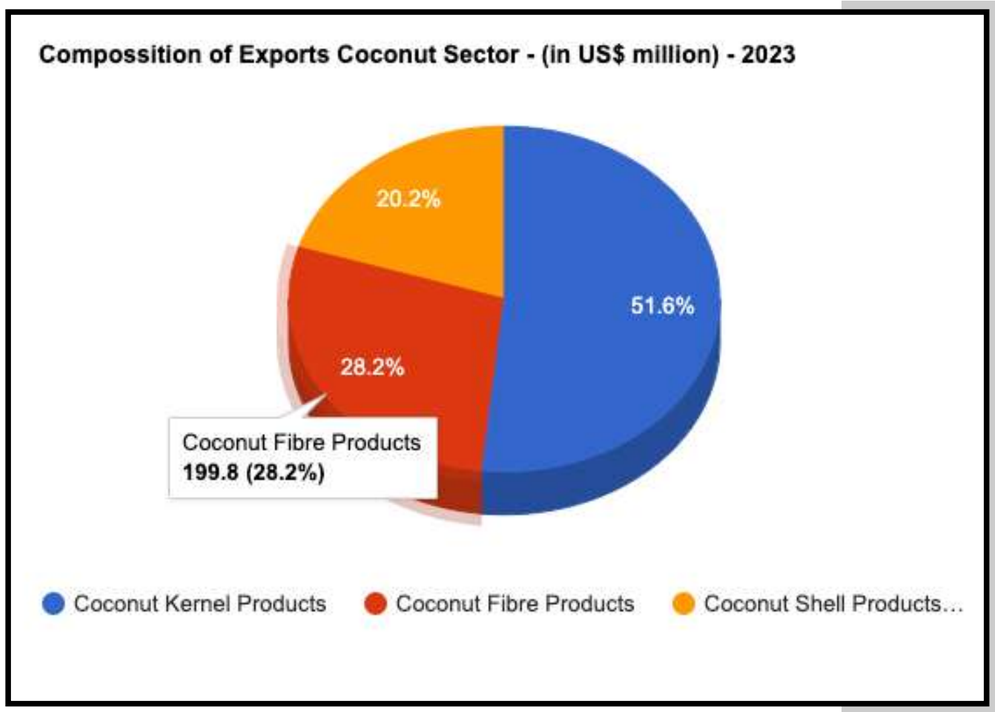
ENHANCING TRANSPARENCY IN THE COCONUT PEAT SUPPLY CHAIN THROUGH A SOFTWARE ENGINEERING APPROACH

Group - 24-25J-313

OUR PROJECT

- 4th largest coconut producer in the world
- The global coco-peat market is valued at USD 2.27 billion (2022) and is projected to reach USD 3.8 billion by 2031 (CAGR of 4.4%).



- Coco-peat, also known as coir pith, is a byproduct of the coconut industry.
- Used extensively in horticulture as a soil substitute and soil conditioner.

Field Visit

Demonstration

CURRENT CHALLENGES

1. Quality Control Issues
2. Inefficiencies in the supply chain
3. Lack of Transparency and Traceability
4. Reluctancy to adopt new technologies

Note : All these information was gathered during the field visit

Research Question

How can transparency be enhanced in the coco-peat supply chain through a software engineering approach integrating blockchain, IoT, and customizable workflow management systems?

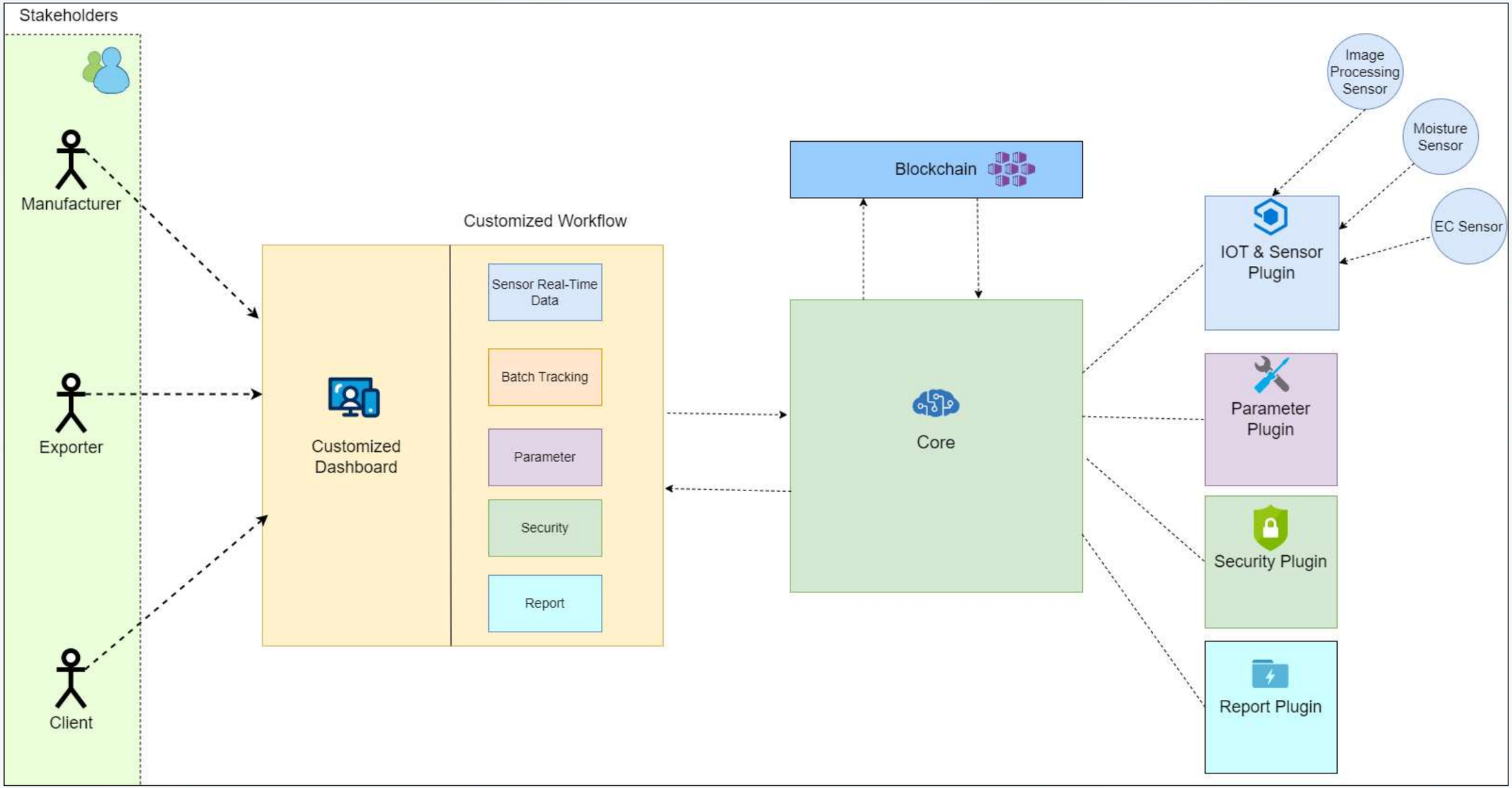
Main Objective

- To develop and implement a comprehensive software engineering solution that enhances transparency in the coco-peat supply chain.

Specific Objectives:

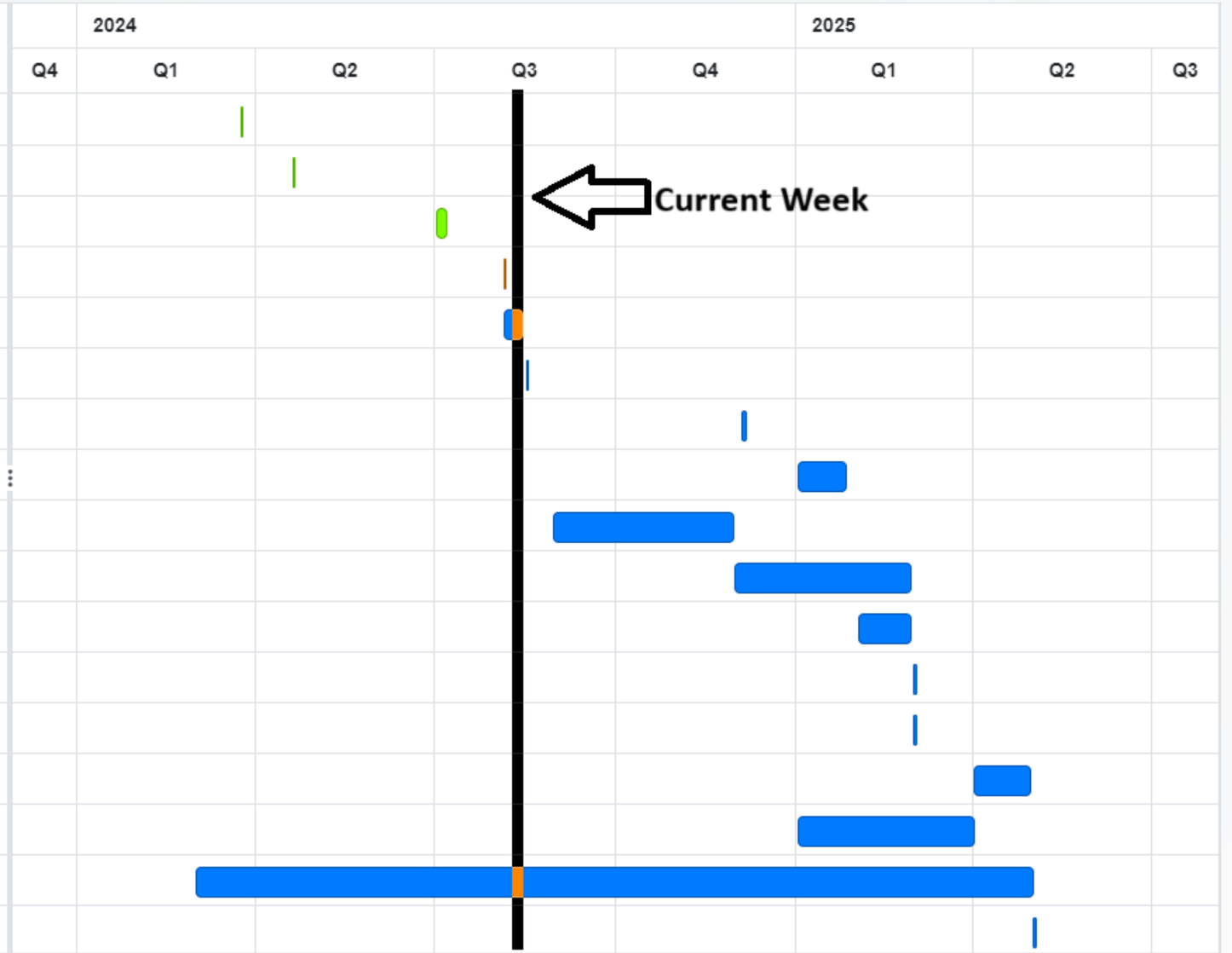
1. Analyze Current Supply Chain
2. Select Appropriate Technologies
3. Design System Architecture
4. Develop Smart Contracts
5. Integrate IoT Devices
6. Customize Workflow Management
7. Test and Validate the System

SYSTEM DIAGRAM



GANTT CHART

ID	Name
1	Brainstorming Workshop
2	Group Registration
3	Topic Assessment Form (TAF)
4	Proposal Reports (Draft)
5	Proposal Presentation
6	Proposal Reports (Final for Marking)
7	Progress Presentation I
8	Status Document I
9	Research Paper
10	Final Reports
11	Progress Presentation II
12	Status Document II
13	Research Paper Registration Notification
14	Final Presentation & VIVA
15	Project Website
16	Research Logbook
17	Final Report (Proofread)



COMMERCIALIZATION

- Sri Lanka Export Development Board (SLEDB)
- Medium to small scale exporters

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ENHANCING SYSTEM STABILITY AND PLUGIN MANAGEMENT IN A MICROKERNEL ARCHITECTURE THROUGH CUSTOMIZED ARCHITECTURE FOR COCONUT PEAT SUPPLY CHAIN

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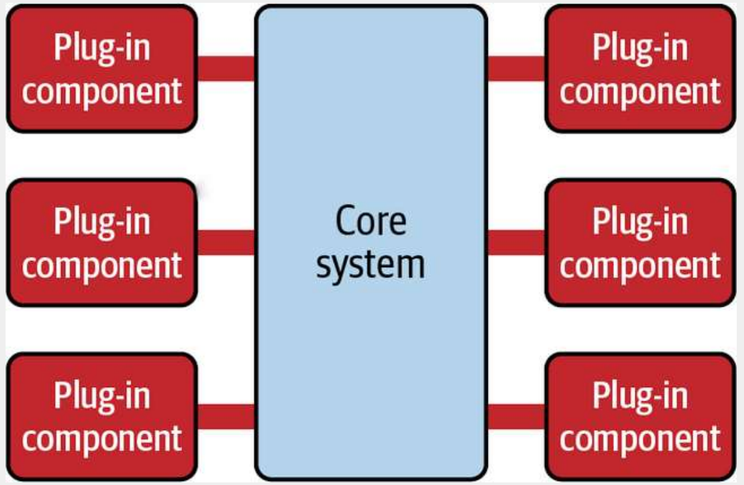
Specialization - Software Engineering

INTRODUCTION

- What is MicroKernel Architecture ?
  - A minimal core that provides basic functionality.
  - Additional functionalities are plugged into the core as plugins.

- Why Microkernel Architecture is important ?
  - Customizability
  - Flexibility
  - Extensibility



RESEARCH GAP

- Integration of Advanced Technologies
  - Most Research focuses on the technologies in isolation rather than as a cohesive system. [2][5][6]
- Case Studies and Practical Implementations
  - Most existing literature focuses on theoretical models or implementation in different contexts. [4][5][6]
- System Stability and Plugin Management
  - lacks of failure recovery methods. [7]

RESEARCH QUESTION

How can a microkernel architecture be effectively utilized and enhanced with modern technologies to improve system stability, manage plugins efficiently, and provide end-to-end transparency in the coconut peat supply chain **?**

OBJECTIVES

Main Objectives:

- Develop a robust core system that integrates Blockchain and IoT technologies, ensures customizability and flexibility, and enhances system stability and plugin management.

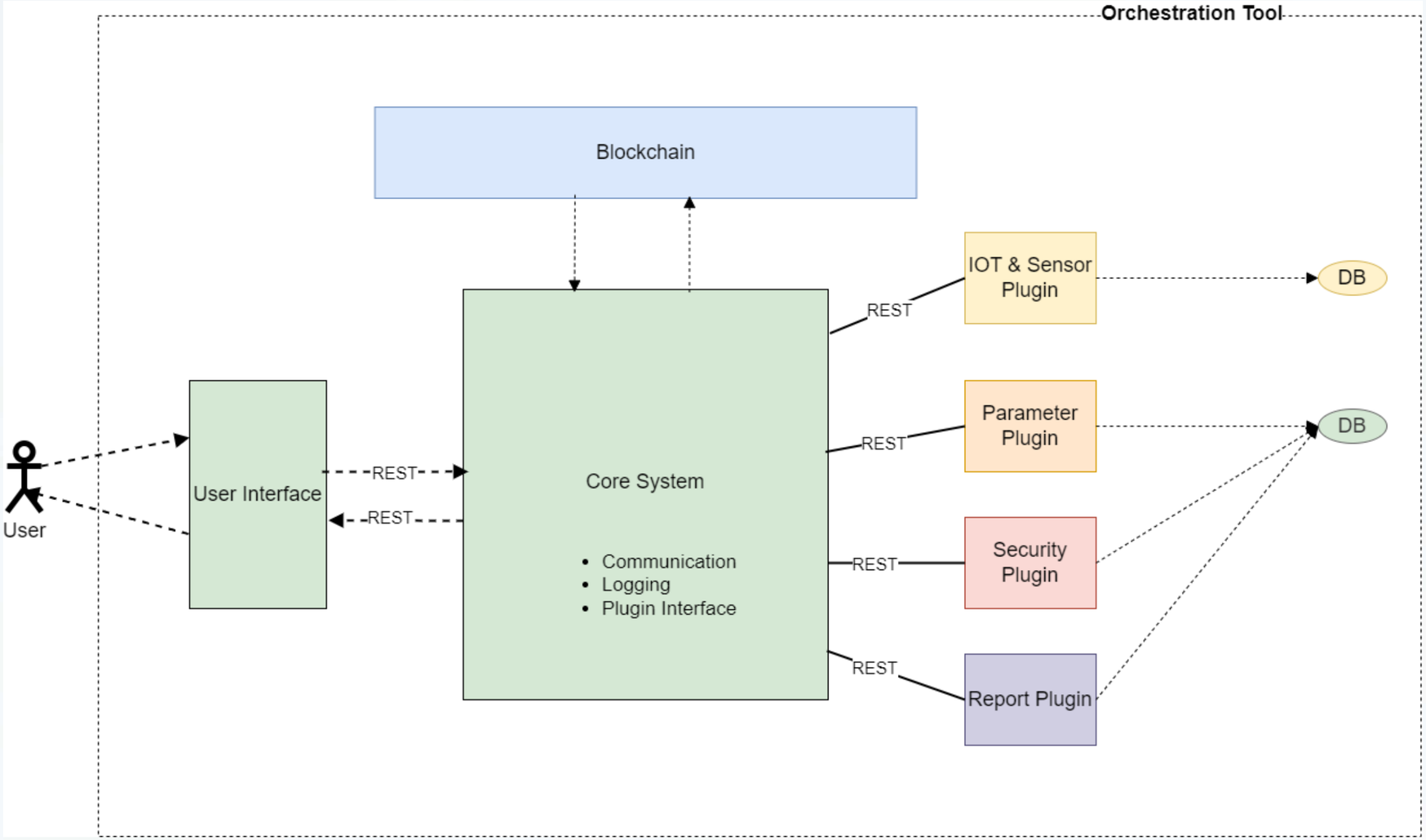
OBJECTIVES

Specific Objectives:

- Optimize Real-time Data Processing:
- Validate Scalability and Performance:
- Achieve End-to-End Transparency:
- Implement Comprehensive Testing and Monitoring

METHODOLOGY

Component Diagram



METHODOLOGY

Technologies Used

PROJECT REQUIRMENTS

Functional Requirements:

- Core System (Microkernel)
- Plugins
- User Interface

User Requirements:

- Usability
- Accessibility
- Customization
- Real-time Data
- Security

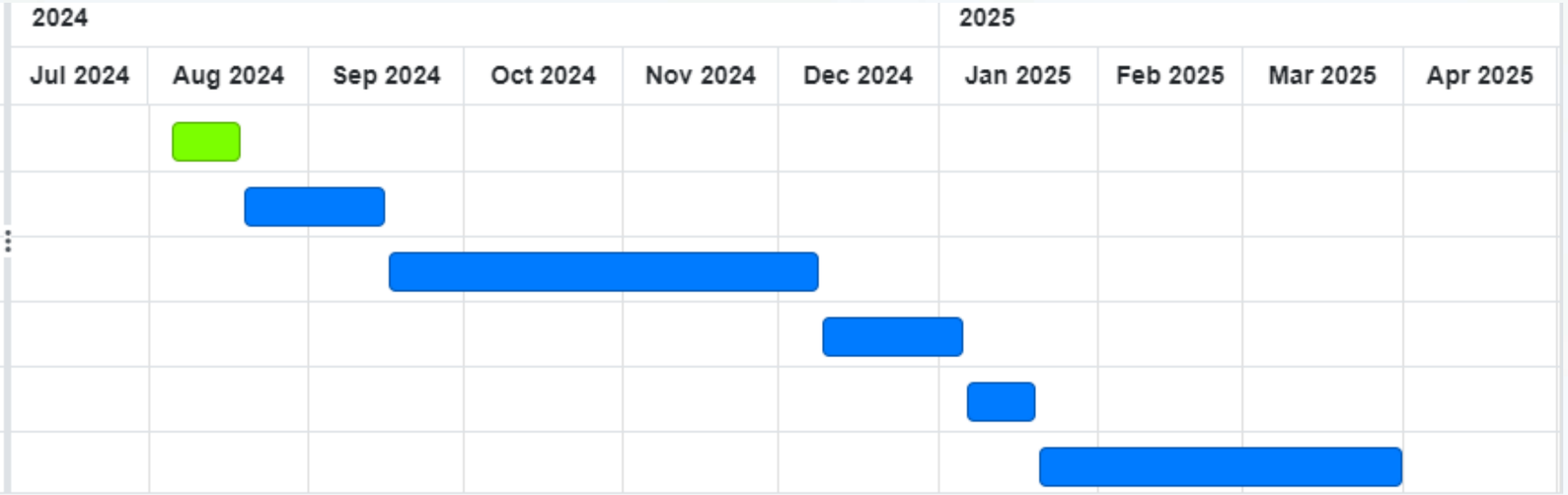
Non-Functional Requirements:

- Performance
- Scalability
- Reliability
- Security
- Maintainability
- Usability
- Compliance
- Interoperability

WORK BREAKDOWN STRUCTURE

Gantt Chart

ID	Name
1	Requirements Gathering and Analysis
2	System Design
3	Development
4	Testing
5	Deployment
6	Maintenance and Support



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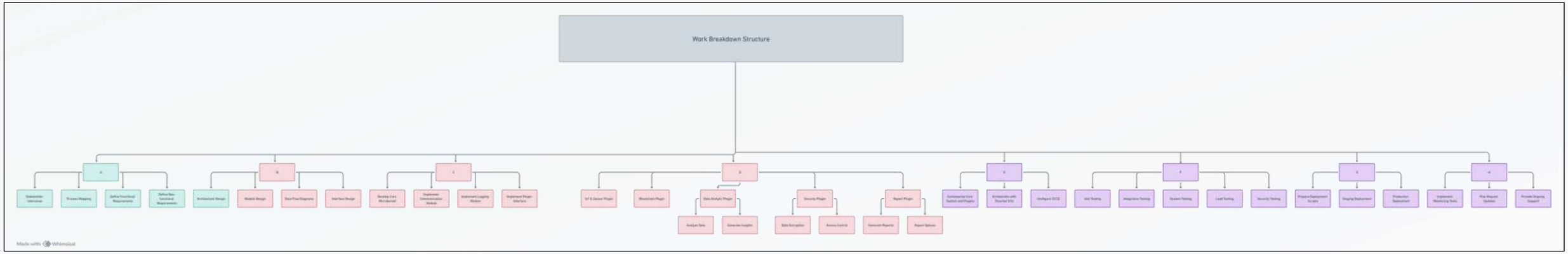

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A CUSTOMIZATION TOOL FOR WORKFLOW MANAGEMENT

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INTRODUCTION

- Existing workflow management in coco-peat manufacturing is often rigid and complex.
- Customization of processes requires technical expertise, limiting flexibility for non-technical users.
- Workflows vary significantly across different manufacturing processes, adding complexity.
- Need for an intuitive tool that allows domain experts to easily customize and manage workflows without technical knowledge.

IMPORTANT FINDINGS

Positive Findings:

- Visual tools improve efficiency and satisfaction
- Customizable systems enhance adaptability
- Real-time data aids decision-making

Negative Findings:

- Existing solutions are complex
- Integration with current systems is challenging
- Security risks in managing workflow data

EXISTING TOOLS AND SOLUTIONS

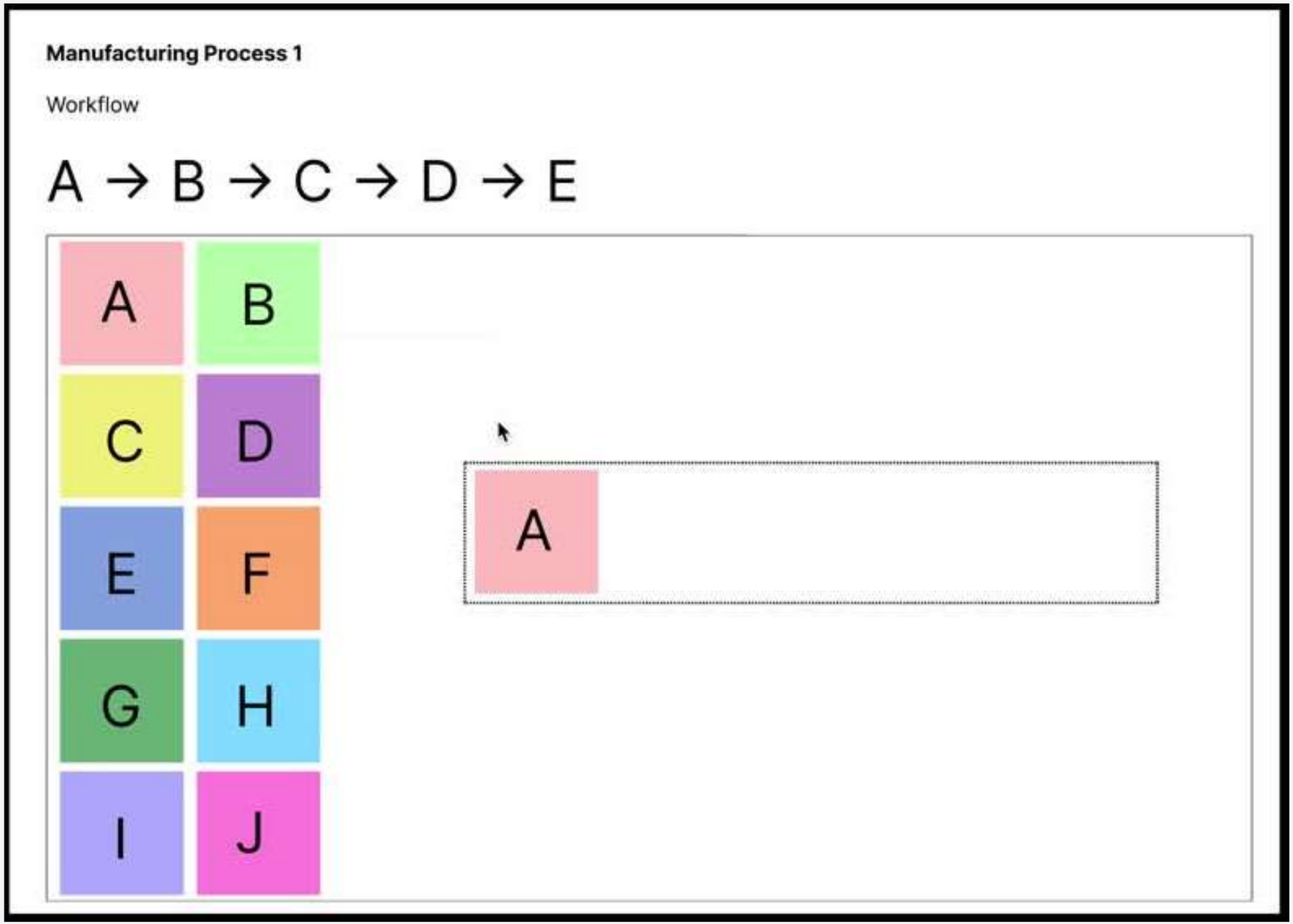
RESEARCH GAP

- Existing tools are general-purpose and may not cater to specific needs of coco-peat manufacturing.
- Most tools are not designed for real-time customization and management of manufacturing workflows.
- Need for a specialized tool tailored to the unique requirements of coco-peat manufacturing, enabling domain experts to customize workflows without technical expertise.

RESEARCH QUESTION

How can domain-specific experts in the coco-peat manufacturing industry manage and optimize workflows to enhance transparency, efficiency, and decision-making without relying on technical expertise?

SAMPLE SOLUTION



OBJECTIVES

Main Objective: Develop a visual, drag-and-drop workflow customization tool.

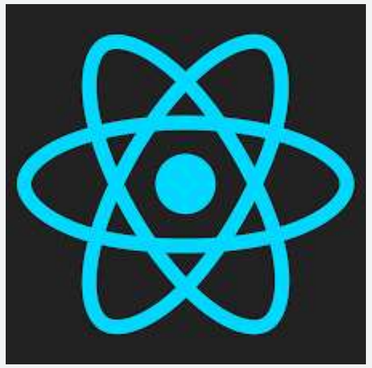
Specific Objectives:

- Create an intuitive user interface
- Ensure seamless system integration
- Provide real-time reporting and analytics tools
- Generate an accurate output

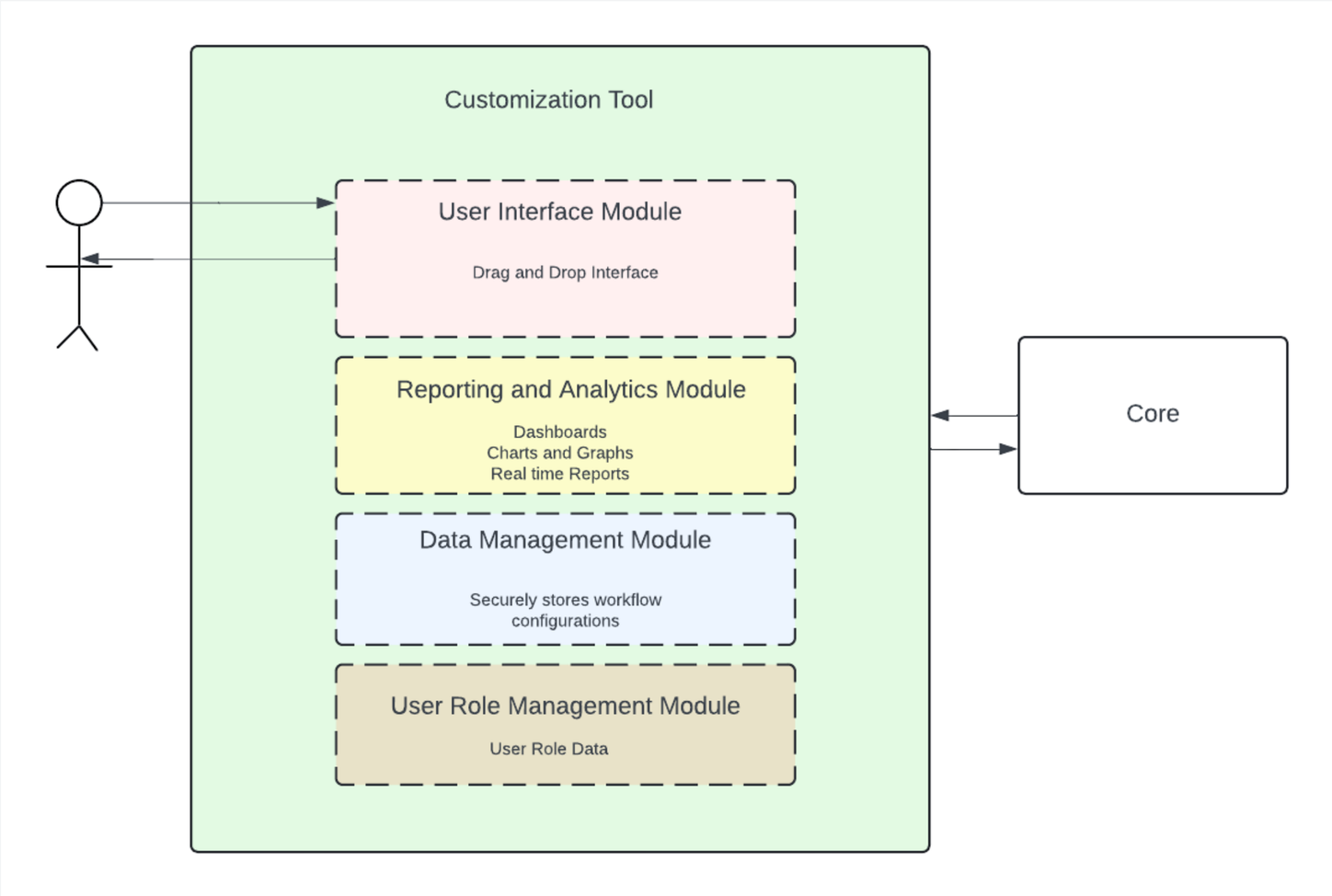
METHODOLOGY

1. Requirement Gathering and Analysis
2. User Interface Design
3. System Architecture Design
4. Select Technologies
5. Develop Frontend and Backend
6. Perform Testing Phase
7. Deploy the Application
8. User Training and Documentation
9. Maintenance and Support

Technologies



Component Diagram



PROJECT REQUIREMENTS

Functional Requirements:

- Customizable workflows for different manufacturing processes.
- Drag-and-drop interface for easy workflow setup.
- Real-time updates and monitoring of workflows.
- Role-based access control.

Non-Functional Requirements:

- High availability and reliability.
- Fast response time and low latency.

PROJECT REQUIREMENTS

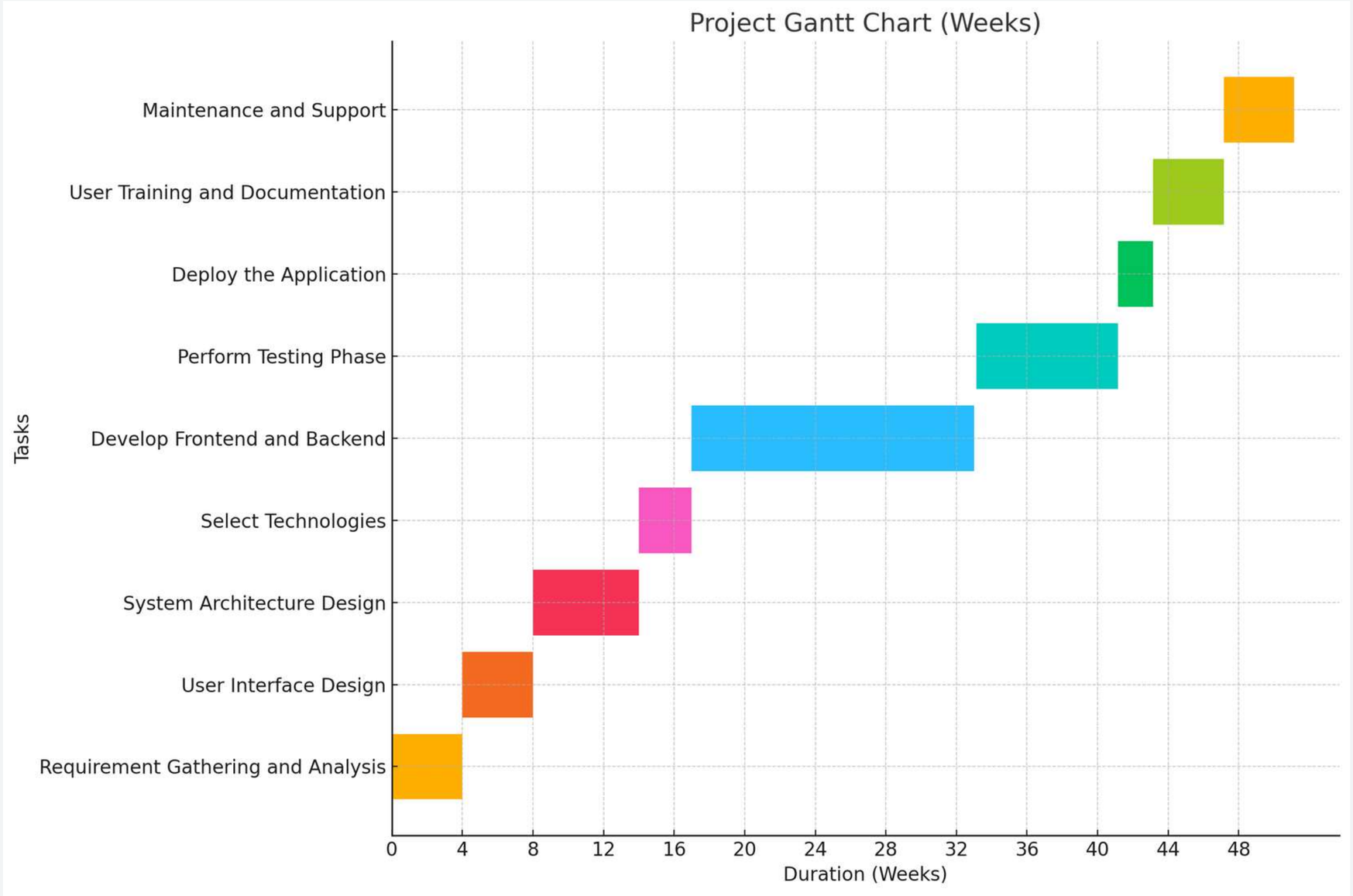
User Requirements:

- Non-technical users must be able to customize workflows easily.
- Users should be able to generate reports and analytics.
- Intuitive interface with minimal learning curve.

System Requirements:

- Compatibility with existing manufacturing hardware and software.
- Scalability to handle multiple concurrent users and large datasets.
- Secure storage of workflow configurations.

GANTT CHART


Project Gantt Chart (Weeks)
Maintenance and Support
User Training and Documentation
Deploy the Application
Perform Testing Phase
Develop Frontend and Backend
Select Technologies
System Architecture Design
User Interface Design
Requirement Gathering and Analysis
Tasks
0
4
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44
48
Duration (Weeks)

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INTEGRATION OF BLOCKCHAIN

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CURRENT SUPPLY CHAIN CHALLENGES

- Lack of transparency.
- Issues with traceability.
- Quality control problems.
- Inefficiencies and fraud risks.

What is Blockchain ?

Blockchain is a type of digital ledger that records transactions across multiple computers in a way that ensures the data cannot be altered

1. Decentralized
2. Immutable
3. Transparency

Case Studies

- Food Supply Chains:
  - IBM Food Trust leverage blockchain to enhance transparency and traceability.
  - Use of IoT devices for real-time data collection ensures consistent quality control.
  - Blockchain reduces fraud risk by providing immutable records.

- Pharmaceutical Supply Chains:
  - Initiatives like MediLedger focus on ensuring the integrity and origin of pharmaceutical products.
  - High adoption of blockchain and IoT technologies driven by regulatory requirements.
  - Stringent quality control measures enforced through automated checks and compliance.

RESEARCH GAP

- Significant research on blockchain in supply chains, but limited application to the coco-peat industry.

- Need for a tailored blockchain solution for the coco-peat supply chain to address unique challenges and requirements.

Novel Integration:

- Combining blockchain tailored specifically for the coco-peat supply chain.
- Creating an immutable ledger for transactions and real-time monitoring of environmental conditions and product status.

Creative Approach:

- Developing smart contracts to automate quality control and compliance checks, reducing human error and enhancing efficiency.
- Designing a user-friendly interface for stakeholders, enabling seamless access to supply chain information.

RESEARCH PROBLEM

- Lack of transparency and traceability in the coco-peat supply chain.
- Traditional approaches fail to ensure data integrity and real-time visibility.
- How to effectively integrate blockchain to enhance transparency and traceability in the coco-peat supply chain.

How to increase transparency and traceability in the cocopeat supply chain while providing data integrity and real-time visibility ?

OBJECTIVES

Main Objective: Develop and implement a blockchain-based system to enhance transparency and traceability in the coco-peat supply chain.

Specific Objectives:

1. Identify key pain points in the current supply chain.
2. Select an appropriate blockchain platform.
3. Design smart contracts.
4. Integrate IoT devices.
5. Test and validate the system.

Methodology

- **System Design**: Blockchain platform, IoT devices, smart contracts, user interface.
- **Data Collection**: Real-time data from IoT devices, stakeholder inputs.
- **Testing**: Data integrity, smart contract functionality, IoT device integration, access control, system performance, user interface.

User Requirements

- Scalability.
- Security.
- Reliability.
- Usability.

Functional Requirents

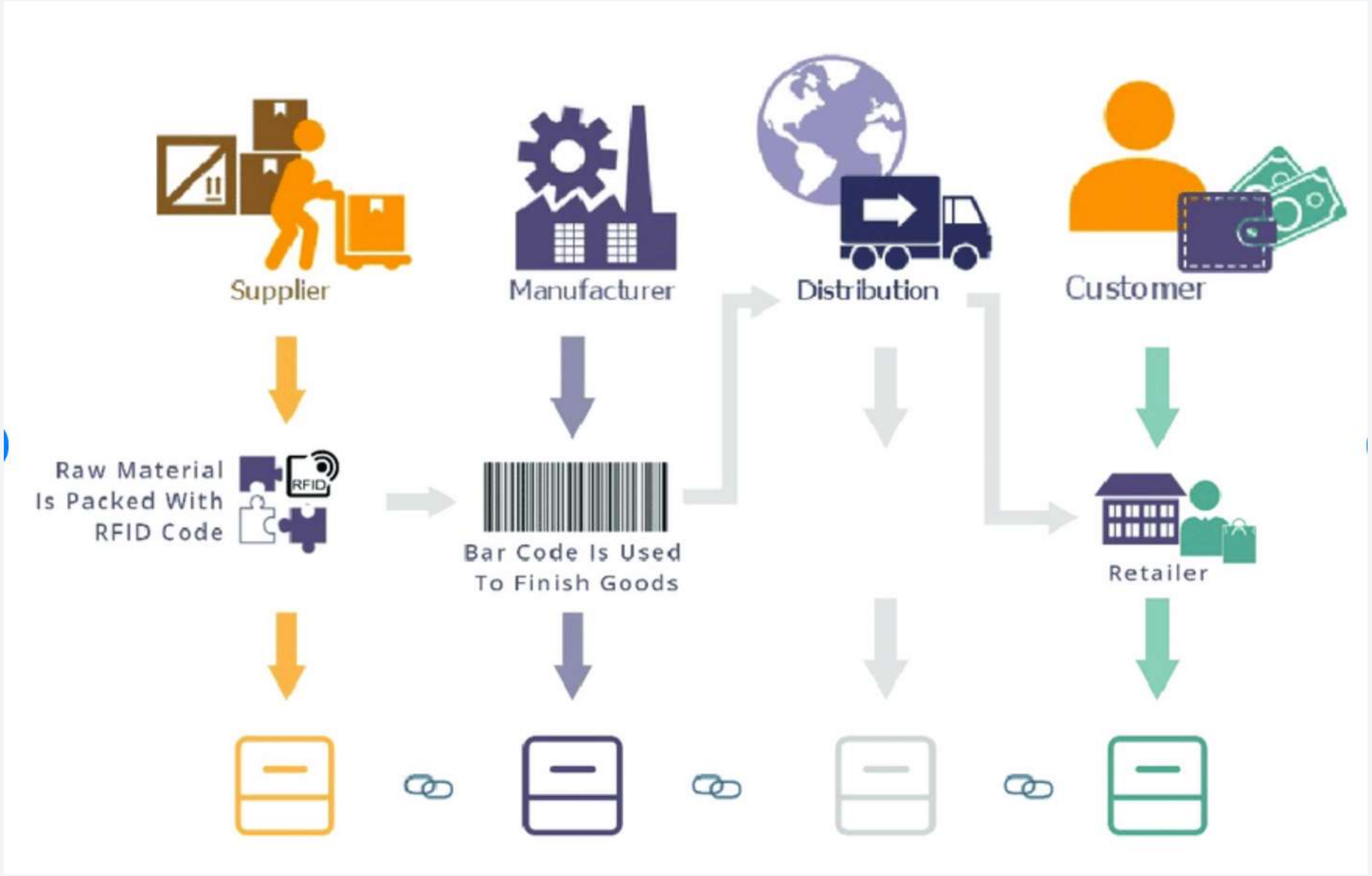
- Real-time data capture.
- Immutable ledger.
- Smart contract automation.
- User access control.
- Traceability interface.

Overview of Blockchain Technologies

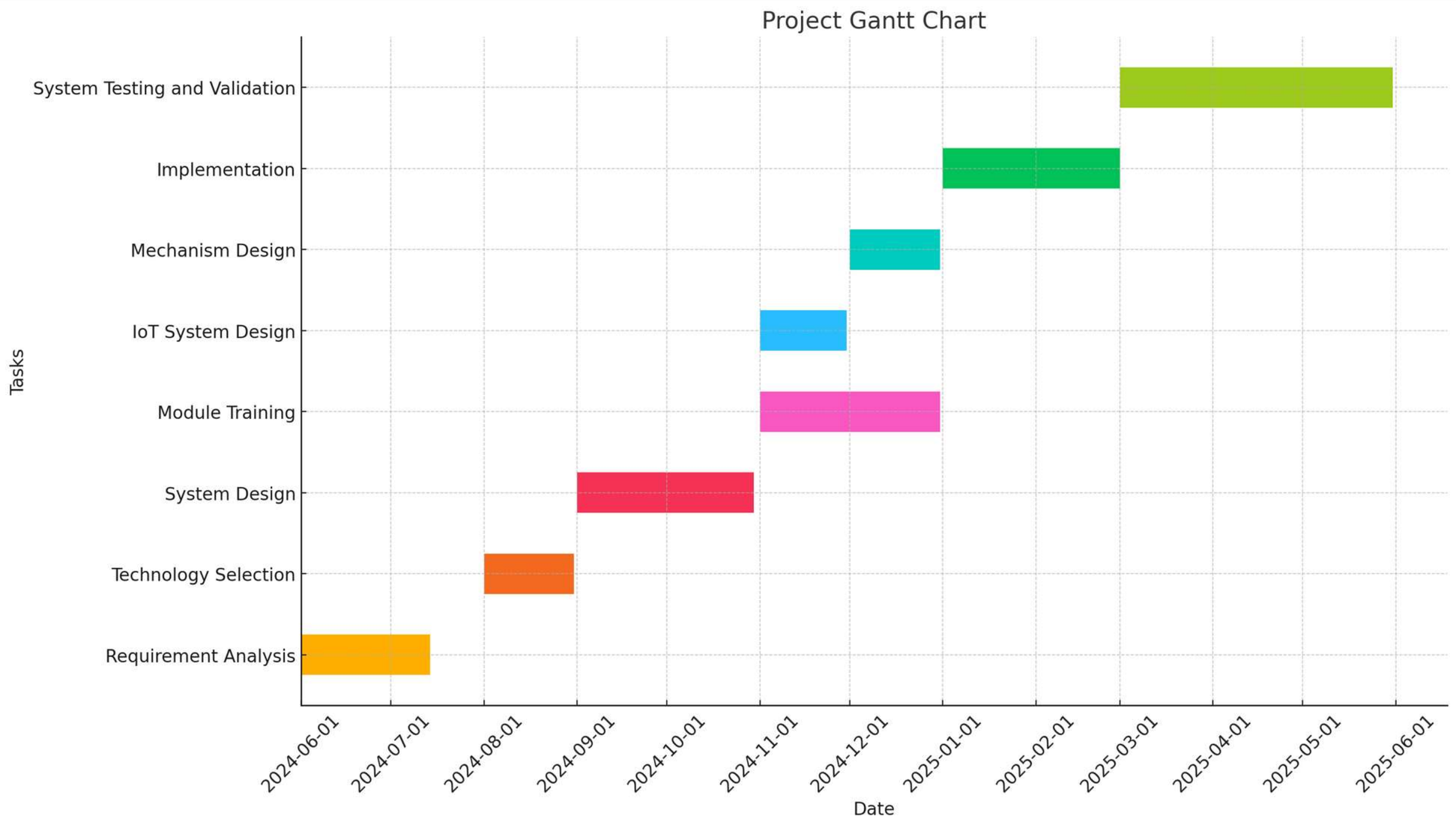
Platform	Features	Pros	Cons
Ethereum	Decentralized, smart contracts, public blockchain	Wide adoption, robust smart contract functionality	Scalability issues, high transaction fees
Hyperledger Fabric	Permissioned blockchain, modular architecture	High scalability, privacy features, enterprise-focused	More complex setup, less decentralized
Corda	Permissioned blockchain, designed for financial institutions	High privacy, efficient for bilateral transactions	Limited to financial use cases, less flexibility

Key Technologies:

- Smart Contracts:
  - Automates transactions and ensures compliance with predefined conditions.
  - Examples: Ethereum’s Solidity, Hyperledger’s Chaincode.
- Consensus Mechanisms:
  - Proof of Work (PoW): Used by Bitcoin, Ethereum.
  - Proof of Stake (PoS): Energy-efficient, used by newer platforms.
  - Practical Byzantine Fault Tolerance (PBFT): Used by Hyperledger Fabric.
- Interoperability Solutions:
  - Ensures seamless communication between different blockchain networks.
  - Examples: Polkadot, Cosmos.


Supplier
Manufacturer
Distribution
Customer
Raw Material
Is Packed With
RFID Code
RFID
Bar Code Is Used
To Finish Goods
Retailer

Workflow


Project Gantt Chart
System Testing and Validation
Implementation
Mechanism Design
IoT System Design
Module Training
System Design
Technology Selection
Requirement Analysis
Tasks
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COCONUT HUSK GRADING SYSTEM USING IMAGE PROCESSING AND COMPUTER VISION. IOT AUTOMATION FOR COCO PEAT QUALITY ASSURANCE

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AUTOMATING COCONUT HUSK GRADING SYSTEM

AUTOMATING COCONUT HUSK GRADING SYSTEM

QUALIFIED

ACCEPTED

DISQUALIFIED

SOLUTION

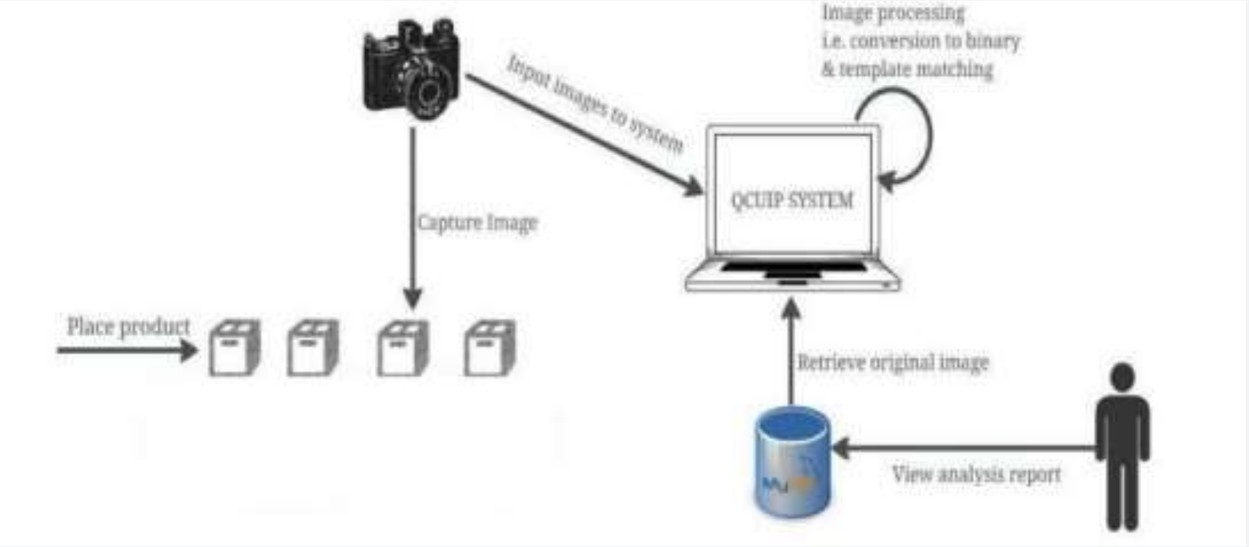
Demonstration

RESEARCH QUESTION

- Which technology is suitable for the husk grading system?

EXISTING SYSTEMS

- Fruit quality classifications [1]
- Detection of fire [2]
- Beef quality identification [3]
- Robotic engineering [4]
- Smart Manufacturing Systems [5]
- Agriculture purpose [6]



TECHNOLOGY

IMAGE PROCESSING

Pros

- Simpler algorithms
- Less computational power required

Cons

- Limited to basic feature extraction

COMPUTER VISION

Pros

- Advanced techniques
- Can handle more complex features

Cons

- Requires more computational resources

IMPLEMENTING IOT SYSTEM FOR COCOPEAT QUALITY ASSURANCE

Demonstration

OBJECTIVES

MAIN OBJECTIVES

- To automate the coconut husk selection process using image processing technology to ensure efficiency and consistency.
- To implement IoT systems for real-time monitoring of coco peat conditions during the washing and drying processes.

SPECIFIC OBJECTIVES

- Design mechanisms for husk transport and scanning.
- Develop and train data models.
- Implement husk sorting and coco peat condition monitoring systems.
- Create a web dashboard for real-time data visualization.

METHODOLOGY

Programming language

- Python

Librarie
s

- OpenCV
- metplotlib

Real-time monitoring

- Grafana

Databas
e

- Influxdb

Raspberry Pi 4

Arduino Uno

influxdb

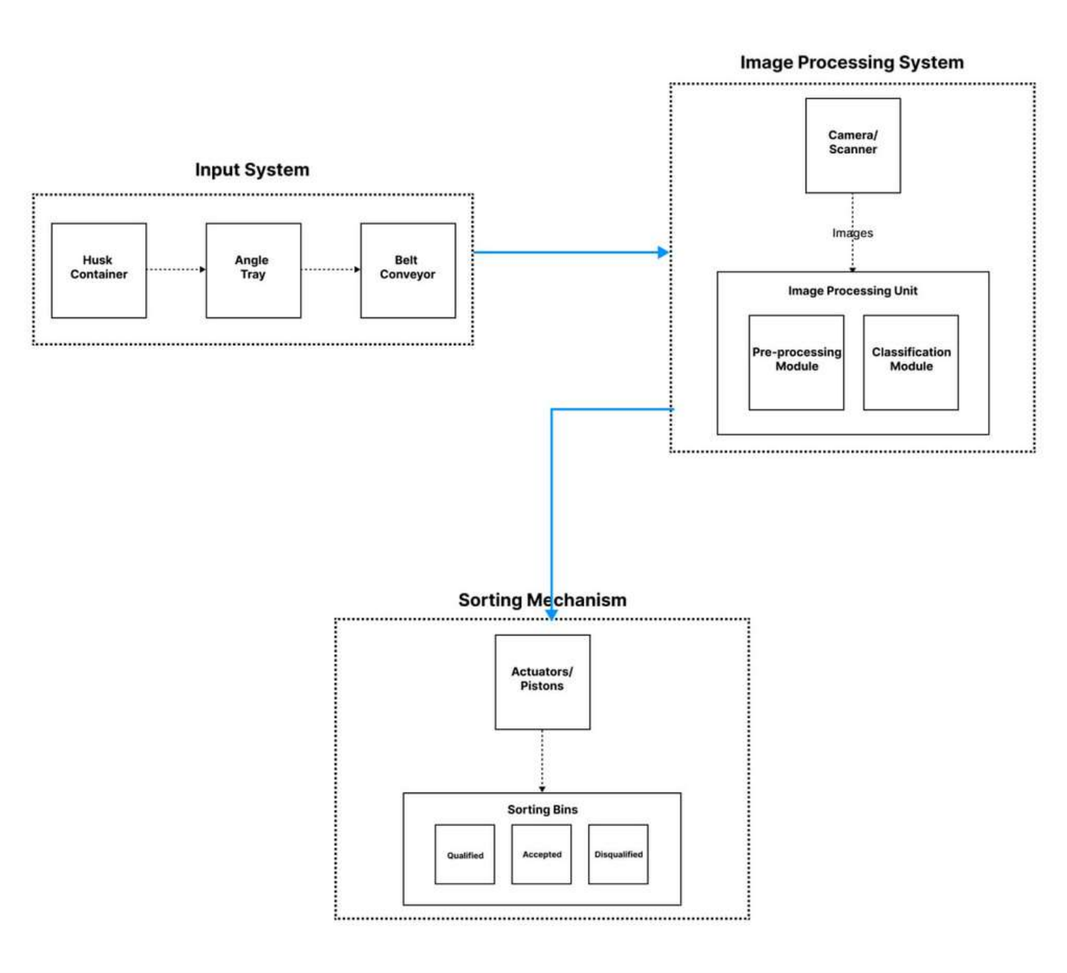
django

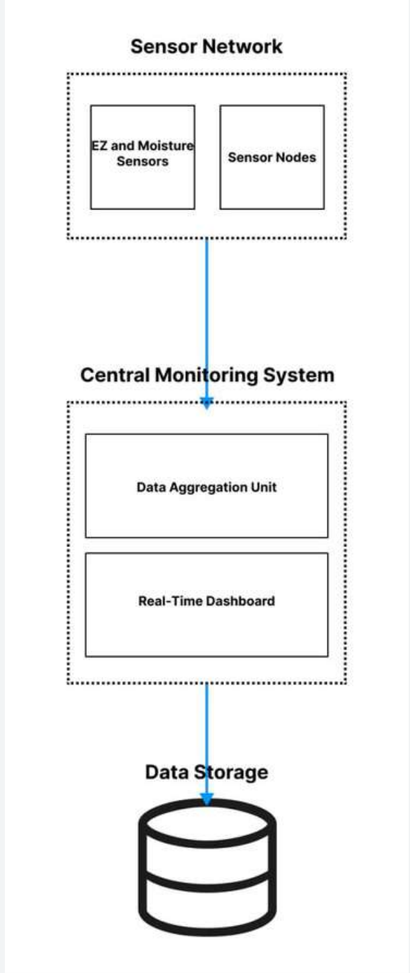
Flask

matplotlib

OpenCV

SYSTEM ARCHITECTURE





PROJECT REQUIREMENTS

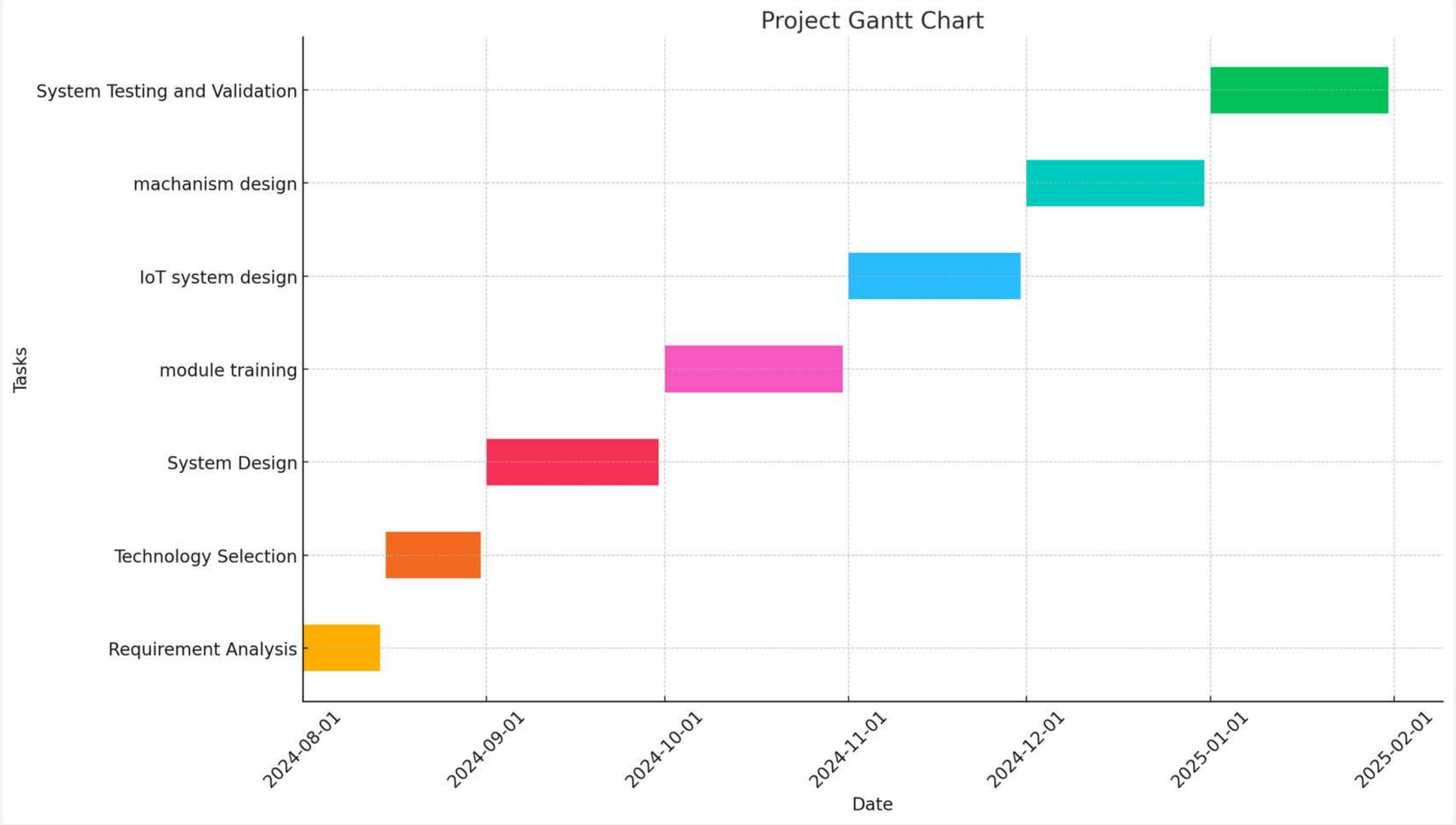
FUNCTIONAL

- Classify husks accurately
- Monitor conditions in real-time

NON FUNCTIONAL

- Reliable
- Low latency
- Scalable

GANTT CHART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THANK YOU !