MINI PROJECT REPORT

ON

SUPPLYCHAIN MANAGEMENT FOR AGRICULTURE USING BLOCKCHAIN

Submitted By

DEVANANDANA S (CEC23MCA-2014)

in partial fulfillment for the award of the degree of

Master of Computer Application

Department of Computer Engineering

College of Engineering, Cherthala

Alappuzha - 688541

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DEPARTMENT OF COMPUTER ENGINEERING

COLLEGE OF ENGINEERING, CHERTHALA

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C E R T I F I C A T E

This is to certify that, the project report titled **"SUPPLYCHAIN MANAGEMENT FOR AGRICULTURE USING BLOCKCHAIN"**is a bonafide record of the **20MCA245MiniProject** presented by **DEVANANDANA S (CEC23MCA2014)**, Third semester Master of Computer Apllication student, under our guidance and supervision, in partial fulfillment of the requirements for the award of the degree, **Master of Computer Application** of **APJ Abdul Kalam Technological University during the academic year 2024-2025**.

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ACKNOWLEDGEMENT

This work would not have been possible without the support of many people. First and the foremost, we give thanks to Almighty God who gave us the inner strength, resource and ability to complete our project successfully.

I, DEVANANDANA S would like to thank **Dr. Jaya V.L**, our Principal, who has provided with the best facilities and atmosphere for the project completion and presentation.I would also like to thank our HoD **Dr. Preetha Theresa Joy** (Professor, Department of Computer Engineering), our project coordinator and my guide **Ms.Renjusha Aravind** (Assistant Professor, Department of Computer Engineering) for the help extended and also for the encouragement and support given to us while doing the project.

I would like to thank my dear friends for extending their cooperation and encouragement throughout the project work, without which we would never have completed the project this well.Thank you all for your love and also for being very understanding.

DECLARATION

I hereby declare that the project "SUPPLYCHAIN MANAGEMENT FOR AGRICULTURE USING BLOCKCHAIN" is a bonafide work done by me during the academicyear 2024-2025 under the guidance of Ms.Renjusha Aravind ,Assistant Professor at College of Engineering,Cherthala and this report has not been previously formed the basis for the award of any degree, diploma, fellowship or any other similar title or recognition in any other university.

DEVANANDANA S

CEC23MCA2014

12/11/2024

ABSTRACT

This project focuses on developing a blockchain-based supply chain management application aimed at enhancing transparency, traceability, and trust within the agricultural industry. By leveraging smart contracts, the system enables the secure, decentralized, and immutable tracking of agricultural products from the point of origin to the final consumer. The platform allows key stakeholders—farmers, distributors, and consumers—to interact directly within a shared, transparent ecosystem that minimizes intermediaries, reduces costs, and mitigates fraud risks.

At its core, the project utilizes a smart contract named SupplyChain, which is developed in Solidity and deployed locally on a Ganache blockchain environment. The contract manages essential product details, including product ID, name, origin, current status, and owner. It incorporates functions for adding new products, transferring product ownership, and confirming product delivery, creating an unbroken digital trail for each item's journey through the supply chain. Farmers can register products onto the blockchain, while consumers can trace product history and make purchases, ensuring accountability and fostering informed buying decisions.

The back end, built using Node.js and Web3.js, provides an interface between the blockchain and the front end, enabling real-time data interaction and seamless integration of smart contract functions. The front end is designed with HTML and JavaScript, featuring separate pages for adding and buying products. This interface facilitates intuitive interaction, allowing users to perform actions like adding new items and purchasing products, with updates dynamically reflected on the page.

Additional project features, planned for future incorporation, aim to improve functionality further, such as automated alerts upon successful actions, enhanced UI/UX for better user engagement, and expanded traceability options to capture a more comprehensive product lifecycle. These planned enhancements will be incorporated into the main project and explained in a detailed presentation to illustrate the potential for scalability and adaptability in diverse supply chain scenarios.

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Chapter 1

INTRODUCTION

Supply chain management in agriculture faces challenges related to transparency, traceability, and efficiency, which are crucial for building trust among producers, distributors, and consumers. Traditional supply chain systems often lack real-time visibility and are susceptible to issues like fraud, counterfeiting, and inefficiencies due to the involvement of intermediaries. These problems are particularly pronounced in the agricultural sector, where perishable goods and time-sensitive transactions require fast, reliable, and secure solutions.

Blockchain technology offers a promising approach to addressing these issues by enabling decentralized, transparent, and tamper-proof records. By using blockchain, supply chain participants can verify product information, ownership history, and transaction records in a secure and trustless manner. Smart contracts further automate processes and enforce agreements without requiring third-party oversight, making blockchain-based solutions especially valuable for enhancing supply chain resilience and accountability.

Chapter 2

PROBLEM STATEMENT

2.1 Problem Statement

The agricultural supply chain is riddled with challenges stemming from a lack of transparency, inefficiencies, and limited traceability. Traditional supply chains rely on centralized systems that often lack real-time visibility and are prone to data manipulation, resulting in issues like fraud, counterfeiting, and miscommunication among stakeholders. In particular, consumers struggle to verify the authenticity and origin of agricultural products, while farmers face hurdles in proving the quality and source of their goods. These inefficiencies not only impact trust but also drive up costs and waste across the supply chain.

Furthermore, with limited accountability and verification mechanisms, the agricultural sector faces challenges in meeting the growing demand for sustainable and ethical sourcing. There is a pressing need for a solution that ensures the traceability of products, reduces dependency on intermediaries, and creates a secure, trustless environment where each stakeholder can interact with confidence.

2.2 Objective

The objective of this project is to develop a blockchain-based supply chain management system that enhances transparency, traceability, and efficiency within the agricultural sector. The system aims to:

1. Enable Secure Product Tracking: Implement a decentralized ledger that records key data points—such as product origin, ownership changes, and delivery status—ensuring an unbroken, tamper-proof digital trail for each product.

2. Enhance Stakeholder Trust and Accountability: Allow farmers, distributors, and consumers to interact in a transparent ecosystem, reducing the need for intermediaries and promoting direct engagement between producers and buyers.

3. Simplify Transactions with Smart Contracts: Use smart contracts to automate key processes within the supply chain, such as product registration, ownership transfers, and delivery confirmation, eliminating manual intervention and minimizing errors.

4. Provide Real-Time Data Access for Consumers: Enable consumers to view complete product histories, from farm to table, empowering them to make informed purchasing decisions and fostering trust in product quality and origin.

5. Demonstrate Scalability and Adaptability: Lay a foundation for potential future features that can further enhance the system's capabilities and adaptability across different supply chain contexts within agriculture and beyond.

Chapter 3

LITERATURE REVIEW

Agricultural supply chains are inherently complex, involving multiple stakeholders and a series of processes that transform raw products into consumables. This complexity often leads to challenges such as limited traceability, lack of transparency, inefficiencies, and the potential for fraud. Traditional agricultural supply chain systems are often centralized, relying on intermediaries and complex documentation procedures, which can delay product delivery, increase costs, and erode trust among stakeholders.

Blockchain technology, combined with the Internet of Things (IoT), has emerged as a transformative approach for overcoming these issues. Blockchain provides a secure, decentralized ledger that enables transparent, immutable record-keeping, while IoT devices allow for real-time monitoring of products as they move through the supply chain. By recording key data—such as product origin, quality metrics, and ownership transitions—blockchain can ensure product authenticity and traceability, empowering stakeholders to verify data at every step.

3.1 CASE STUDY 1

Supply Chain Management in Agriculture Using Blockchain and IoT [1] The study illustrates a pilot project in a rice supply chain in India, where blockchain and IoT were used to monitor product quality and origin. IoT sensors tracked temperature and humidity levels, ensuring optimal storage conditions, while blockchain recorded product histories from farm to end consumer. This case demonstrates improved traceability and accountability, leading to reduced product spoilage and greater consumer trust.Dutta Borah and colleagues investigate how blockchain, combined with IoT, can enhance agricultural supply chains by improving data transparency and minimizing intermediaries. This study underscores blockchain's potential to automate record-keeping and enforce trust through decentralized transactions. IoT devices play a crucial role by gathering real-time data on product quality and logistics, which is stored on the blockchain to ensure verifiability.

3.2 CASE STUDY 2

Blockchain-Based Solution to Improve the Supply Chain Management in Indian Agriculture [2] This study details an experiment with a blockchain-based platform in the vegetable supply chain, where blockchain was used to document each stage of the product's journey. The platform allowed consumers to verify product origin, while smart contracts automated the payment process once quality checks were completed. The case highlights how blockchain can protect both farmers and consumers from fraud and ensure consistent product quality.Sudha and colleagues focus on blockchain's role in enhancing Indian agricultural supply chains, specifically addressing transparency issues and the need for efficient data sharing. Their proposed solution advocates for a decentralized platform that empowers farmers by enabling secure transactions directly with retailers and consumers, eliminating the need for intermediaries and ensuring fair prices.

3.3 CASE STUDY 3

Agriculture-Food Supply Chain Management Based on Blockchain and IoT: A Narrative on Enterprise Blockchain Interoperability [3] The study presents a case involving dairy products, where blockchain and IoT were used to monitor the temperature of milk throughout transportation. The system ensured product freshness and alerted suppliers to deviations from ideal storage conditions. By connecting disparate blockchain networks, the case shows how interoperability enables information flow across different stakeholders, enhancing transparency and operational efficiency.Bhat and colleagues explore the challenges and opportunities in creating interoperable blockchain systems for agricultural supply chains. They emphasize that the lack of interoperability among various blockchain networks limits scalability and collaboration between enterprises. The study suggests integrating IoT devices for real-time tracking and adopting cross-chain interoperability frameworks to create a seamless, enterprise-ready blockchain ecosystem.

3.4 CASE STUDY 4

Impact of Blockchain Implementation on Food Supply Chain Performance [4] A case study in the fruit export sector demonstrates blockchain's impact on supply chain performance. By implementing a blockchain-based tracking system, the exporting company reduced the time required for customs clearance and minimized paperwork. The transparency offered by blockchain helped streamline international logistics, reducing waste and ensuring timely delivery of perishable goods.Vu and colleagues assess how blockchain technology impacts the performance metrics of food supply chains, including delivery speed, cost-effectiveness, and waste reduction. Their study reveals that blockchain can significantly reduce delays in product delivery by streamlining documentation and ensuring data accuracy. They also highlight the importance of regulatory compliance, as blockchain provides an auditable trail for quality checks and certifications.

3.5 CASE STUDY 5

Blockchain Technology in Agriculture for Indian Farmers: A Systematic Literature Review, Challenges, and Solutions [5] The authors examine a case involving small-scale tea farmers in India. Blockchain technology was used to record each farmer's production volume and quality metrics, allowing for better price determination and reducing exploitation by intermediaries. This case illustrates blockchain's potential to empower small-scale farmers by providing direct market access, thus promoting financial inclusion and fair trade.Sugandh and colleagues provide a systematic review of blockchain applications in Indian agriculture, highlighting current challenges such as low awareness among farmers, high implementation costs, and the lack of regulatory support.

Chapter 4

PROPOSED SYSTEM

4.1 Solution

The proposed solution is a blockchain-based supply chain management system for agriculture to address transparency, traceability, and efficiency issues. By creating an immutable, decentralized ledger and implementing smart contracts, this system allows for seamless data flow across all supply chain stages, ensuring that key product details such as origin, quality, and handling conditions are transparent and verifiable.

1. Blockchain Ledger
2. Smart Contracts
3. Interoperability Framework

4.2 Feasibility Study

The feasibility of implementing this blockchain-based solution depends on several factors, including technological readiness, cost implications, and stakeholder adoption. Here's an in-depth look at these considerations:

- Technical Feasibility
- Social Feasibility

- Operational Feasibility
- Economic Feasibility

4.2.1 Technical Feasibility

Blockchain technology is now widely accessible, with platforms like Ethereum, Hyperledger, and Corda providing customizable frameworks for supply chain applications. These platforms offer the flexibility to tailor permissions, enabling controlled data access among verified users. Cross-chain interoperability remains a challenge, but solutions like sidechains, bridges, and oracle networks (such as Chainlink) are maturing, making it feasible to connect different blockchain networks and facilitate data exchange.

4.2.2 Social Feasibility

Blockchain's decentralized nature and transparency can build trust among farmers, retailers, and consumers by ensuring all parties have access to accurate product data.Blockchain's decentralized nature and transparency can build trust among farmers, retailers, and consumers by ensuring all parties have access to accurate product data.Blockchain's decentralized nature and transparency can build trust among farmers, retailers, and consumers by ensuring all parties have access to accurate product data.

4.2.3 Operational Feasibility

The system must be user-friendly for all participants, especially for farmers who may lack technical expertise. Simple mobile interfaces and localized support could help farmers interact with the platform easily, promoting adoption. Educating stakeholders on blockchain usage, data entry, and IoT functionality is essential for operational success. Partnerships with agricultural organizations and government agencies could support training programs to bridge knowledge gaps. Educating stakeholders on blockchain usage, data entry, and IoT functionality is essential for operational success. Partnerships with agricultural organizations and government agencies could support training programs to bridge knowledge gaps.

4.2.4 Economic Feasibility

Educating stakeholders on blockchain usage, data entry, and IoT functionality is essential for operational success. Partnerships with agricultural organizations and government agencies could support training programs to bridge knowledge gaps.By eliminating middlemen and automating transactions through smart contracts, this system reduces administrative costs. In particular, small-scale farmers can benefit from increased profits by engaging directly with consumers or retailers. As this solution matures, economies of scale will likely reduce costs, making the system more affordable and attractive for a broader range of stakeholders over time.

Chapter 5

SOFTWARE REQUIREMENT SPECIFICATION

5.1 Overall Description

The Blockchain-based Agricultural Supply Chain Management System is designed to enhance transparency, efficiency, and security within the agricultural supply chain. By integrating blockchain technology, this system addresses critical challenges in the agricultural industry, such as product traceability, quality assurance, and supply chain inefficiencies. The system allows stakeholders to track agricultural products in real-time from farm to consumer, ensuring transparency and reducing the risks associated with fraud, product spoilage, and delays in the supply chain.

5.1.1 Product Perspective

This system is a comprehensive, end-to-end solution for managing agricultural products across the entire supply chain. It includes features for product registration, real-time condition monitoring, ownership transfers, and payment processing using smart contracts. By utilizing blockchain, the system guarantees immutable records of all transactions, ensuring that each product's journey is verifiable at any time. A decentralized, immutable ledger to record transactions related to product movements, ownership changes, and payments.

5.1.2 Function

The system will offer the following key features:

- Product Registration and Traceability
- Smart Contracts for Automation
- Traceability and Verification
- Product Verification and Consumer Access

5.1.3 Operating Environment

- Blockchain Platform: The system uses a blockchain platform (e.g., Ethereum, Hyperledger, or Hyperledger Sawtooth) to ensure transparency, data immutability, and secure transactions between parties. The blockchain platform will be configured to support smart contracts and provide decentralized storage for product-related transactions.
- Smart Contract Platform: Smart contracts will be written in languages such as Solidity (for Ethereum) or Chaincode (for Hyperledger) to automate actions based on predefined conditions.

5.1.4 Design and Implementation Constraints

- Frontend is developed using html, css and JavaScript
- Blockchain Scalability

5.1.5 Assumptions and Dependencies

- Availability of Internet Connectivity.
- Blockchain Platform Stability.
- Mobile and Web Application Platforms.

5.2 External Interface Requirements

5.2.1 User Interfaces

Web Interface (Farmer,Consumer) : The web interface is designed for use by farmers, distributors, retailers, and consumers. It provides an intuitive and easy-to-navigate platform to add products, track supply chain progress, and make purchases.

5.2.2 External System Interfaces

Payment Gateway Interface : The system will integrate with external payment gateways to facilitate financial transactions between consumers and suppliers .

5.2.3 Software Interfaces

The software interface requirements define how the blockchain-based agricultural supply chain management system will interact with external software components, applications, and platforms.

5.3 Non-functional Requirements

- Performance Requirements: The system must respond within 2 seconds for 95 percent of interactions, such as product addition, transaction updates, and status checks.
- Reliability Requirements: The system should have an uptime of 99.9 percent or higher, ensuring minimal downtime and continuous availability.
- Security Requirements: All data transmitted between users, IoT devices, and the blockchain must be encrypted using AES-256 and SSL/TLS protocols to ensure data privacy and prevent unauthorized access.
- Scalability Requirements:The system must be able to scale horizontally to handle an increase in users, IoT devices, and blockchain transactions.

Chapter 6

SYSTEM DESIGNS

6.1 Farmer Module

The Farmer Module provides functionalities for farmers to add, manage, and monitor their products within the blockchain network. This module ensures that products are tracked from their origin and meet all necessary standards and requirements.

- Product Registration:

  Allows farmers to add new products to the blockchain with relevant details, such as product ID, name, origin, quantity, quality certifications, and production date.

- Sales and Payment Integration:

  Farmers can set prices and sell products directly to consumers.

6.2 Consumer Module

The Consumer Module allows consumers to browse, verify, and purchase products while gaining full transparency into each product's supply chain history. This module builds trust by providing consumers with verified product information directly from the blockchain.

- Product Browsing and Search:

Allows consumers to search for products based on various criteria such as type, origin, certification, and freshness.

- Purchase and Payment Processing:

  Enables consumers to buy products directly from farmers or other sellers, with integrated payment options (e.g. cryptocurrency).

6.3 Use-case Diagram

Use Case Diagram for your blockchain-based agricultural supply chain system. This diagram represents the main interactions between Farmers, Consumers, and the System itself.

- Actors
- Use cases
- System functions

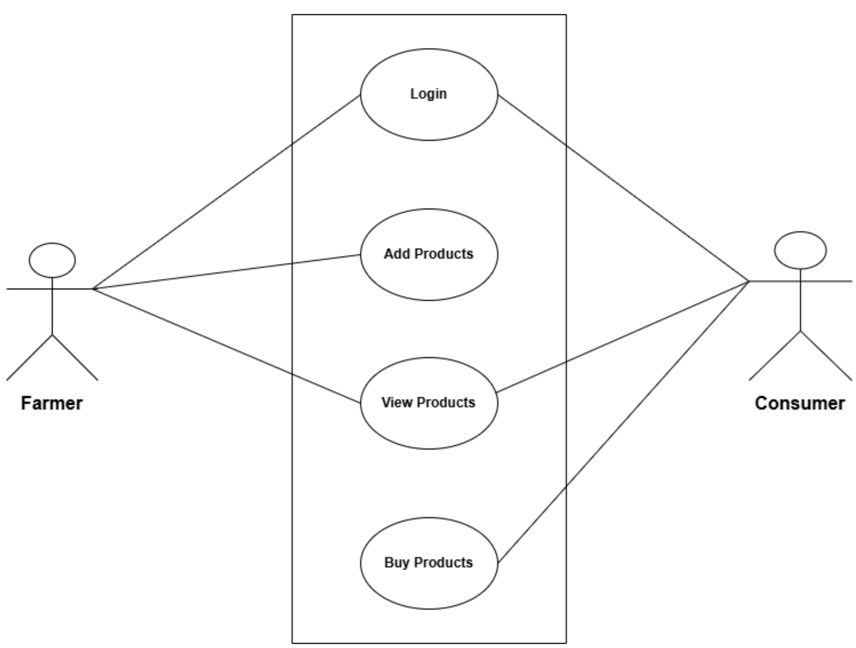


Fig. 6.1: Usecase diagram

6.4 Data Flow Diagram

The data flow diagram (DFD) is used for classifying system requirements to major transformation that will become programs in system design. This is starting point of the design phase that functionally decomposes the required specifications down to the lower level of details

Lines: Represent the logic flow of data.

Data can trigger events and can be processed to useful information. Systems analysis recognizes the central goal of data in organizations.

6.4.1 Level 0

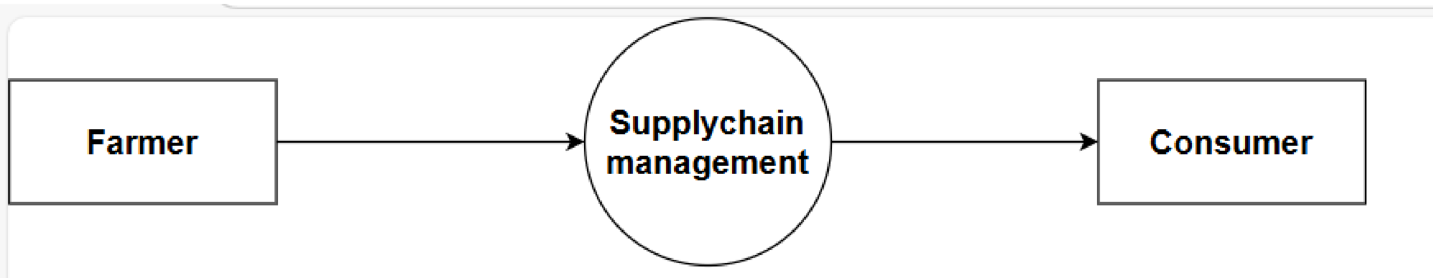
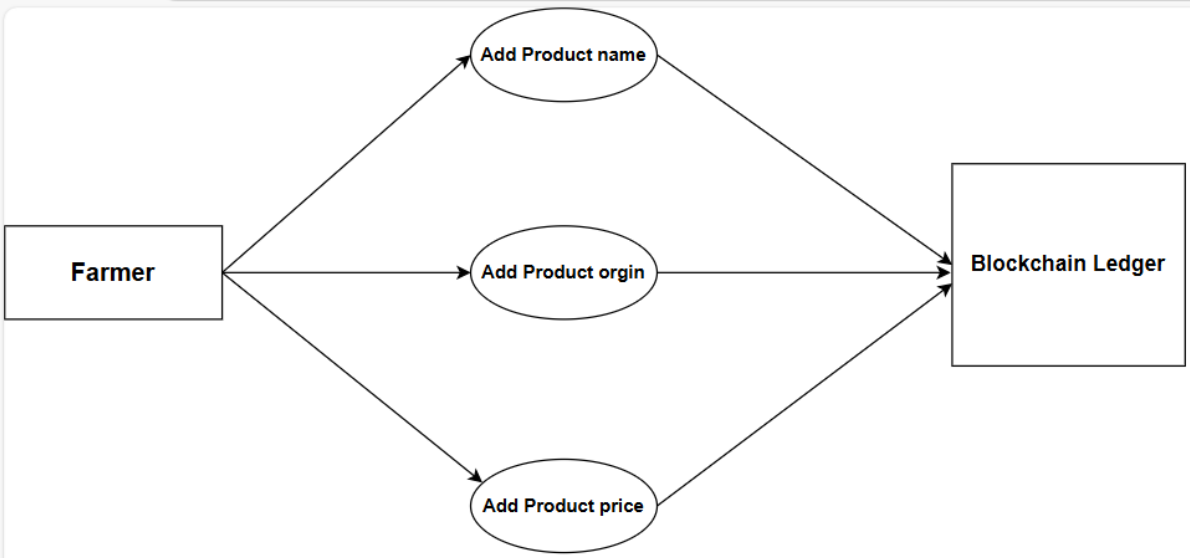


fig : level 0

6.4.2 Level 1



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6.4.3 Level 2

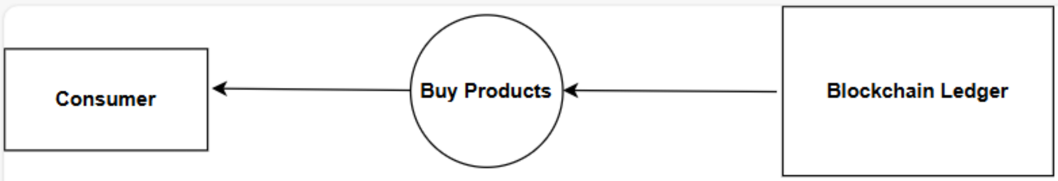
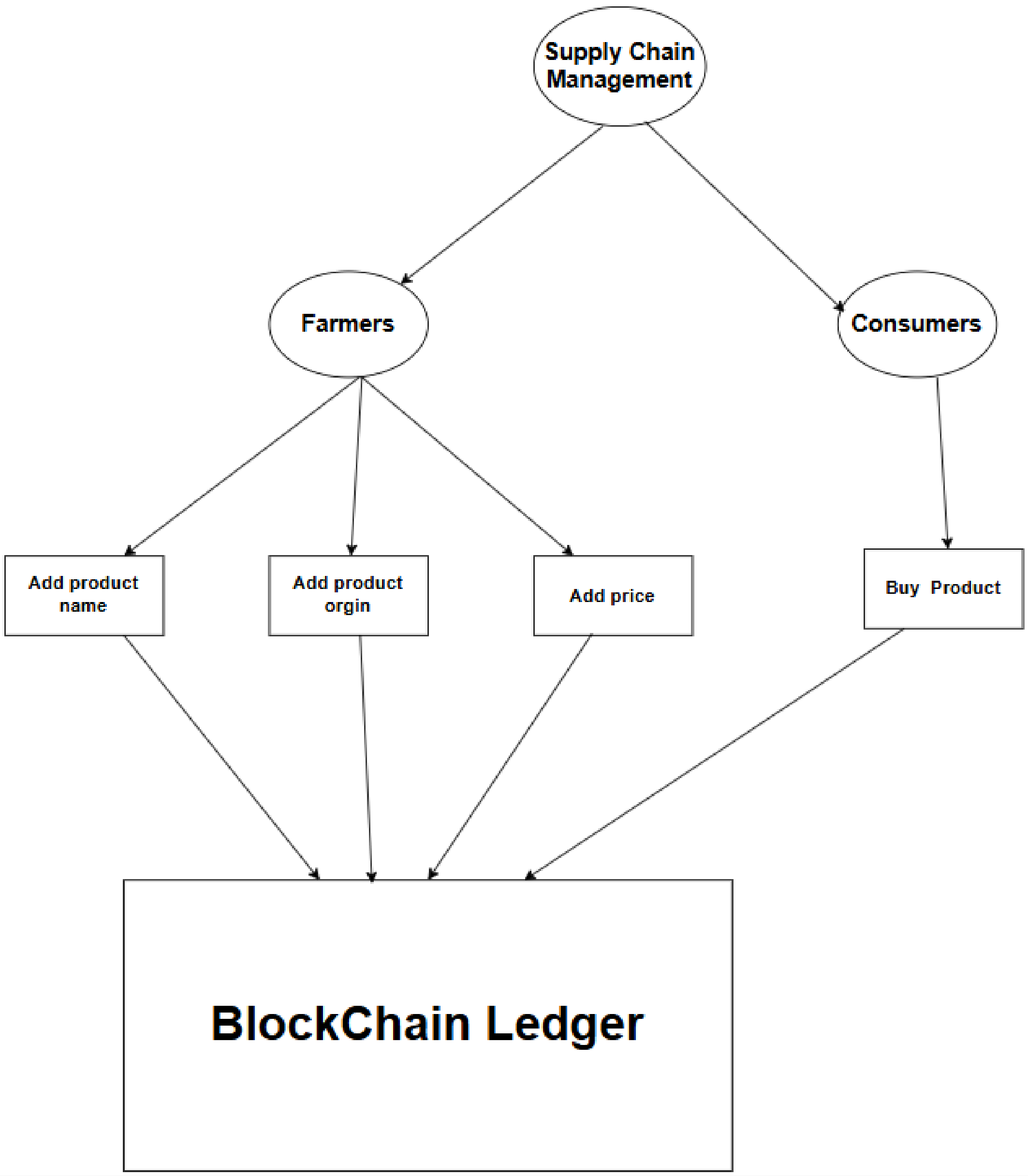


fig: level 2

6.5 System Architecture



Chapter 7

SOFTWARE AND HARDWARE REQUIREMENT

7.1 Software Requirements

7.1.1 Development and Backend

- Operating System: Windows
- Programming Language: Solidity , JavaScript
- Development Frameworks: Node.js,Express.js
- Blockchain and Smart Contract Tools:Truffle,Ganache,Web3.js
- Integrated Development Environment (IDE):Visual Studio Code
- Testing: Truffle Suite

7.1.2 Frontend

- HTML , CSS ,JavaScript

7.2 Hardware Requirements

7.2.1 For Development and Testing

- Processor: Intel i5

- RAM: Minimum 8GB
- Storage: SSD with at least 256GB

7.2.2 For Deployment

- Processor: Multi-core CPU
- RAM: 8GB minimum
- Storage: SSD with 512GB
- Cloud Providers: AWS, Google Cloud

Chapter 8

IMPLEMENTATION

The implementation of this blockchain-based supply chain project involves setting up a robust development environment, writing and testing smart contracts, and integrating a backend API with a React-based frontend for seamless user interaction. Using Node.js, Truffle, Ganache, and MongoDB, the system ensures secure and trackable transactions for managing product ownership and history in the supply chain. Key steps include validating and normalizing data, extracting on-chain and off-chain features, and performing rigorous testing to ensure functionality and performance. Future recommendations focus on scalability, predictive analytics, and enhanced security, establishing a strong foundation for a user-friendly, efficient, and scalable supply chain application.

8.1 Coding Environment Used

The project uses Node.js and Truffle for backend development, Ganache for a local blockchain environment, React.js for the front end, Web3.js for smart contract interactions, and MongoDB for storing non-blockchain data. This setup enables efficient testing and deployment.

8.2 Data Preprocessing

Data preprocessing ensures that all product and user data is validated, formatted, and consistent with smart contract requirements. This process includes input validation, duplicate prevention, and data normalization to streamline blockchain interactions.

8.3 Feature Extraction

Key features like product ownership, transaction history (on-chain), and user profiles (off-chain) are extracted to support tracking, authentication, and enhanced functionality within the supply chain.

8.4 Training

Smart contracts are rigorously tested on Ganache to validate their functionality. Simulated transactions are used to prepare the system for real-world usage, with a focus on ensuring reliability in user interactions and error handling.

8.5 Testing

Testing includes unit tests for individual contract functions, integration tests for API and blockchain interaction, user acceptance tests to ensure usability, and performance tests to measure transaction efficiency, ensuring a stable system.

8.6 Recommendation

Future enhancements include exploring blockchain scalability solutions, integrating AI for demand forecasting, and adding multi-signature wallets and role-based access control for better security, aiming to optimize and secure the system as it scales.

Chapter 9

RESULT AND ANALYSIS

9.1 Screenshots

9.1.1 Product registration page for farmers

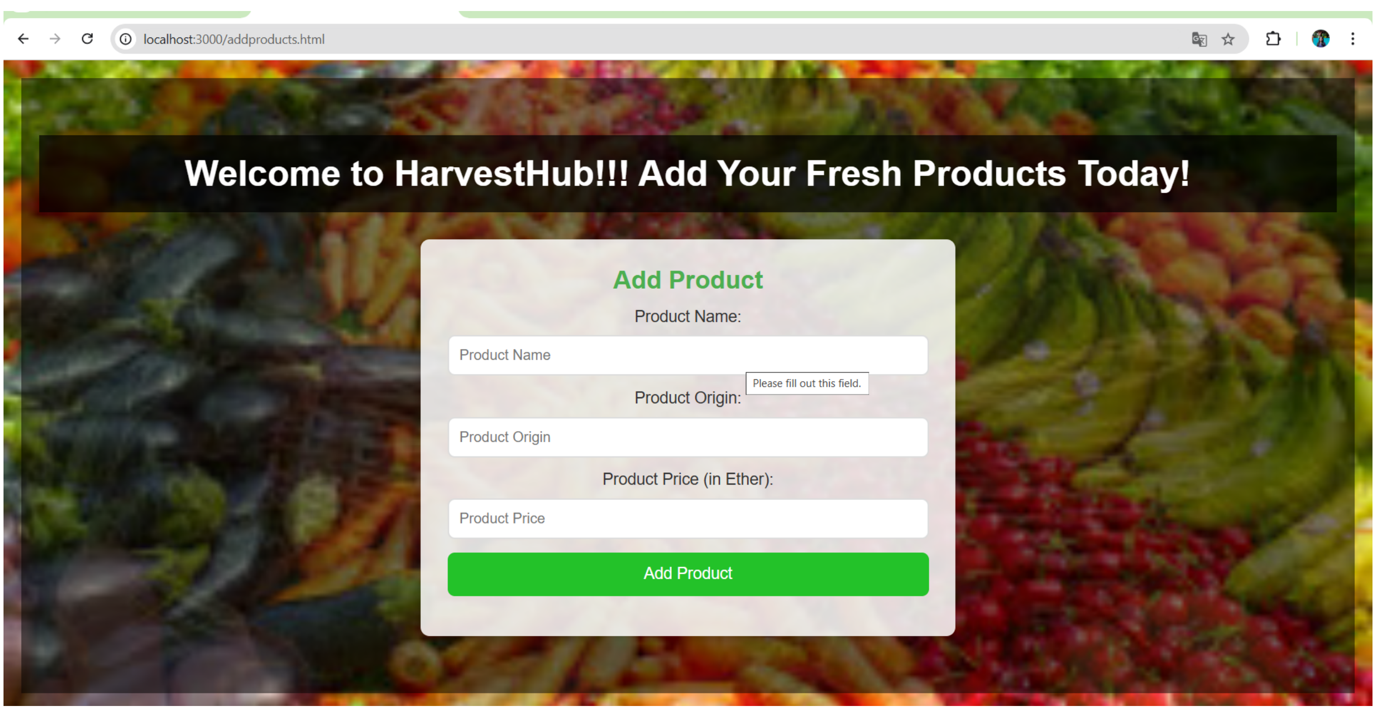


Fig. 9.1: Registration page

9.1.2 Product buying page for consumers

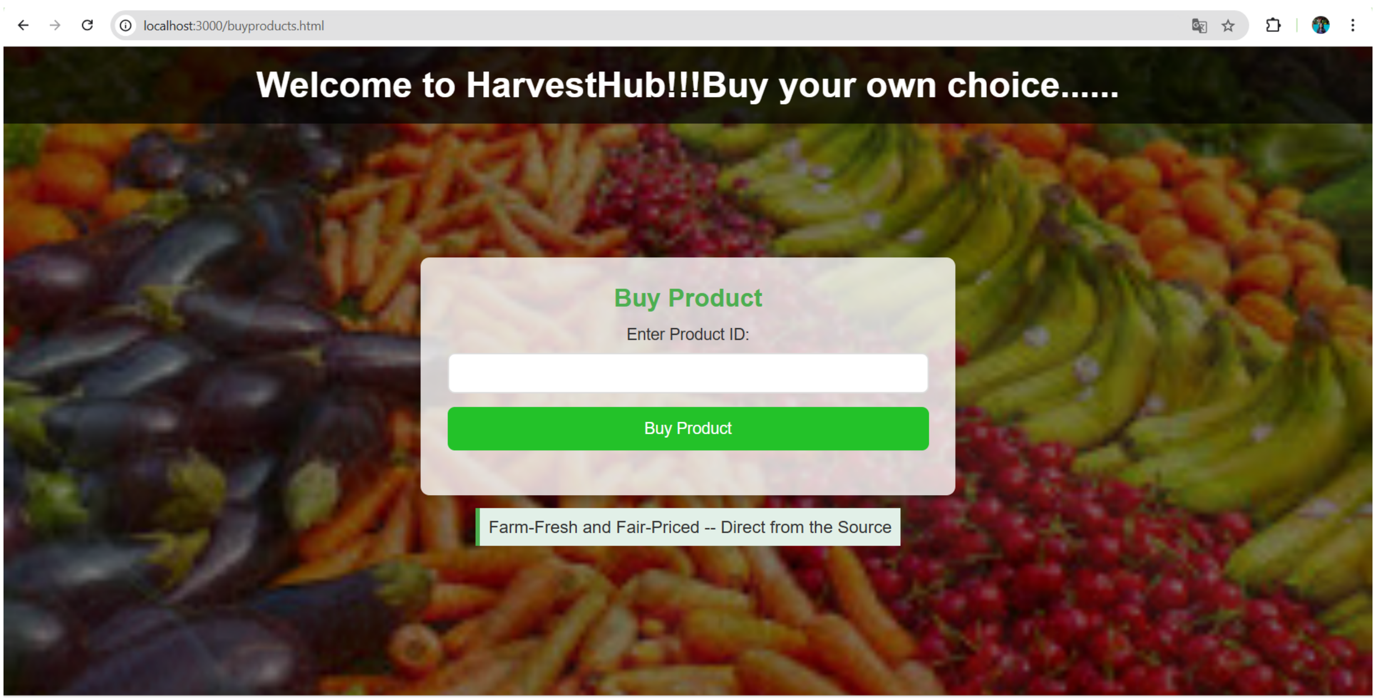


Fig. 9.2: Purchasing page

9.1.3 successfully registered by farmers

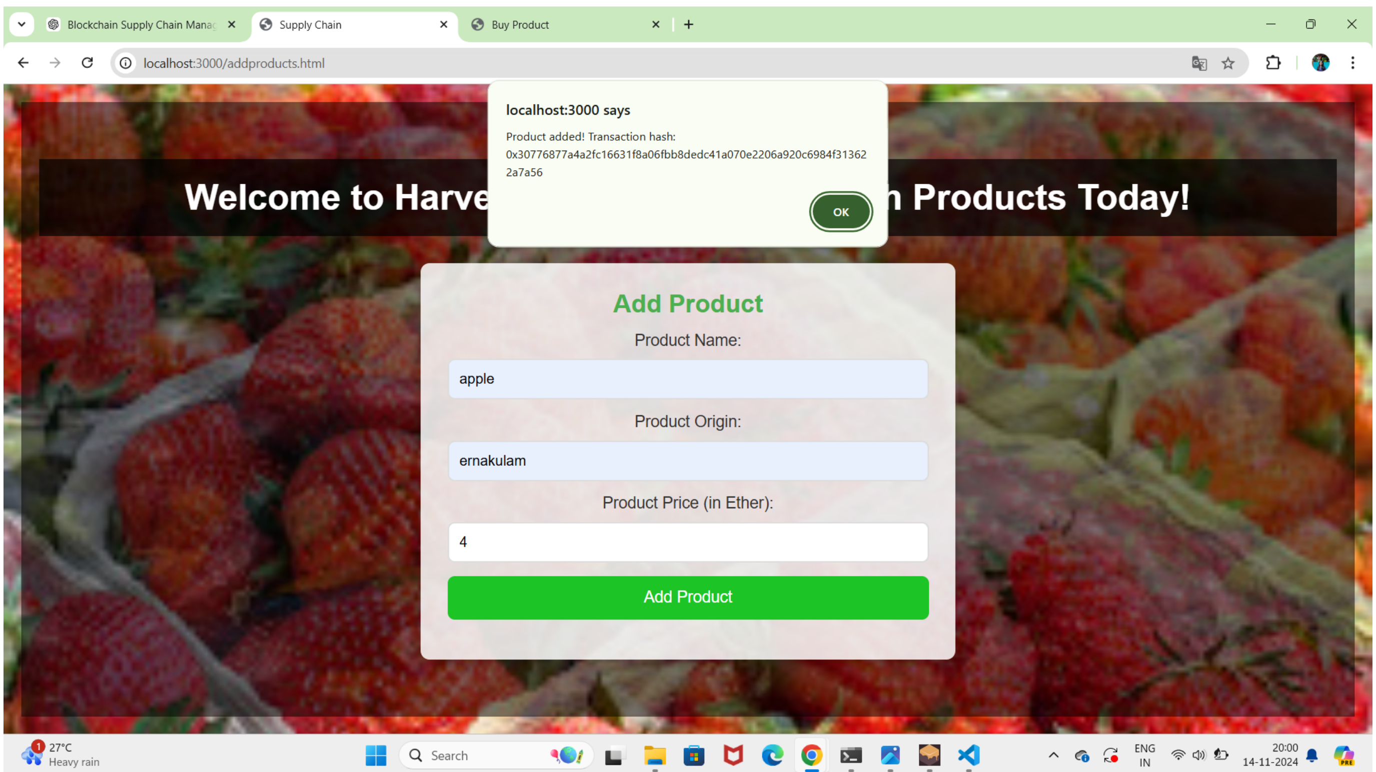


Fig. 9.3: Product Register

9.1.4 successfully purchased by consumers

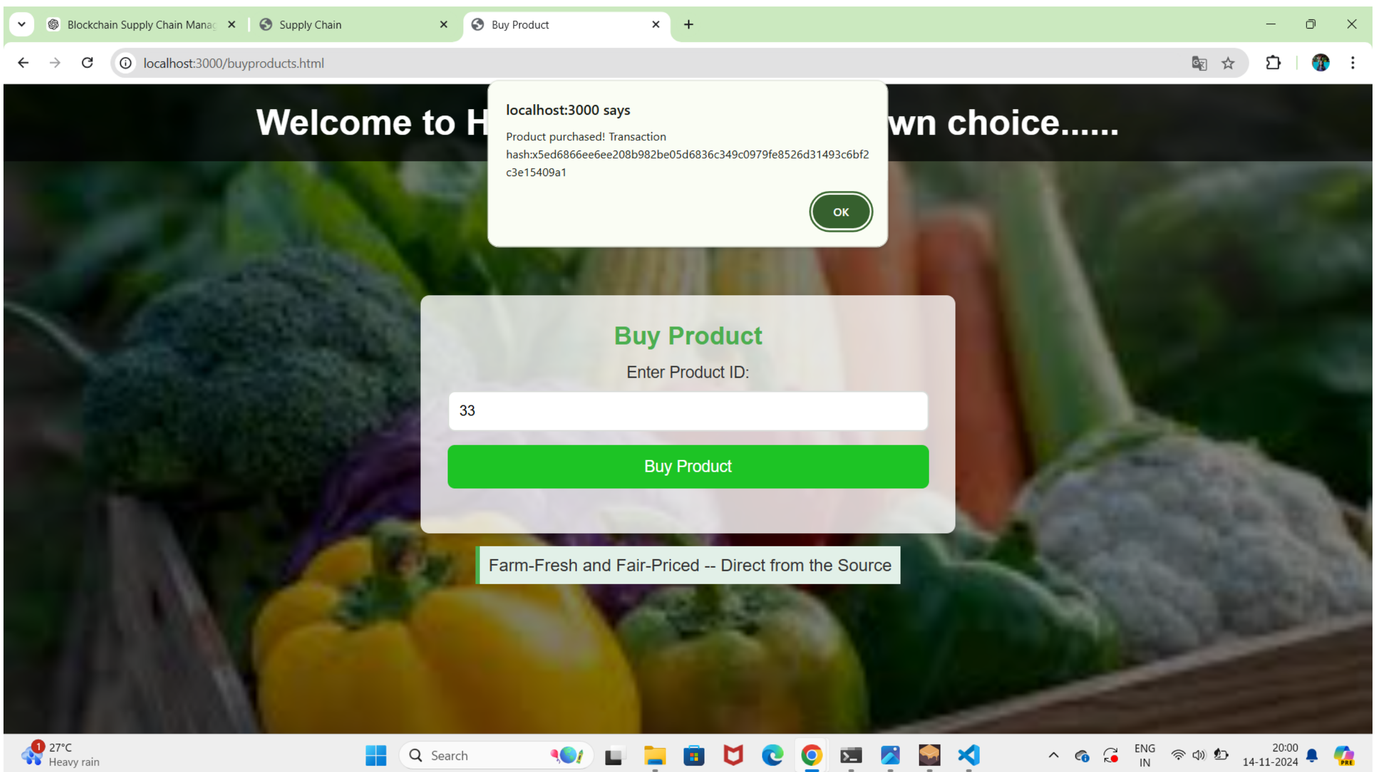


Fig. 9.4: Product Purchased

9.1.5 Transactions are successfully done in Ethereum

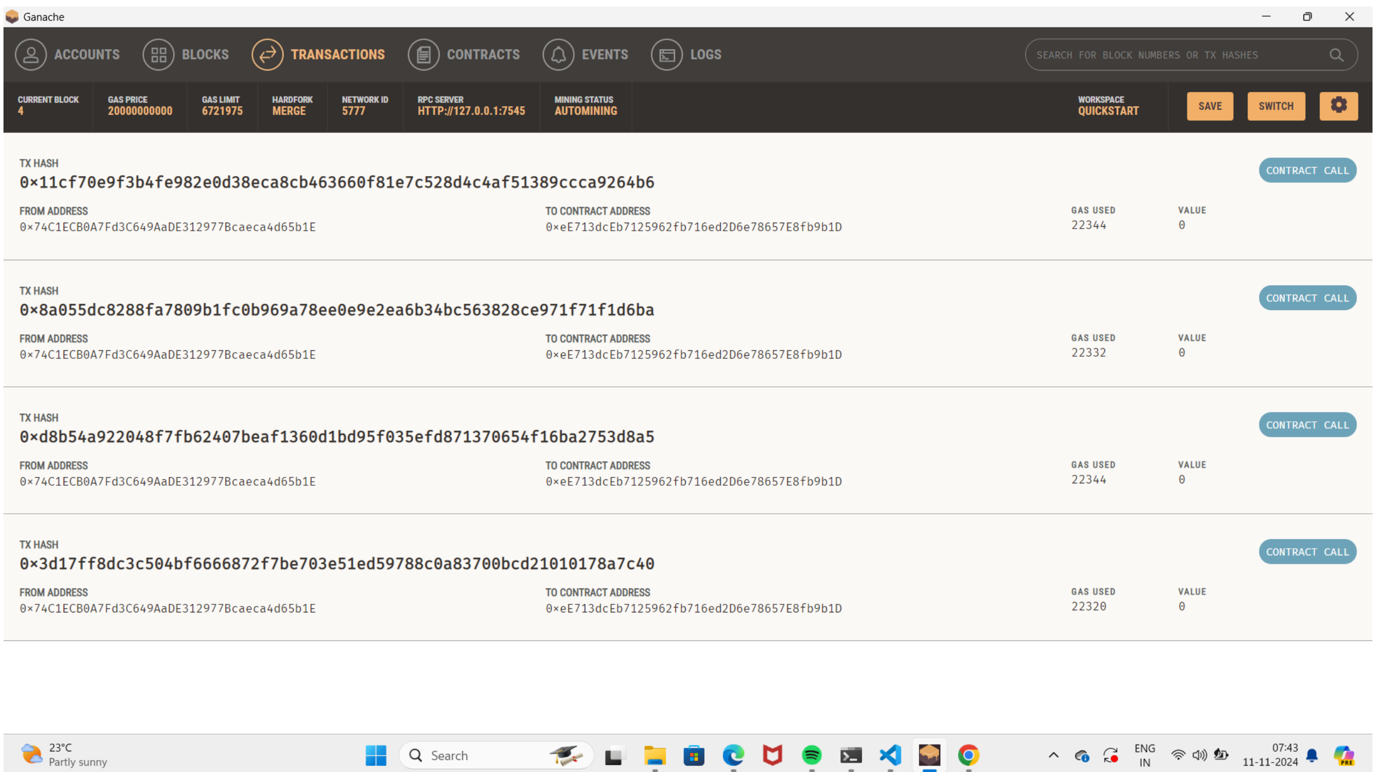


Fig. 9.5: Transactions in Blockchain

Chapter 10

SAMPLE CODES

10.1 Smart contract code

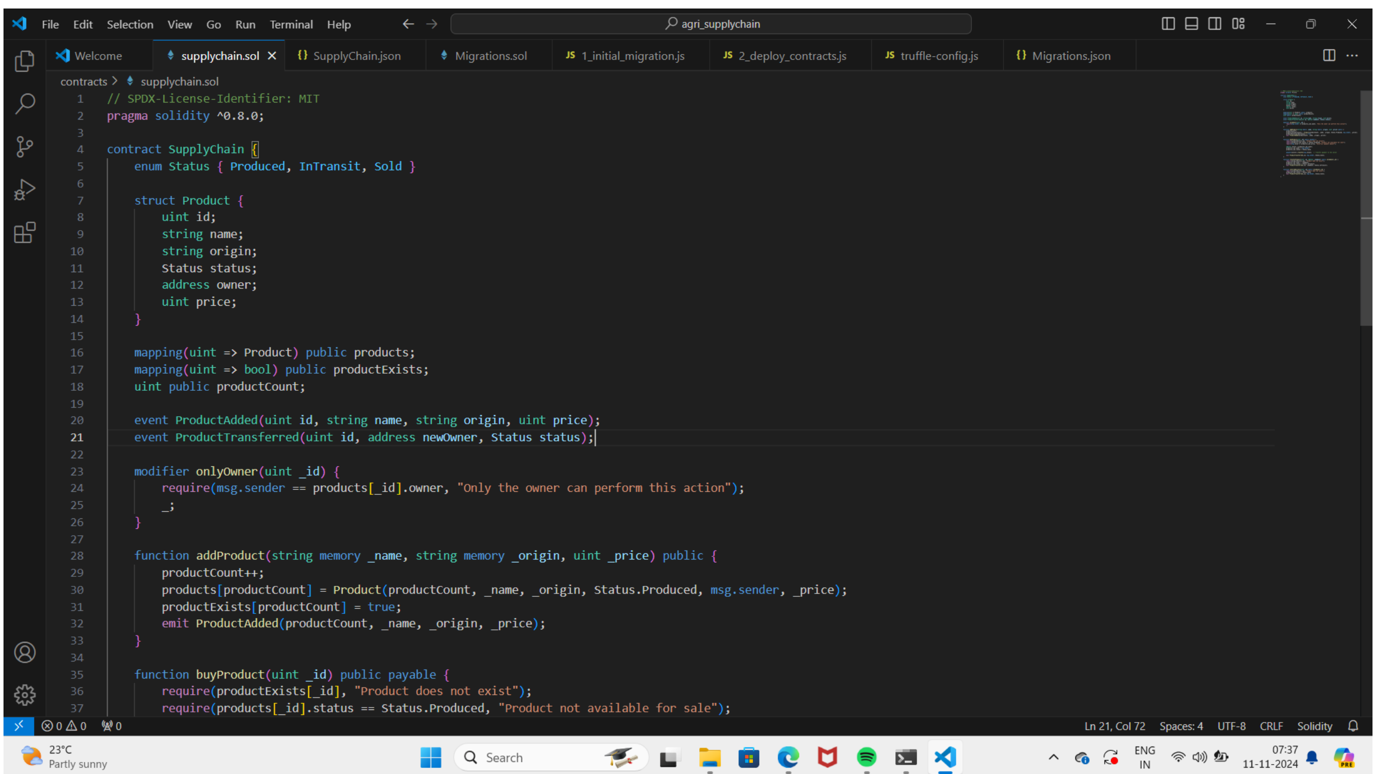


Fig. 10.1: supplychain.sol

10.2 Deployed successfully

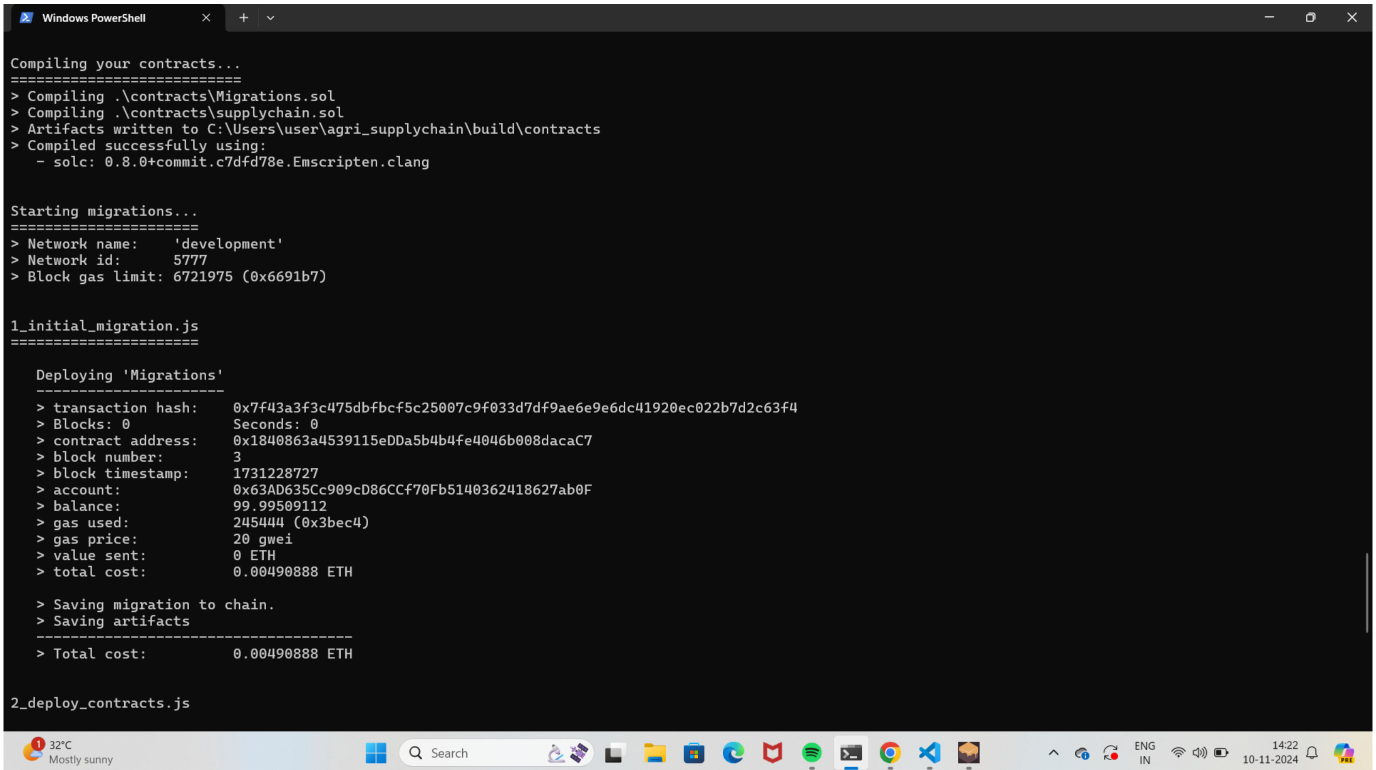


Fig. 10.2: Deployed contract

10.3 JSON file

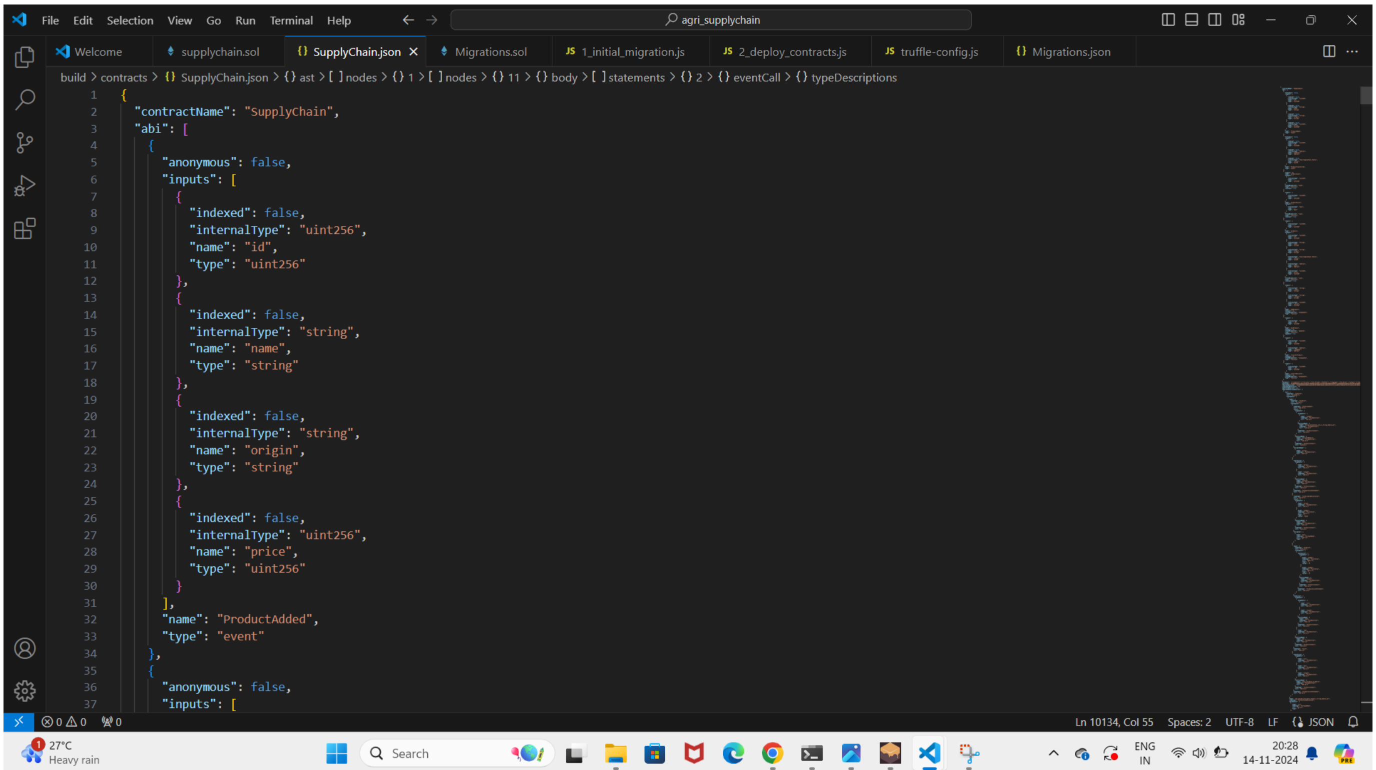


Fig. 10.3: SupplyChain.json

Chapter 11

CONCLUSION & FUTURE SCOPE

The successful deployment of the blockchain-based supply chain project marks a significant achievement in utilizing blockchain technology for enhancing transparency, traceability, and efficiency in agricultural supply chains. Through the integration of Ethereum smart contracts, the system allows farmers to securely add products, track ownership, and transfer goods while consumers benefit from verifiable, tamper-proof product histories. This decentralized approach reduces the need for intermediaries, enhances trust among stakeholders, and provides a reliable, transparent method for product tracking.

The system is designed to improve the agricultural supply chain by leveraging blockchain's strengths, such as immutability, decentralization, and security. The project has successfully addressed key challenges such as product provenance, transaction integrity, and reducing fraud in the supply chain, thus benefiting both farmers and consumers alike. The integration with a user-friendly frontend and a reliable backend architecture ensures smooth interactions for all users, making it an effective tool in the agricultural sector.

Future Scope of this project are as follows:

- Scalability: As the user base grows, the system could face performance bottlenecks. To address this, scalability solutions like Layer 2 technologies (e.g., Optimistic Rollups, zk-Rollups) or sidechains could be integrated to reduce transaction costs and improve processing speed.

- AI and Data Analytics: Incorporating artificial intelligence (AI) and machine learning algorithms for demand forecasting, price prediction, and inventory management could significantly enhance the efficiency of the supply chain by predicting trends and optimizing product distribution.

- Interoperability: Future development can focus on achieving cross-chain interoperability, allowing the supply chain to interact with other blockchain ecosystems, such as Hyperledger or Corda, for broader integration with various industries.
- Mobile App Development: Expanding the system to a mobile application would increase accessibility, allowing farmers and consumers in rural areas to interact with the platform easily using smartphones, further promoting adoption.
- Smart Contract Enhancements: More sophisticated smart contracts could be developed to include automated payments, insurance mechanisms, or reputation systems to improve trustworthiness and reduce risks.
- Global Adoption and Integration: The system could be expanded to cater to international markets, integrating with global trade systems and standards to facilitate cross-border agricultural trade and logistics.
- Sustainability and Carbon Footprint Tracking: Future versions could include features to track the environmental impact of products in the supply chain, such as carbon footprint and sustainability metrics, aligning with global trends toward environmentally conscious sourcing and consumption.

By incorporating these future enhancements, the blockchain-based supply chain system has the potential to revolutionize the agricultural industry, driving greater efficiency, transparency, and sustainability in global food systems.

Chapter 12

REFERENCES

1. Dutta Borah, M., Naik, V.B., Patgiri, R., et al. (2020). **"Supply chain management in agriculture using blockchain and IoT".** *Springer.*

2. Sudha, V., Kalaiselvi, R., Shanmughasundaram, P. (2021). **"Blockchain-based solution to improve the supply chain management in Indian agriculture".** In *2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS)* (pp. 1289-1292). IEEE.

3. Bhat, S. A., Huang, N. F., Sofi, I. B., Sultan, M. (2021)." **Agriculture-food supply chain management based on blockchain and IoT: A narrative on enterprise blockchain interoperability."** *Agriculture, 12*(1), 40.

4. Vu, N., Ghadge, A., Bourlakis, M. (2022)." **Impact of blockchain implementation on food supply chain performance".** In *29th EurOMA International Annual Conference* (pp. 1-6). Berlin, Germany.

5. Sugandh, U., Nigam, S., Khari, M. (2022)." **Blockchain technology in agriculture for Indian farmers: A systematic literature review, challenges, and solutions".** *IEEE Systems, Man, and Cybernetics Magazine, 8*(4), 36-43. https://doi.org/10.1109/MSMC.2022.3197914