SMART ROSE: AI-IOT PLATFORM FOR SMART GREENHOUSE ROSE FARMING IN SRI LANKA

25-26J-299

Project Proposal Report

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

Department 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.

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Signature Of the Supervisor

Date

27/oct/2025

ABSTRACT

Rose cultivation is one of the most valuable sectors within Sri Lanka's floriculture industry, especially in the cool regions such as Nuwara Eliya, Bandarawela, Ella, and Kandy. Although these areas are ideal for growing high quality roses, one of the biggest challenges faced by both farmers and florists is maintaining freshness after harvest. Many local florists rely on simple, traditional methods keeping flowers in water illed vases or cold rooms and judging freshness by visual appearance. These manual practices often lead to early wilting, inconsistent quality, and financial loss due to spoilage.

This research proposes an IoT based Freshness Monitoring, Management, and Smart Storage System designed to help florists monitor and preserve rose freshness scientifically. The system integrates sensors to measure key environmental factors such as temperature, humidity, ethylene gas concentration, and water level in real time. The collected data is transmitted to a cloud connected dashboard, where an AI regression model analyzes patterns and predicts both freshness score and remaining vase life hours.

When freshness levels begin to drop, the system provides alerts and care recommendations, and can also perform automatic water replacement and preservative addition to maintain optimal conditions. This closed-loop design enables florists to make quick, data-based decisions that extend rose lifespan by 30 – 40%.

By combining IoT sensing, cloud computing, and AI driven decision support, the proposed system offers a low cost, data driven solution for small and mid range Sri Lankan florists. It bridges the post harvest gap between farmers and retailers, reducing waste while ensuring consistent flower quality and longer lasting beauty.

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LIST OF ABBREVIATIONS

Abbreviation	Description
ML	Machine Learning
AI	Artificial Intelligence
HCI	Human Computer Interaction
PC	Personal Computer
API	Application Programming Interface
AWS	Amazon Web Services
IDE	Integrated Development Environment
IoT	Internet Of Things

1. INTRODUCTION

1.1. Background & Literature survey

Rose farming is one of the most profitable and rapidly developing sectors within Sri Lanka’s floriculture industry, particularly in the cool climatic regions such as Nuwara Eliya, Bandarawela, Ella, and Kandy. These areas provide ideal environmental conditions for cultivating high quality roses throughout the year. However, one of the most persistent challenges that affects both farmers and florists is maintaining flower freshness after harvest, as post harvest losses remain significantly high in the local cut-flower market [5].

Most local florists rely on simple and traditional methods to preserve flowers once they are delivered from farms. Typically, roses are placed in vases of water or stored in a refrigerator or cold room, where freshness is judged visually based on petal color, firmness, and overall appearance. When the flowers begin to wilt, they are immediately replaced or discarded. While some florists use homemade or commercial preservative solutions containing sugar, citric acid, or bleach to delay wilting, these methods do not include scientific monitoring or data-driven control [6].

Research worldwide has established that temperature, humidity, and ethylene gas levels are the most critical factors influencing the vase life of cut roses. Studies by Ichimura et al. demonstrated that glucose and citric acid treatments could extend the vase life of roses by improving water uptake and reducing bacterial growth [1]. Similarly, Bist and Hom (2024) reported that combinations of sucrose and citric acid enhanced petal color retention and slowed dehydration [2].

In Sri Lanka, research on post harvest freshness monitoring of cut flowers is still limited. Existing studies primarily analyze post-harvest handling, temperature control, and packaging practices rather than real time IoT based monitoring or AI driven prediction [5]. This highlights a major opportunity to introduce IoT and AI technologies for real time freshness tracking, water quality monitoring, and automated vase life management providing local florists with a scientific approach to maintaining quality and reducing spoilage.

1.2. Research Gap

Although many floriculture businesses in Sri Lanka have begun adopting technology for greenhouse monitoring and farm management, there is still no practical solution for tracking rose freshness after harvest. Existing systems mainly focus on production environments and do not extend to the vase or storage stage, where most freshness loss occurs.

Local and mid range florists typically use basic tools such as digital thermometers, refrigerators, or cold rooms, but these methods do not provide real time data or predictive insights on flower condition. No system currently monitors key parameters such as temperature, humidity, ethylene gas concentration, or water quality once the flowers are displayed in shops.

Furthermore, imported freshness monitoring systems available in international markets are expensive and not suitable for small or medium scale Sri Lankan florists. This creates a major gap for a low cost, IoT based freshness monitoring and management solution that can continuously measure environmental factors, analyze data through AI, and help predict how long roses will remain fresh after harvest.

1.3. Research Problem

Roses lose their freshness quickly after harvest mainly because storage conditions such as temperature, humidity, and air quality are not continuously monitored or managed. Most Sri Lankan florists still depend on visual observation and experience rather than data driven techniques, which often leads to early spoilage, economic loss, and inconsistent flower quality.

So, the main research problem is:

How can an IoT based system be designed to monitor and predict the freshness of post harvest roses in real time, providing alerts and actionable care recommendations to help florists maintain flower life?

2. OBJECTIVES

2.1. Main Objectives

The main objective of this research is to design and develop an Iot based System that monitors and predicts the freshness of post harvest roses, helping florists and distributors maintain ideal environmental conditions and reduce flower soilage.

This system will collect real time data on temperature, humidity, ethylene gas and water level concentration, analyze these factors and generate freshness scores with automated alerts. By integrating AI based regression modeling the system aims to provide accurate predictions of vase life duration and recommend suitable actions such as refilling water, adjusting temperature, or replacing flowers before they lose freshness.

2.2. Specific Objectives

1. To design and implement an IoT sensor module that can measure a vase's water level, ethylene gas, temperature, and humidity continually.
2. To develop an automated freshness management system that maintains optimal vase conditions by controlling water refill in response to sensor data and AI predictions.
3. To create a dashboard that is connected to the cloud and shows environmental trends, freshness percentage and real time sensor readings.
4. To create a regression model using AI that evaluates gathered data and predicts the roses' remaining vase-life hours or freshness percentage.
5. To evaluate the system's performance by comparing the actual vase-life results under various temperature and humidity conditions with the anticipated freshness scores.

3. METHODOLOGY

The methodology of the IoT Based Freshness Monitoring and Post Harvest Management system for Roses is designed to continuously monitor environmental and water conditions after harvest and use artificial intelligence to predict flower freshness and remaining vase life in real time.

The system integrates IoT sensors, cloud based data processing, and machine learning models to provide florists with data driven insights instead of manual visual inspection. This approach helps reduce post harvest losses and improves flower quality during storage and display.

3.1. System Architecture

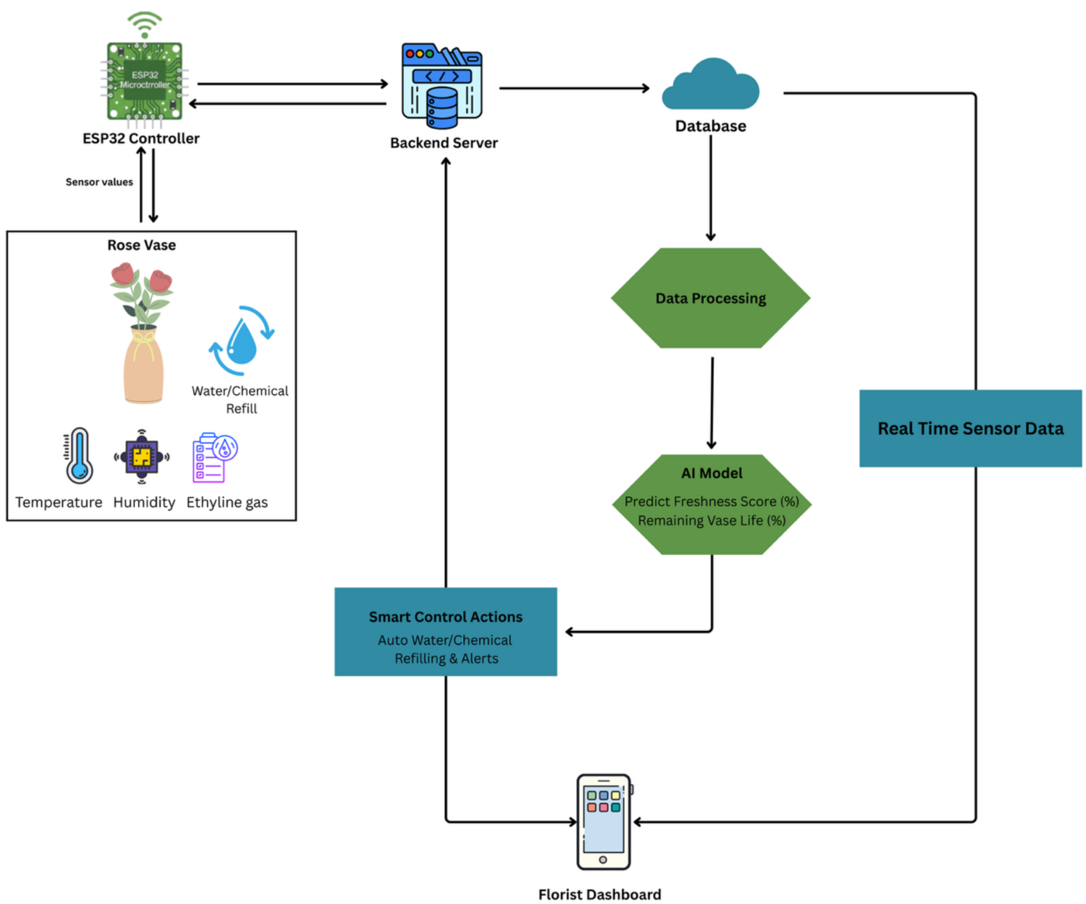

Figure 1 : System Architecture

3.2. Project Execution Approach

The project combines cloud connectivity, AI based analysis, and IoT hardware integration using an iterative and modular development methodology. There will be five primary stages to the system's implementation:

1. Requirement Analysis & Design
   - Identify which freshness factors temperature, humidity, ethylene gas, and water level have an impact on rose vase life.
   - Design the overall architecture.
2. IoT Hardware development
   - Setup sensors (temperature, humidity, Water level, ethylene gas).
   - Connect every sensors to microcontroller to get real time data collecting.
   - Add relay-controlled mini pumps or solenoid valves to automate water replacement when freshness drops.
3. Dashboard Development
   - Transmit sensor data to a cloud database.
   - Develop a mobile dashboard to display data. (e.g: "Low temperature, Low Water, High ethylene")
   - Integrate control buttons or indicators to show automatic water-refill actions.
4. AI Model Development & Testing
   - AI model that predicts the freshness score and remaining vase life hours is trained using the data that has been collected.
   - Verify predictions by comparing model output with real, controlled observations of vase life.
5. Evaluation & Improvements
   - Test the functionality of the system (Accuracy, Response Time, Reliability, automation effiency).

- Set sensor thresholds and model parameters to reflect real rose farm.

3.3. Machine Learning Workflow

1. Data Preprocessing & Normalization
    - Clean and organize sensor data collected from the Smart Vase, including temperature, humidity, ethylene gas, and water-level readings.
    - Remove missing values and normalize the data for uniform scaling.
2. Feature Selection
    - Identify the critical elements that affect rose freshness and vase life, including temperature, humidity, water level, ethylene content, and time since harvest.
3. ML Model Training
    - Train a regression based machine learning model using pre processed data to predict freshness score and remaining vase life hours.
4. Model Evaluation
    - Compare the actual vase life data collected under various conditions with the predicted freshness.
5. Deployment
    - The model outputs freshness scores and vase life estimates, which trigger automated control actions (e.g: refilling water) when freshness drops below threshold levels.
    - To make monitoring and management easier, show predictions and notifications on the florist dashboard.
    - Deploy the model that was trained on the cloud backend to make predictions in real time.

3.4. Data Requirements & Collection

The proposed IoT based freshness monitoring system requires continuous and reliable data collection to accurately assess the post-harvest condition of cut roses and predict their remaining vase life. The data collected represents the environmental and storage conditions that directly influence rose freshness after harvest.

The project requires both sensor generated data and experimental observation data to validate the freshness prediction model.

1. Data Requirements :

The system collects the following primary data parameters using IoT sensors connected to an ESP32 microcontroller:

- Air Temperature (°C):

  Measured using a DHT22 sensor to monitor the surrounding air temperature, as higher temperatures accelerate respiration and wilting in cut roses.

- Relative Humidity (%):

  Captured using the DHT22 sensor to evaluate moisture levels in the air, which affect dehydration and petal firmness.

- Ethylene / Air Quality Level:

  Measured using an MQ135 gas sensor to detect air quality changes related to ethylene buildup, a key hormone responsible for flower aging.

- Water Level (%):

  Measured using a water level sensor to determine whether sufficient water is available for the roses, as inadequate water supply directly reduces vase life.

- Water Temperature (°C):

  Measured using a DS18B20 temperature sensor to monitor water conditions, since high water temperature encourages bacterial growth and reduces water uptake.

- Timestamp:

  Automatically recorded to track freshness changes over time and support historical analysis.

- Device Identifier:

  Used to distinguish data collected from multiple vases or monitoring units.

In addition to raw sensor data, the system generates the following derived data using AI models:

- Freshness Score (0–100%)
- Estimated Remaining Vase Life (hours or days)

2. Data Collection :

Parameter	**Sensor**	**Unit**	**Expected Range**
Temperature	DHT22 / DS18B20	C0	4 - 22
Humidity	DHT22/SHT31	%RH	60 - 95
Water Level	YL-69 / Ultradonic Sensor	%	30 - 100
Ethylene Gas	MQ-135 / Mics - 6814	ppm	0 - 0.2

Table 1: Sensors

Data collection is performed continuously through IoT enabled smart vases. Sensors installed in each vase measure environmental and water conditions at regular intervals. The ESP32 microcontroller aggregates sensor readings and transmits them to the backend server via a WiFi connection.

The backend system stores all incoming data in a MongoDB database, where it is pre processed and analyzed using trained machine learning models. The AI model uses historical and real time sensor data to predict freshness levels and remaining vase life.

Collected data is visualized through a mobile application dashboard, allowing florists to monitor real time conditions, receive alerts, and review historical freshness trends. This continuous data collection framework ensures accurate freshness prediction, early detection of unfavorable conditions, and improved post harvest flower management.

Data will be collected for several rose batches under both cold-room and room temperature conditions to capture diverse patterns. Approximately 2,000–3,000 records will be generated over 2–3 weeks.

4. PROJECT REQUIREMENTS

4.1. Functional Requirements

The System must provide the following functions

1. Temperature, humidity, water level, and air quality (ethylene content) will all be continuously measured by the system using IoT sensors that connect to the ESP32 microcontroller.
2. Through a dashboard on a mobile app, the system will show all real-time data, including environmental conditions and freshness percentage.
3. The system will calculate the remaining vase-life hours and estimate a freshness score (0–100%) using a trained AI model.
4. The system shall estimate the remaining vase life duration (in hours or days) based on sensor readings and historical patterns.
5. The system shall display real time sensor readings, freshness score, and estimated vase life through a mobile application dashboard.
6. The system shall allow users to view historical freshness and sensor data trends for decision-making and quality analysis
7. The system shall generate alerts when critical conditions are detected, such as:
   - Low water level
   - Poor air quality
   - Rapid freshness degradation
8. To The system shall support automatic water refilling based on freshness score and water level thresholds.
9. The system shall allow users to manually trigger water refilling through the mobile application when water level is low.
10. The system shall uniquely identify each smart vase using a device ID and manage data from multiple devices.
11. The system shall store all sensor readings, freshness predictions, and timestamps in a MongoDB cloud database.

4.2. Non – Functional Requirements

1. Performance : When sensor data changes, the system should update readings in 5–10 seconds.
2. Accuracy : A minimum of 85% correlation between the freshness prediction model and actual vase-life data should be attained, and temperature and humidity readings should maintain an accuracy of ±1°C and ±3% RH.
3. Scalability : Future updates should be able to monitor several vases units with the same platform.
4. Security : To avoid unwanted access, all sensor data sent to the cloud needs to be protected.
5. Usability : The dashboard interface should be user friendly and visually clear enough for farmers who are not technical understand.
6. Maintainability : The hardware and software configuration of the system should be easily upgradeable and adaptable to accommodate new sensors or functionalities.
7. Reliability : At least 48 hours should pass without any interruptions in the system's operation.

4.3. System Requirements

Hardware Requirements

- Microcontroller: ESP32 Module with built in WIFI connectivity.
- Sensors : DHT22(Temperature, Humidity), MQ-135(Gas Sensor), Water level, Water Temperature.
- Other : Vase, Valve, Water pump, Power Adapters

Software Requirements

- Programming Languages: Python, Dart
- Frameworks: Flutter scikit-learn
- Database: MongoDB
- IDE/Tools: Arduino, VS code, Jupyter Notebook, Figma

4.4. Use Case Diagram

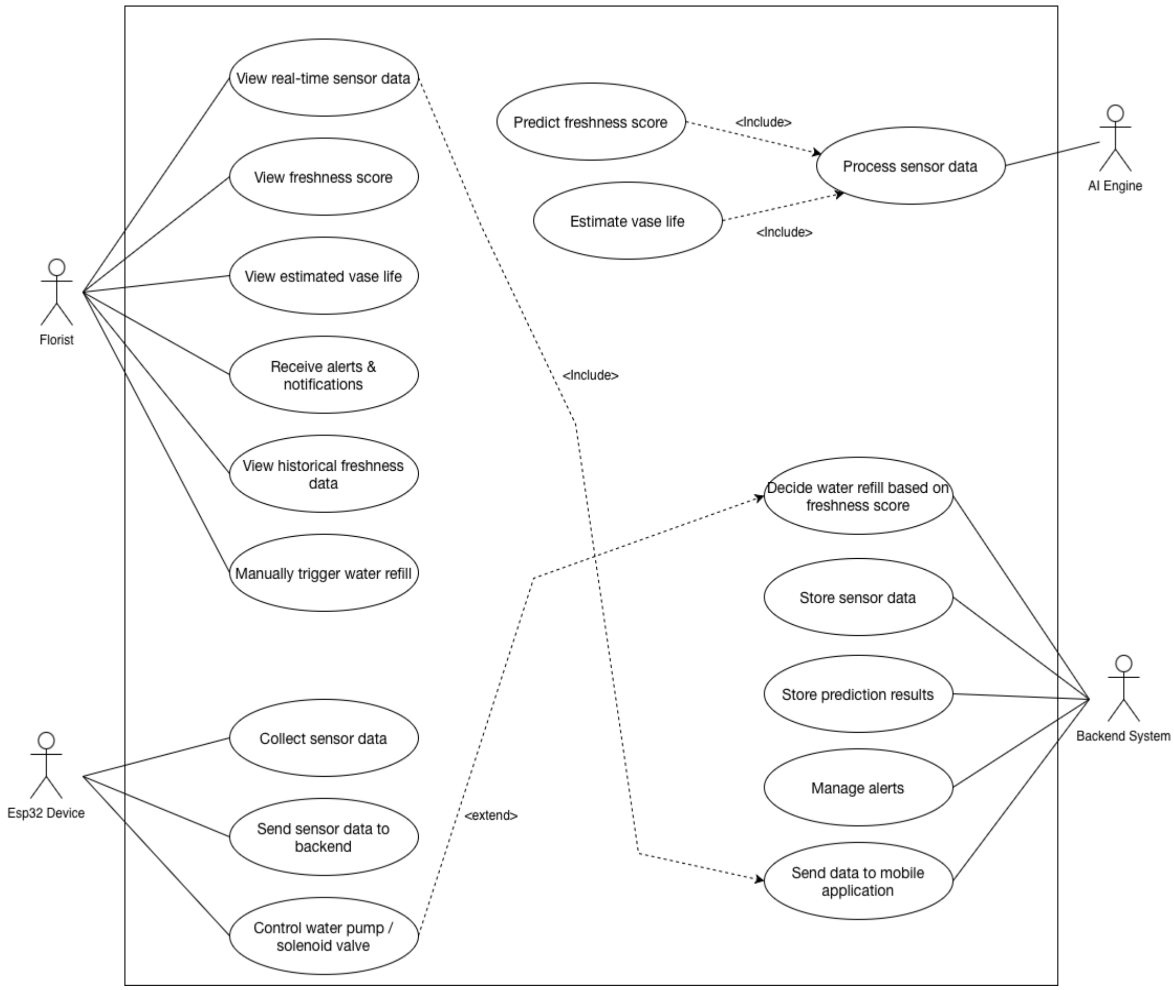

Figure 2 : Use case Diagram

5. Gantt Chart

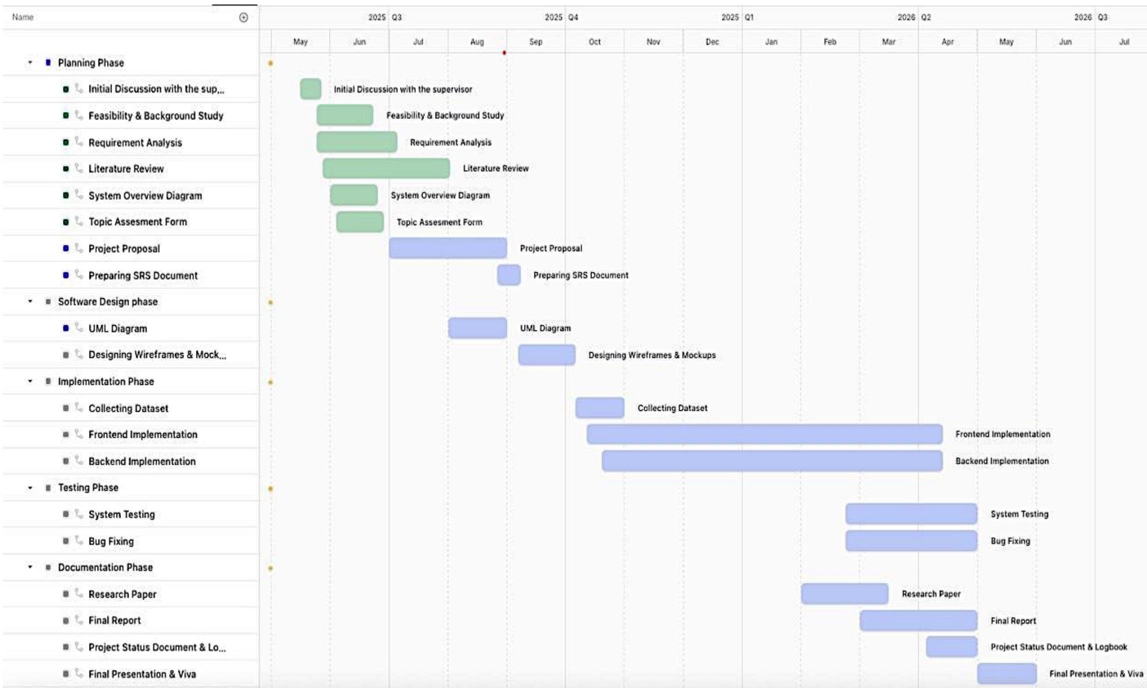

Figure 3 : Gantt Chart

5.1. Work Breakdown Structure

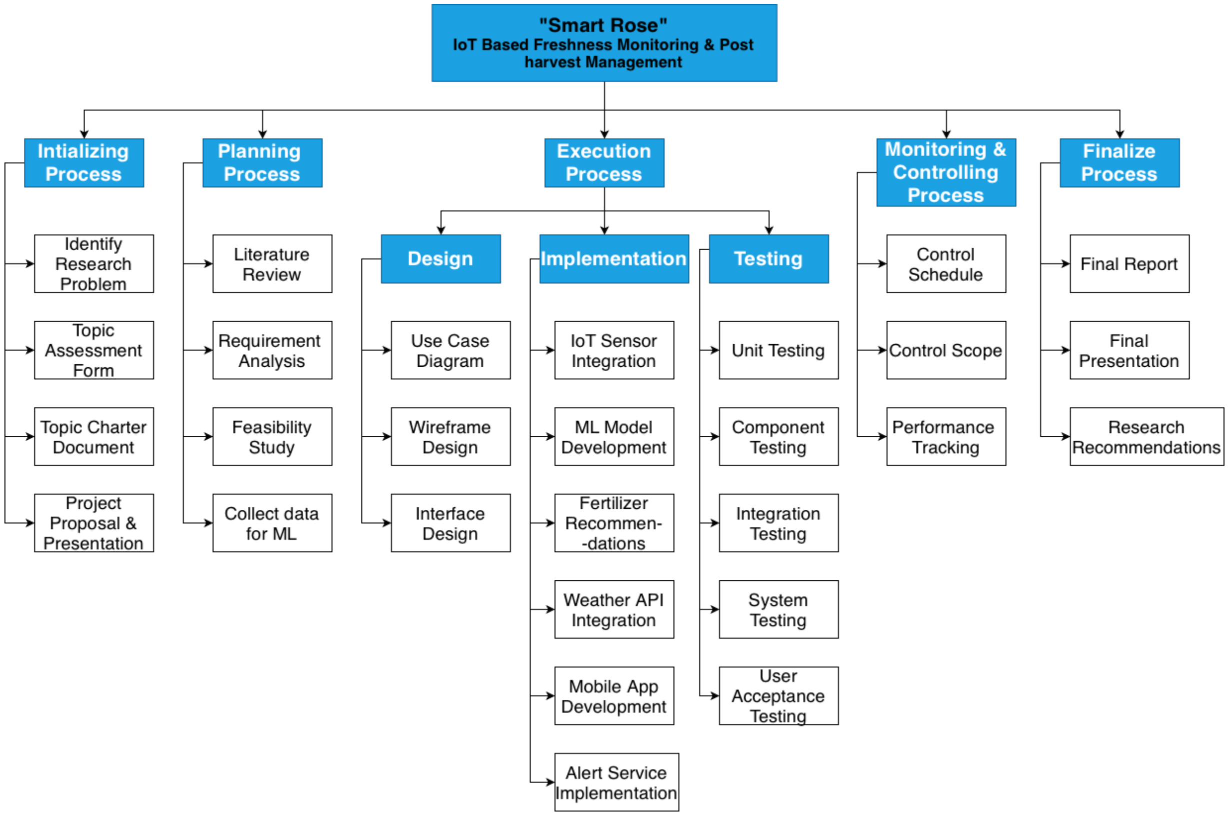

Figure 4 : Work Breakdown Structure

6. DESCRIPTION OF PERSONAL AND FACILITIES

6.1. Personal

This research is carried out individually by Chamikara Bandara (Student ID: IT22367594), an undergraduate student of the B.Sc. (Hons) in Information Technology degree program at the Sri Lanka Institute of Information Technology.

The student is responsible for the complete development of the IoT Based Freshness Monitoring and Smart Storage component of the SmartRose: AI IoT Platform. This includes the design, implementation, and evaluation of the post harvest freshness monitoring system focused on florist level environments.

Key responsibilities include

- Reviewing literature related to post harvest flower preservation, freshness indicators, and IoT based monitoring systems.
- Designing and implementing the Smart Vase hardware using ESP32 and environmental sensors.
- Developing the data collection pipeline and training machine learning models to predict freshness score and remaining vase life.
- Integrating the IoT system with a cloud backend and mobile application for real time monitoring.
- Testing and validating the system using real cut rose samples under controlled conditions.
- Preparing technical documentation, analysis, and final research reports.

The project is supervised by Dr. Junius Anjana (Supervisor) and Ms. Kaushika Kahatapitiya (Co-supervisor), who provide continuous feedback on system design, AI integration, and research methodology.

6.2. Facilities

- Computing Resources: A personal laptop with sufficient processing capability for software development, backend integration, and machine learning model training.
- IoT Hardware: ESP32 development board, DHT22 sensor (air temperature and humidity), MQ135 gas sensor (ethylene proxy), water-level sensor, DS18B20 water temperature sensor, breadboard, relays, and supporting electronic components.
- Software Tools: Arduino IDE for ESP32 programming, Python for machine learning model development, FastAPI for backend services, MongoDB for data storage, and Flutter for mobile application development.

- Testing Environment: Controlled indoor setup using cut rose bunches placed in water filled vases to simulate real florist shop conditions.
- Institutional Support: Access to SLIIT library resources, academic supervision, plagiarism checking tools, and periodic progress evaluations.

These facilities are sufficient to successfully design, implement, and evaluate the proposed freshness monitoring system within the scope of undergraduate research.

7. BUDGET AND BUDGET JUSTIFICATION

Item Estimated Cost	**Description**	**Estimated Cost (LKR)**
Laptop / PC (existing)	Development and ML model training	0
Cloud Hosting (AWS/Azure)	Deployment and testing of prototype	20,000
IoT Hardware Component	Includes ESP32 microcontroller, temperature & humidity sensor, ethylene gas sensor, water level and TDS sensors, relays, pumps, and wiring.	20,000
Notification API	For real-time notifications to patients/guardians during testing	12,000
Software Tools (Arduino, IDE, GitHub, Figma, Draw.io)	Open-source / free academic licenses (for design, version control, wireframes)	0
Data Collection (Surveys, Printing)	Printing questionnaires, distributing surveys	6,000
Travelling	Connectivity, electricity for development/Testing	25,000
Internet & Utilities	Connectivity, electricity for development/testing	8000
Contingency Allowance	Unexpected minor expenses	5000

Total Estimated Budget: LKR 96,000

8. COMMERCIALIZATION AND ENTREPRENEURSHIP POTENTIAL

The IoT Based Freshness Monitoring and Smart Storage component demonstrates strong commercialization and entrepreneurship potential as a practical post harvest solution for Sri Lanka's floriculture sector. Unlike farm level smart agriculture systems, this component directly targets the florist and flower distribution stage, where the highest level of flower spoilage and financial loss occurs.

Sri Lanka's cut flower market includes thousands of small and medium scale florists operating in urban areas such as Colombo, Kandy, Galle, and Matara. These businesses rely heavily on visual judgment and experience to assess flower freshness, resulting in inconsistent quality and high waste. The proposed Smart Vase system introduces an affordable, data driven method to monitor freshness in real time, making it highly suitable for local market adoption.

Market Opportunity

- Primary Market: Small and mid scale florists in Sri Lanka who handle cut roses daily and face losses due to poor freshness assessment and manual water management.
- Secondary Market: Flower wholesalers, wedding decorators, hotel floral departments, and flower distribution centers that require consistent quality and longer vase life.
- Expansion Potential: The system can be adapted for other cut flowers such as lilies, carnations, gerbera, and orchids, and extended to export-oriented floriculture markets.

Revenue and Business Model

- Smart Vase Hardware Package: A low cost IoT kit including ESP32, freshness sensors, and water temperature monitoring, sold as a one time purchase.
- Mobile App Subscription: Florists can subscribe to a monthly plan to access freshness scores, vase life predictions, alerts, and historical analytics.
- Value Added Services: Premium features such as automated water replacement logic, advanced freshness prediction models, and multi vase monitoring dashboards can be offered for higher tier subscriptions.
- B2B Licensing: The technology can be licensed to large flower retailers, event management companies, or cold storage operators for customized deployment.

Competitive Advantage

- AI Based Decision Support: Predicts freshness and remaining vase life instead of relying only on static thresholds.
- Post Harvest Focus: One of the first IoT AI solutions in Sri Lanka specifically designed for florist level freshness monitoring rather than farm cultivation.
- Affordable and Localized Design: Uses ESP32 and low cost sensors suitable for Sri Lankan small businesses.
- Waste Reduction Impact: Helps reduce flower spoilage, improving profitability and sustainability.
- Scalability: Can be integrated with other SmartRose components such as disease detection or nutrient management to form a complete floriculture intelligence platform.

9. REFERENCE LIST

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10. APPENDICES

10.1. Plagiarism Report

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