potential to enhance the management and treatment of this chronic condition [2].

A research study conducted by B. A. Annapoorna, Y. N. Isarga, Rachana R. Shastry, and P. K. Sreelatha focused on chronic renal disorder (CKD). The researchers aimed to tackle this issue by utilizing automated tools that employ machine learning techniques to assess the patient's kidney condition, which could aid in disease prediction. Their system extracted significant features related to CKD and utilized machine learning methods to automatically classify the disease into different stages

based on severity. The primary objective of the research was to predict the disease stage and provide personalized diet recommendations for CKD patients using classification algorithms applied to medical test records. The diet recommendations were tailored based on the patient's potassium zone, calculated using blood potassium levels, with the aim of slowing down CKD progression [3].

1.2 Research Gap

A crucial aspect of effectively managing chronic kidney disease (CKD) is providing patients with appropriate dietary recommendations, particularly for those with comorbidities such as high blood pressure and diabetes. The recommendation for a patient's specific dietary needs will be determined based on the ZONE data and the output from a predictive model.

- SAFE
- CAUTION
- DANGER

The dietary recommendations will be sourced from a diet database.

It is crucial for individuals at higher risk of developing chronic kidney disease to undergo these tests. Having diabetes or high blood pressure can increase their risk of kidney disease.

Selected Research / **Task**	**01** [4]	**02** [5]	**03** [6]	**KidniFy**
The ZONE attribute is established by measuring the amount of potassium in the blood, and it is used to generate dietary suggestions.	Yes	Yes	Yes	Yes
Consider any other medical conditions the patient may have before making predictions.	No	No	No	Yes
Predict the dietary plan based on patients Age.	No	No	No	Yes

Check the given food plan and if the patient chooses certain foods because he has allergies with those foods, recommend another food.	No	No	No	Yes

Table 1:Research Gap

2 RESEARCH PROBLEM

Many people are unaware of how food affects kidney health and the importance of a healthy diet. This lack of awareness can have severe consequences for kidney patients, who may consume foods that worsen their condition. This build-up can cause various complications, such as high blood pressure, electrolyte imbalances, fluid overload, and mineral and bone disorders. This can lead to misconceptions, myths, and conflicting advice about what foods are safe or harmful for CKD patients, making it difficult for patients to follow a consistent and effective diet plan. Even those who know which foods are good for kidney health need help to create a balanced diet plan that suits their health needs. A diet plan tailored to their individual needs can help reduce the workload on their kidneys, control the levels of nutrients and fluids in their body, and prevent or manage these complications. Another major challenge for people with less financial resources is limited access to specialized medical care. The cost of dialysis or transplantation is often unknown, and people may need to realize the financial burden they may face if they develop kidney disease. It is essential to increase awareness about the impact of food on kidney health and to promote the development of affordable, accessible, and effective diet plans for kidney patients in Sri Lanka. Educating kidney patients about healthy eating habits tailored to their needs can play a crucial role in preventing the worsening of kidney disease and reducing reliance on expensive treatments.

3 OBJECTIVES

3.1 Main Objectives

The primary objective of this component is to provide personalized recommendations to kidney patients regarding the most appropriate diet, exercise, and lifestyle changes based on their health condition. Implementing a diet that is conducive to kidney health can alleviate the burden on the kidneys and potentially slow down the advancement of kidney disease.

3.2 Specific Objectives

- Based on the GFR, Potassium and Prosperous levels of the blood, categorize the patient into three zones, Safe, Cautious and Danger.
- Provide an estimated cost for medical help in Sri Lanka if the patient falls into the Cautious or Danger zones.
- If the patient is suggested to do dialysis or a transplant, educate them on each option's benefits, risks, and costs.

4 METHODOLOGY

4.1 System Architecture

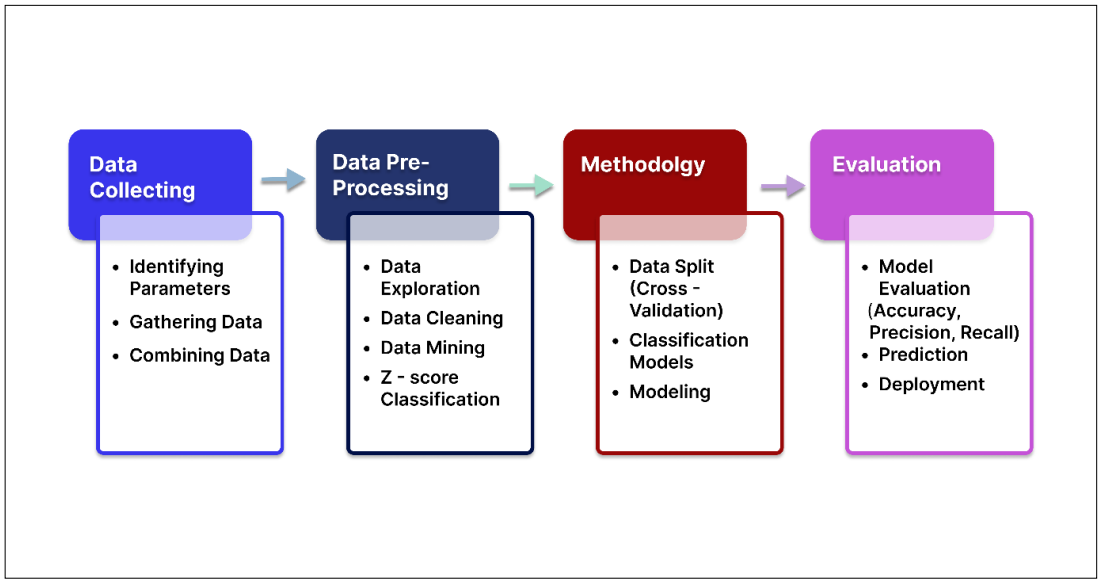


Figure 1:Component Overview

In this component the patient will be suggested a healthy dietary plan according to the patients health assessment. So to do that, our system is designed to collect and preprocess patient data, train multiple machine learning models, evaluate their accuracy, and utilize the best-performing model to provide personalized diet recommendations within the mobile app. To begin, we collect data from patients, which may include factors such as their medical history, dietary restrictions, and many other factors. This data is then preprocessed to ensure it's in the right format for analysis. Next, we train several machine learning models on this preprocessed data, utilizing a variety of algorithms to capture different aspects of the dietary planning process. By training multiple models, we can compare their accuracy and select the one that performs best. Once the models are trained, we evaluate their accuracy using appropriate metrics. This allows us to determine which model is most accurate in

predicting the dietary needs of kidney patients. Once the best-performing model is identified, it is integrated into the mobile app's user interface. Within the mobile app, patients can choose the options related to their dietary preferences, restrictions, and health conditions. By analyzing these answers, the app utilizes the trained machine learning model to generate personalized diet plans for each patient. The dietary recommendations are communicated to the patient using an attractive user interface, providing them with clear and understandable guidance on their dietary choices.

4.2 Commercialization of the Product

1. Develop a comprehensive marketing strategy: The first step would be to develop a marketing strategy that targets kidney patients and those at risk of kidney disease. This could involve promoting the app on social media, targeted advertising, and outreach to health organizations and medical professionals.
2. Launch the mobile app: Once the marketing strategy is in place, launch the mobile app. Ensure that the app is user-friendly and that features such as the risk prediction tool, image analysis, and water quality measurement device are easy to use.
3. Offer a free trial: To encourage users to try out the app and see its value, offer a 30-day free trial with access to all features. During the trial period, users can evaluate the app and decide whether to continue using it by purchasing a subscription. Consider offering incentives to users who subscribe after the free trial, such as a discounted subscription price or additional features not included in the trial version.
4. Partner with healthcare providers: Partner with healthcare providers such as hospitals and clinics to offer our app as a resource for their patients. We could also consider partnering with healthcare insurance providers to offer the app as part of their member benefits.
5. Collect and analyze data: Collect data from app users to identify patterns and trends in kidney disease prevalence and risk factors. Use this data to improve the app's features and functionality and to develop targeted marketing campaigns.

5 SOFTWARE / HARDWARE METHODOLOGY

5.1 Software Methodology

We decided to use Agile methodology in our development process. The Agile methodology is a collaborative and iterative approach to software development that prioritizes flexibility, feedback, and continuous improvement. It is particularly well-suited to our scenario because it allows you to work in short sprints, gather feedback from stakeholders, and adjust the project's scope and priorities based on their input.

1. **Plan and define the project scope**: Define the project objectives and scope. Identify the stakeholders involved, the desired outcomes, and the constraints affecting the project's development. Identify and prioritize the features of the application and the data to be collected from the patients, such as their symptoms, medical history, lifestyle factors and other necessary health information.
2. **Create the backlog**: Create a prioritized product backlog. Each item should be clear and concise and represent a tangible functionality. Consider integrating the machine learning algorithms and the other technologies in the backlog as separate stories.
3. **Plan sprints**: Using the product backlog, plan a series of sprints that each deliver a subset of the backlog. Sprints should be short and iterative (two to four weeks) to allow for adjustments in requirements and feedback from stakeholders.
4. **Conduct sprint reviews**: At the end of each sprint, conduct a sprint review with stakeholders to assess progress and demonstrate completed work. Gather feedback that can be used to adjust priorities in the next sprint.
5. **Conduct sprint retrospectives**: Conduct a retrospective after each sprint review to identify areas for improvement and potential changes in the project approach. Take the feedback from the retrospective into account when planning the next sprint.

6. **Develop machine learning algorithms**: Use TensorFlow to develop the machine learning algorithms that will be used to analyze the patient data and categorize patients into Safe, Cautious, or Danger zone. Train the models on a large set of data representative of the patient population.
7. **Build the application**: Develop the React Native application, integrating the machine learning algorithms and other features. Build the user interface, data analysis, and recommendations engine. Use NodeJS to develop the backend API that interacts with the application and stores the patient data in MongoDB.
8. **Test and QA**: Testing the application is essential to ensure it aligns with the functional and non-functional requirements outlined in the product backlog. This involves comprehensive assessments of usability, performance, security, and accessibility. Utilizing automated testing wherever feasible can enhance efficiency in the testing process.
9. **Deploy and maintain**: Deploy the application to AWS, ensuring it is scalable and secure. Monitor the application for bugs and issues and regularly update it with new features and enhancements. Use AWS services such as Elastic Beanstalk, Lambda, and API Gateway to manage the deployment and maintenance of the application.
10. **Iterate and improve**: Use feedback from users and stakeholders to improve the application continuously. This may involve adding new features, improving the machine learning algorithms, or updating the user interface.

5.2 Tools and Technologies

- **React Native**: React Native can be used to develop a mobile app that can run on both major mobile operating systems. It will be used to develop the front end of the application.
- **NodeJS**: NodeJS can be used to develop the backend APIs that the mobile app will interact with. The APIs can be used to process the patient data, retrieve the GFR value, run machine learning algorithms, and provide the recommended health advice and treatment options.

- **TensorFlow**: TensorFlow can be used to develop the machine learning models that analyze the patient data and categorize them into safe, cautious, or danger zones. The models can be trained to provide personalized recommendations based on the patient's specific health conditions and medical history.
- **MongoDB**: MongoDB can be used to store patient information and health data. The database can be used to securely store patient information, and the data can be accessed by machine learning algorithms and backend APIs.
- **AWS**: AWS can be used to host the backend APIs and machine learning models. AWS provides a secure and scalable platform for hosting these components, which ensures that the app can handle a large number of users and requests.
- **Payhere**: Payhere can be used to integrate various payment methods into the app, including Visa and Mastercard, digital wallets, and bank transfers. This makes it easier for patients to pay for medical help and treatment options.

6 DESCRIPTIONS OF PERSONAL AND FACILITIES

Member	Component	Task
Isurika W.B.M.A.	Utilizing machine learning for personalized Dietary Prediction and Health Assessment.	• Identify the factors required to predict a kidney patient's diet plan, such as age, weight, gender, current medications, and comorbidities. • Collect the relevant data for each factor. • Study additional factors like GFR value, potassium level of blood to categorize the kidney patient into three categories. • Identify the treatment plans available for patients who need dialysis or a kidney transplant. • Preprocess the collected data by cleaning, filtering, and transforming it into a suitable format that can be used by a machine learning algorithm.

		• Select the most relevant features from the preprocessed data to predict the diet plan for kidney patients. • Choose an appropriate machine learning algorithm that can handle the data's complexity, size, and accuracy. • Train the selected machine learning algorithm on the preprocessed data using suitable training techniques. • Validate the trained model before deployment. • Deploy the model in the mobile application to enable users to predict their diet plans based on the collected data. • Include an option to update the model with new data to improve its accuracy over time.

Table 2:Individual Tasks for the component

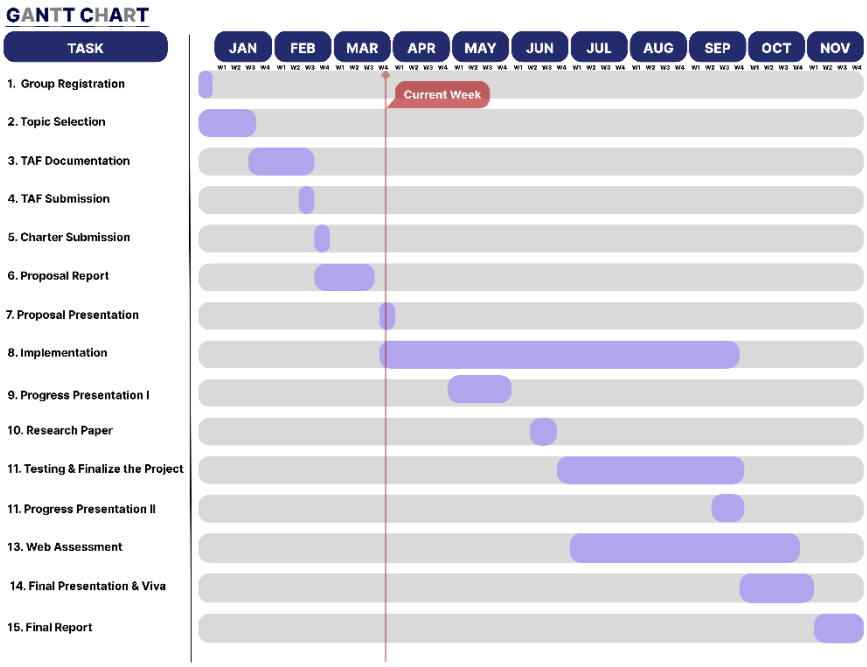
7 BUDGET AND BUDGET JUSTIFICATION

Resources	Estimated Price (LKR)
Cloud server host	25000
Travelling	10000
Internet	5000
Stationery	2000

Miscellaneous	5000
Total	**47000**

Table 3:Estimated Expenditure

The proposed budget total cost amount is LKR 47000. To cover this expenditure, our group plans to collect funds from group members. The budget table should detail all the project expenses, including any necessary equipment, materials, or services required to complete the project. These costs might change in the future due to



unforeseen circumstances or unexpected expenses, but with a clear budget plan and contributions from group members, the project can be completed successfully.

8 GANTT CHART

Figure 2:Gantt Chart for the Component

The Gantt chart above represents our proposed plan for the research project, with a focus on my component. We have made progress from January until this week, which is indicated by the green color. The remaining tasks are in purple, which we plan to complete in the coming months.

This Gantt chart is an essential tool for our research plan, as it helps us manage our time and resources effectively. It shows the timelines for each task, the dependencies between them, and the overall project schedule.

9 WORK BREAKDOWN CHART

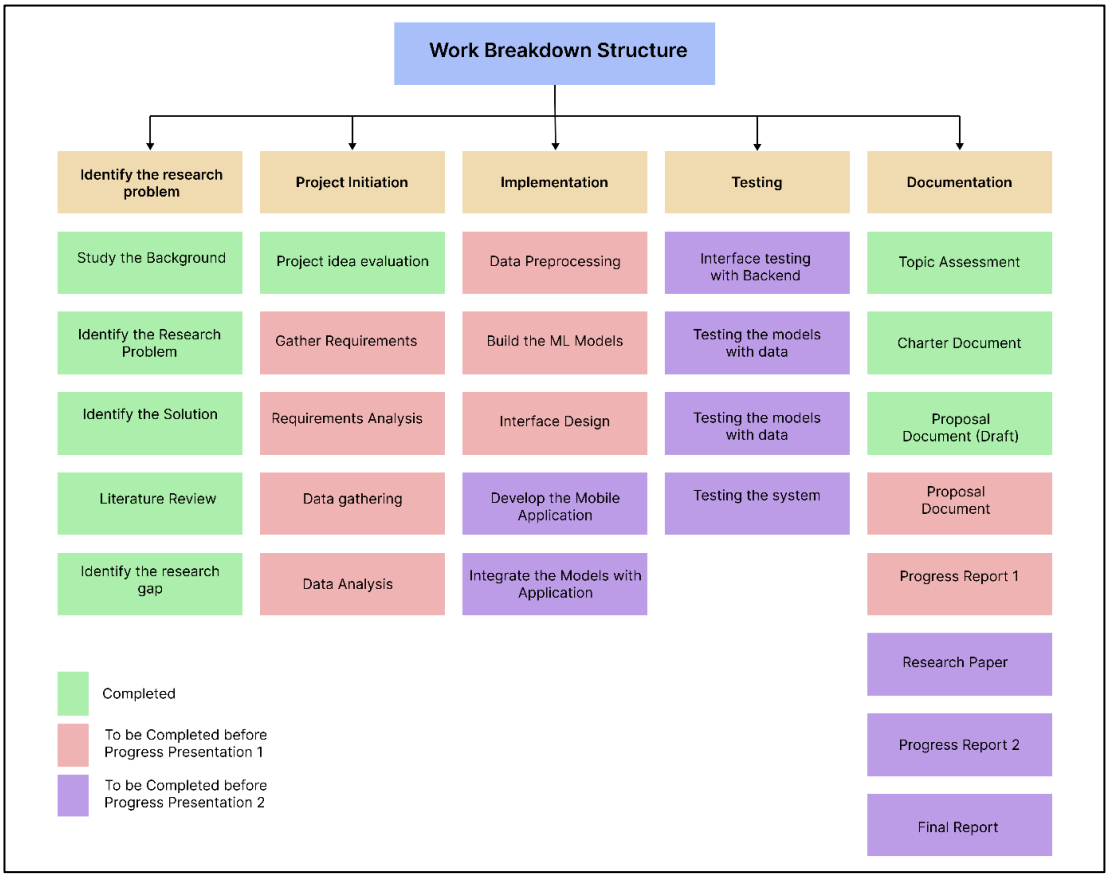


Figure 3:Work Breakdown Chart for the component

The work breakdown structure diagram for this project comprises five stages: the identification of the research problem, the initial stage, implementation, testing, and documentation. In the first stage, the research problem will be identified and analyzed thoroughly to develop a comprehensive understanding of the project's objectives and requirements. The initial phase will involve designing the software components of the mobile app-based diet planning system for chronic kidney patients. The implementation stage will focus on developing the machine learning algorithms that analyze patient data, including medical history, dietary restrictions, and health goals, to suggest personalized diet plans. The testing stage will be used to evaluate the accuracy and effectiveness of the diet plan recommendations using simulated patient data. Finally, the documentation stage will involve preparing comprehensive documentation of the project, including technical specifications, user manuals, and the project report.

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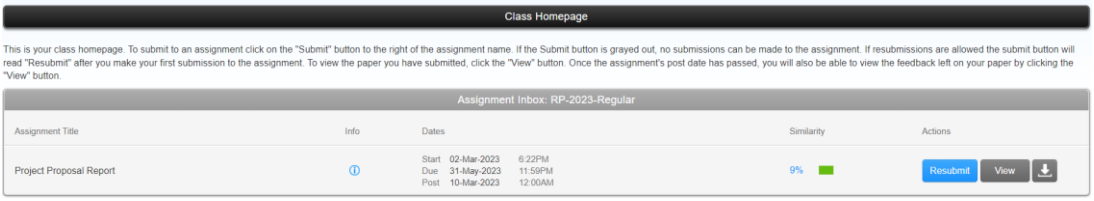
11 APPENDIX


Class Homepage
This is your class homepage. To submit to an assignment click on the "Submit" button to the right of the assignment name. If the Submit button is grayed out, no submissions can be made to the assignment. If resubmissions are allowed the submit button will read "Resubmit" after you make your first submission to the assignment. To view the paper you have submitted, click the "View" button. Once the assignment's post date has passed, you will also be able to view the feedback left on your paper by clicking the "View" button.
Assignment Inbox: RP-2023-Regular
Assignment Title
Info
Dates
Similarity
Actions
Project Proposal Report
Start 02-Mar-2023 6:22PM
Due 31-May-2023 11:59PM
Post 10-Mar-2023 12:00AM
9%
Resubmit
View