SMART GREENHOUSES DECISIONSUPPORT SYSTEMS FOR TOMATO CULTIVATION

24-25J-064

Project Proposal Report

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August 2024

DECLARATION

We 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 my 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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ABSTRACT

The "Harvest Predictor" app tackles the problems tomato farmers face when trying to guess harvest times, which is key to managing crops well. Current ways often don't work because of changing weather spotty data collection, and not enough tech use leading to poor harvests and money losses. This new

system aims to fix these issues by using cutting-edge tech to give exact, up-to-the-minute guesses for tomato harvests.

Building on earlier studies, this app has special features that make it more precise and easier to use. The system keeps gathering and examining info about weather, soil, and how plants grow. It does this using smart computer programs like Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN). These programs help the app guess harvest dates well by learning from old and new info. Farmers can use the app through a simple screen where they can put in data, get predictions, and make smart choices about their crops.

The project faces hurdles like blending different data types making sure the system can adapt to various farm settings, and keeping users interested with a simple easy-to-use design. In the end, this study pictures a future where tech-powered farming boosts output and eco-friendliness giving farmers trustworthy tools to handle their crops better.

Keywords: tomato harvest, prediction, machine learning, CNN, RNN, real-time data, agriculture

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LIST OF ABBREVIATIONS

Abbreviation	Description
ARIMA	Auto Regressive Integrated Moving Average
LSTM	Long Short-Term Memory
ML	Machine Learning

INTRODUCTION

tailored to provide optimal tomato harvest dates for farmers within, the timing of which is a very important farming issue. The demand for a data-driven solution has emerged because of inefficiencies and imprecision in estimating harvesting times. The proposed system has been developed to improve the accuracy, whilst predicting tomato harvest date using advanced analytics and technology.

In comparison of previous research, the application includes newer features to monitor growth stages and organizes better predictions where farmers may harvest when needed. This app is designed to serve farmers it speaks Sinhala and has different voice guides for high, middle low level of literate people.

This application development involves their core technologies such as image processing and machine learning. A combination of Auto Regressive Integrated Moving Average (ARIMA), Long Short-Term Memory (LSTM) and Machine Learning (ML) Algorithms are used for harvesting pattern recognition, environmental conditions analysis, past data analytics that helps to predict harvest timings with high accuracy.

Through the application, farmers can keep a detailed check on their crops like plant health, yield prediction among other and receive timely alerts for harvesting periods. All the features are designed from intense analysis of farming techniques and environment. Obstacles encountered during the development stage include improving prediction accuracy, combining live data streams from different providers and avoiding user abandonment.

In future, this research will provide a pathway for technology-driven agri practices that would render farming more efficient and profitable while helping to escape from existing limitations and surge in agricultural sector.

Background & Literature survey

Background

Tomatoes are one of the most widely cultivated crops globally, playing a crucial role in both local and international markets. The timing of tomato harvests is essential for maximizing yield quality, reducing post-harvest losses, and meeting market demands. Accurate prediction of tomato harvest dates enables farmers to optimize their agricultural practices, ensuring that tomatoes are harvested at their peak ripeness for the best flavor, texture, and nutritional value.

The Importance of Harvest Timing

Tomato harvest time is a critical point in the agricultural supply chain. Harvesting prematurely leads to unripe tomatoes which are tasteless and more likely to rot while being transported. On the other hand, overripe fruits are susceptible to spoilage and decays when harvested late. This results in reduced market value as well as increased waste thus making accurate timing for harvest an important factor both economically and environmentally.

Literature survey

Prediction of tomato harvest dates is a key aspect of farm planning since it enables optimizing resource allocation, achieving market timing and minimizing post-harvest losses. Analysis of factors like weather, soil types, plant diseases & condition and phenological stages is done before predicting the date when the crops will be ready for harvesting. The aim of this literature review is to reflect on different methodologies and technologies that have been used to predict tomato harvest dates with emphasis on data collection improvements, modeling techniques, technological integration among others.

Past Approaches for Predicting Harvest Dates

In the past, people used various empirical methods to guess tomato harvest time using traditional knowledge and observation. These methods included visual assessment of fruit color and size, as well as calendar-based systems that took into account regions' usual growing periods. However, these approaches were often wrong due to their use of static models which did not take into account changing environmental conditions.

The Role of Climatic and Environmental Data

Climatic factors such as temperature, rainfall and sunlight are important for the growth of tomatoes and their ripening process. In earlier studies, these factors were incorporated into linear models in order to predict when the crop will be ready for harvest with some degree of success.
However, these models failed to respond quickly to unexpected weather changes resulting in false predictions. The advent of real-time data collection through IoT (Internet of Things) devices has allowed for more dynamic modeling, integrating real-time environmental data into prediction systems.

ML and Predictive Modeling

The accuracy of forecasting harvest dates has recently been improved through developments in machine learning (ML). Machine learning models such as artificial neural networks (ANN), convolutional neural networks (CNN), and recurrent neural networks (RNN) have been used to predict the harvest date more accurately from agricultural data. These models are capable of processing large amounts of data including historical weather patterns, soil conditions, and plant health metrics thereby revealing complicated associations and insights that conventional models may not uncover.
Through this, the prediction of tomato harvest dates has moved away from the traditional observational methods to tech-savvy approaches. By integrating machine learning, remote sensing, and real-time data collection, it became possible to make predictions with higher degrees of accuracy

which give farmers powerful tools for optimizing their harvest timing. However, further research is needed to address issues related to variability and data integration in order to achieve effective deployment of these technologies across different agro-ecosystems.

Research Gap

Overall, the research presented in the literature review was compared with the proposed system for predicting tomato harvest dates. See the table below for a summary of the comparison.

Existing Products / Research	Features		
	Manual harvesting tool	fully Automated harvesting system	Basic Automated tool
Current Methods	✓	✗	✓
Proposed System	✗	✓	✗

Table 1.1 Comparison of previous Research

With this research in mind, it is the intent of this study to put forth a novel way to determine tomato harvest dates to increase yields and efficiency in farming. As shown in the above figure, we expect this proposed system to deliver a range of features that, through a multitude of downloadable user-friendly applications, provide more efficiency and accuracy in achieving harvest prediction. While in-depth study of other agricultural settings has documented several approaches, this can be considered a targeted application for tomato farmers who will be led down each step of the path using a user-friendly interface, downloadable application, and by being able to monitor real-time data. The use of LSTM algorithms, the incorporation of weather forecast, monitoring soil conditions, and growth stage observations are the features that distinct this proposed system.

Most importantly, for tomato farmers who struggle to determine what time to harvest tomatoes, they will even be able to identify and confirm the best time to harvest tomatoes based on each grower, as well as their conditions in a single application.

In addition to predicting harvest times, grower will be able to take advantage of some features to improve overall farm management. This mobile application addresses almost all the needs a tomato grower needs to have successful and profitable harvest. Each feature was developed with the goal of engaging their expertise, improve decision-making, and nurture application and relationship to sustainable agriculture.

RESEARCH PROBLEM

There are a number of systems for predicting tomato harvest dates around the world. Still, this particular harvest date predictor is underdeveloped and underdeveloped.

This leads to several more questions along the way. As a proven fact, this harvest date prediction has become increasingly popular. It is clear that achievement and effectiveness require full learning support.

OBJECTIVES

Main Objectives

Based on historical data, implementation of the best tomato harvesting date and analysis of weather conditions, soil moisture and plant growth that affect it.

Specific Objectives

- Implement a Real-Time Data Collection System.
- Integrate Weather Forecast Data
- Develop a Predictive Model
- Enable Customization for Different Varieties

METHODOLOGY

Forecasting tomato harvest dates is a real-time data collection is built from collecting data collecting data on many different factors that could consider, confidence level, like the temperature, precipitations, moisture in the soil, or even the health of the plants while that data has been received and collected. Data has been received, analyzed and understand the current state of the tomato plants is so conceivable on in the present time. Once the real time data has been analyzed and the system is able to subsequently produce continue to yield timely post real time. Timely updates on understood duration of predicted real time harvest dates.

Machine learning is used to create models to predict harvest dates projected to harvest date, based on learning from historic data along with real time data. Models are being generated from the algorithms, while analyzing patterns and trends from points like previous printed harvest dates, along with previous additional historic weather or moisture in the substrate, projected harvest time is estimated on growing. As machine learning examines data within the models over time, the accuracy of understanding becomes better by learning from the latest new data and adjusting models as well understanding. You have a more precise and clear manner of projecting projected harvest time

System Overview Diagram

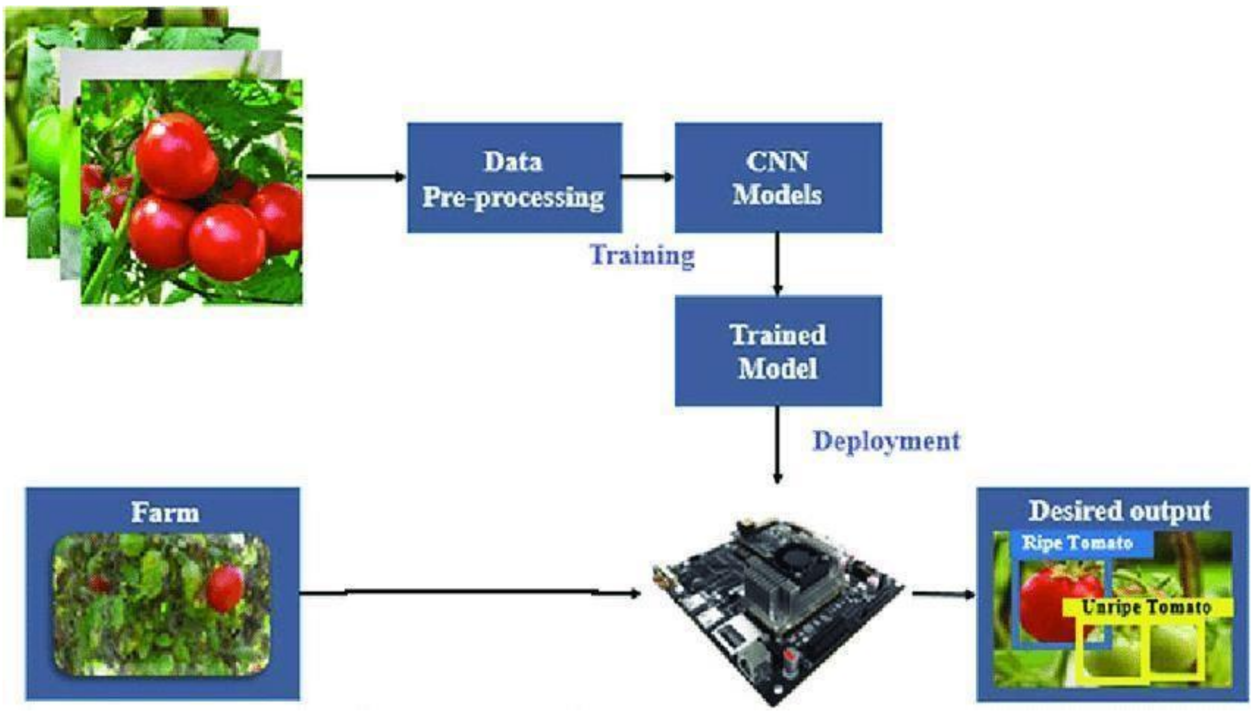

Figure 4.1.1 System Overview Diagram

Use Case Diagram

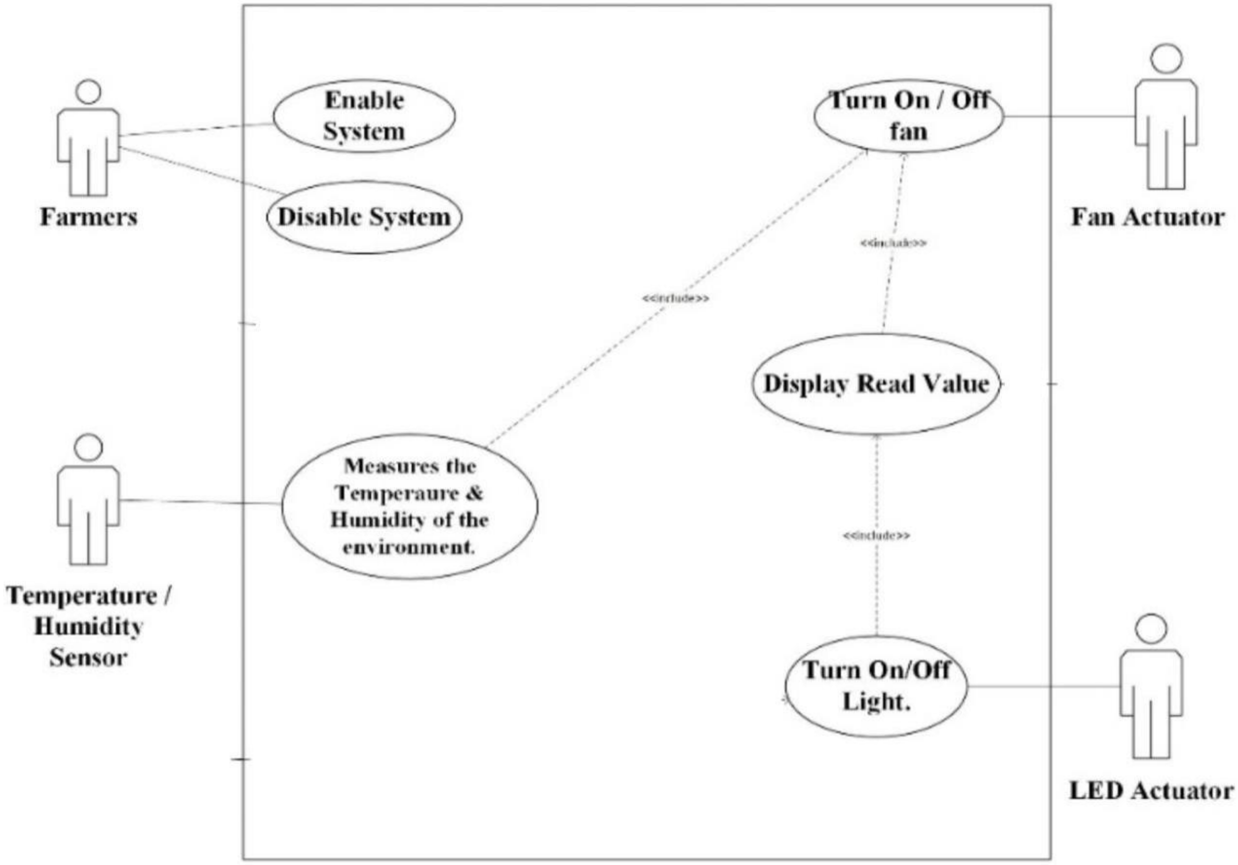

Figure 4.2 Use Case Diagram for tomato harvest dates

Sequence Diagram for tomato harvest dates

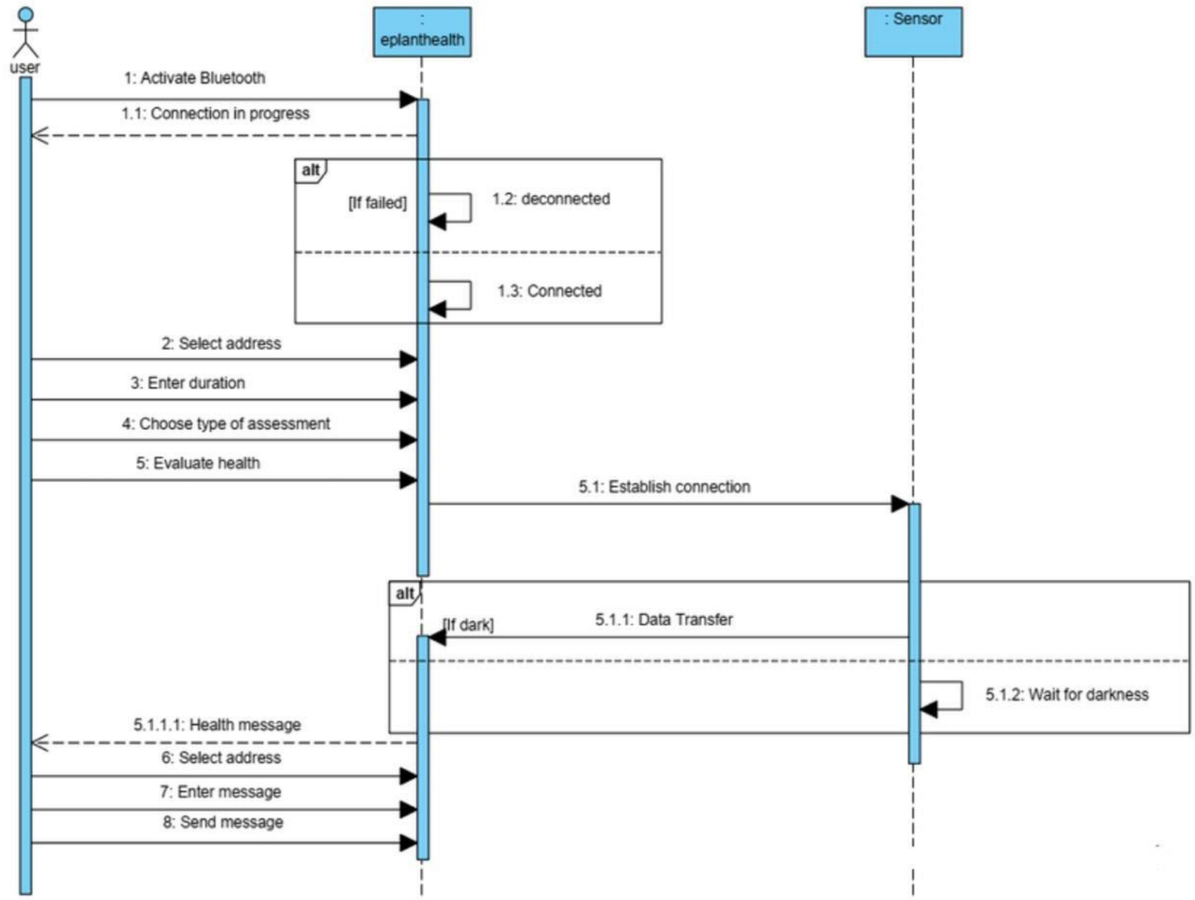

Figure 4.3 Sequence Diagram for tomato harvest dates

Commercialization

Target Audience

- Students (Special need students from grade one to five)

- Parents or guardians
- Primary school teachers
- Pediatricians/ Community Pediatricians
- Special need education centers for children

Market Space

- Primary school students with dyslexia/ dyscalculia in Sri Lanka
- No need of advanced knowledge of technology

How to Promote

- First, a free beta version of the mobile application will be released

- The developed mobile application will be mainly promoted on social media platforms

- For the premium version of the application, subscription fee will be charged for monthly, yearly and permanently
- Also, free subscription opportunity will be offered for child orphanages and low income families.

REQUIREMENTS

Functional requirements

- Use interface experience
- Real-time image capture and analysis
- Automated image-based identification
- Integration with AR Visualization
- Data security and ensure privacy
- Data integration and pattern recognition
- Maintenance and updates

Non-Functional requirements

- Performance
- Accuracy
- Privacy and Security
- Usability
- Compatibility
- Reliability
- Accessibility

System requirement

- Identify written texts and drawings of students
- Compatibility with several devices and operating systems.
- Secure and maintain user data and privacy.
- Quick response time with data input and organization

User requirement

- Basic Smartphone knowledge.

GANTT CHART

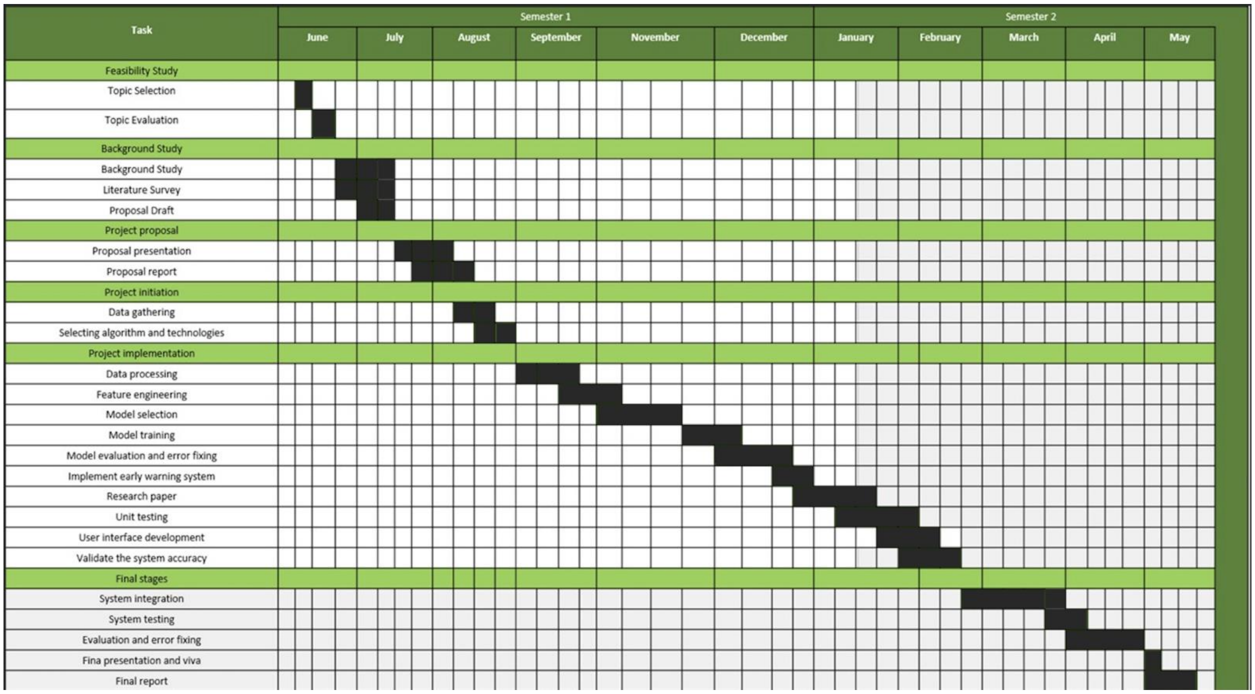

Figure 6.1 Gantt chart

WORK BREAKDOWN STRUCTURE (WBS)

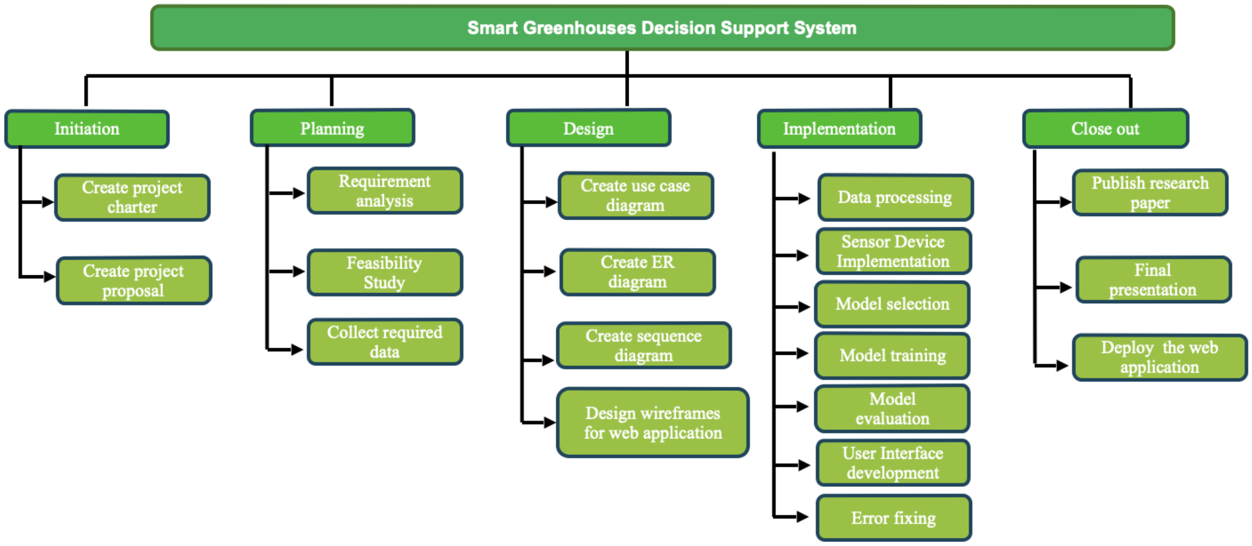

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Figure 7.1 Work Breakdown Structure

BUDGET AND BUGET JUSTIFICATION

The below table depicts the overall budget of the entire proposed system.

Component	Amount (USD)	Amount (LKR)
Travelling fee for the possible consultation sessions and data gathering (1. Department of Agrarian Development	5.01	1500.00
Internet Charges (The development and technical information learning)	6.67	2000.00
Technical consultation charges (External technical information sessions)	10.01	3000.00
Total	**21.69**	**6500.00**

Table 8.1 Overall Budget of the Research

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