JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

AUTHENTICITY IN FOOD SUPPLY CHAIN

[1]Ankita Shripad Naik, [2]K Neeha Shetty, [3]Leesha Sagar, [4]Manavi S C Author

[1234]Final Year B.E. Students, Department of Computer Science & Engineering,
Srinivas Institute of Technology, Mangaluru, India

Abstract: The food supply chain is a vital yet complex system essential for ensuring global sustainability and food security. With the increasing geographical expansion of the supply chain and the involvement of numerous stakeholders, the process has become longer, more intricate, and prone to various challenges such as lack of traceability, fraud, and inefficient distribution. This project proposes a decentralized food supply chain management system leveraging blockchain technology to enable end-to-end traceability, improve transparency, and deliver reliable information to consumers. The system is designed around three core modules: a Traceability System for recording and verifying product histories, a Trading Mechanism to securely manage ownership transfers, and a Reputation System that allows verified consumers to post immutable product reviews. Key features of the platform include the ability to trace food products globally, prevent the circulation of duplicate and unauthentic items, ensure efficient food distribution, and reduce overall supply chain costs. The solution is implemented using tools and technologies such as JavaScript, HTML, CSS, and Solidity, offering a robust, transparent and secure architecture suitable for real-world deployment in the food industry.

Index Terms - **– Blockchain, Food Supply Chain, Traceability, Smart Contracts, Decentralized Systems, Reputation System, Ethereum, Security, Transparency**

1.INTRODUCTION

The food supply chain is a complex but necessary food production arrangement needed by the global community to maintain sustainability and food security. The supply chain has been extended geographically involving many more stakeholders, making the supply chain longer and complicated and thus involving many challenges. The complexity of the food supply chain arises from its multi-tiered structure, which includes producers, processors, distributors, retailers, and consumers, all operating within a globalized system. As the chain extends geographically, the number of interactions and intermediaries increases, leading to higher risks of inefficiencies, miscommunication, and malpractices. One of the most pressing challenges is ensuring the authenticity of food products as they move through these interconnected stages. The risks of mislabeling, adulteration, substitution, and fraud grow with the length and complexity of the supply chain..

2. LITERATURE SURVEY

Literature survey is the documentation of a comprehensive review of the published and unpublished work from secondary sources data in the areas of specific interest to the researcher. It is important for gathering the secondary data for the research which might be proved very helpful in the research. The literature survey can be conducted for several reasons. The literature review can be in any area of the business. Below are the few papers referred.

2.1 Data Collection and Preprocessing

The system gathers data on soil properties such as nitrogen (N), phosphorus (P), potassium (K), pH levels, and environmental factors like temperature, humidity, and rainfall. This data can be sourced from agricultural databases or collected in real-time using IoT sensors. Preprocessing steps include cleaning the data, handling missing values, and normalizing features to ensure consistency and accuracy in the subsequent analysis.

2.2 Feature Engineering

Relevant features that significantly impact crop growth and productivity are identified and extracted. This may involve analysing soil types, nutrient levels, climatic conditions, and other agronomic factors to create a comprehensive dataset that accurately represents the farming environment.

2.3 Model Training and Evaluation

The dataset is divided into training and testing subsets. Models are trained on the training set and evaluated on the testing set using metrics such as accuracy, precision, recall, and F1-score to assess their performance and generalization capability.

2.4 Recommendation Engine

The trained model serves as the core of the recommendation engine. When a farmer inputs current soil and environmental conditions, the model predicts the most suitable crop(s) for cultivation. This assists farmers in making informed decisions to optimize yield and resource utilization.

2.5 Real-Time Data Integration

For enhanced accuracy, the system can integrate real-time data from IoT sensors measuring soil moisture, nutrient levels, and weather conditions. This dynamic data enables the model to provide timely and context-aware crop recommendations. By systematically combining these methods, the Crop Recommendation System empowers farmers with actionable insights, leading to improved crop selection, increased productivity, and sustainable agricultural practices.

3. SYSTEM DESIGN

3.1 Data Flow Diagram

Figure 3.1 Data flow diagram (DFD) is a graphical representation of the "flow" of data through an information, modelling its process aspects. Often, they are preliminary steps used to create an overview of the system. DFDs can also be used for the visualization of data processing (structured design). Dataflow diagram are constructed from a limited repertoire of shapes, connected with arrows. Figure 3.1 shows dataflow diagram for Authenticity in Food Supply Chain.

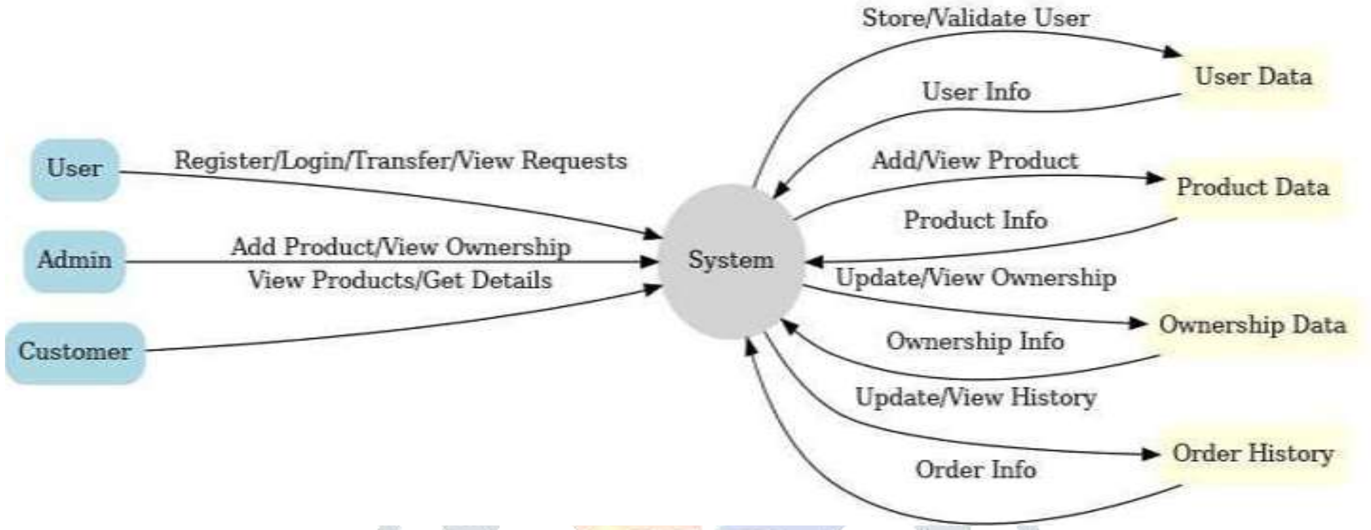

Fig 3.1: -Data Flow Diagram

3.2 Use case diagram

This Use Case Diagram illustrates interactions between three actors—Admin, User, and Customer—and the system. Admin manages core functions like adding products and transferring ownership. Users handle product viewing, ownership details, and history. Customers focus on order history and transfer-related tasks. Key functionalities include registration, login, product management, ownership transfer, and history tracking. Relationships show Admin's full access, Users' product-related access, and Customers' limited focus on orders and transfers.

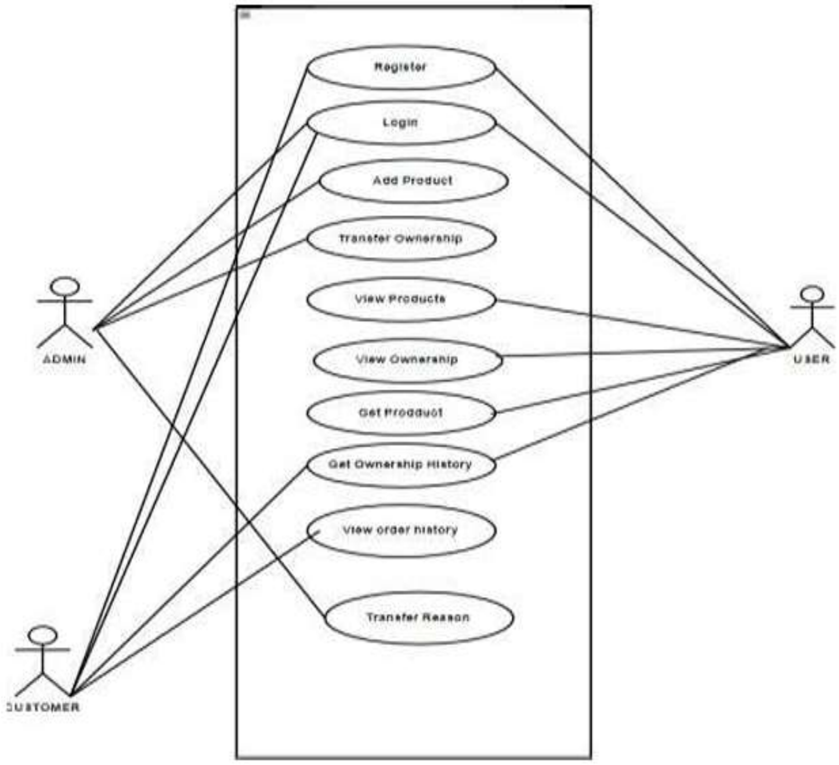

Fig 3.2: -Use case Diagram

Use Case Diagram for a Crop Recommendation System using Smart Algorithms provides a visual representation of the system's functional requirements by illustrating the interactions between external entities (actors) and the system's use cases. This diagram helps stakeholders understand how users engage with the system to achieve specific relationships between actors and use cases are depicted through associations, indicating the interactions and dependencies within the system. For instance, the farmer interacts with the system by inputting data and receiving recommendations, while the administrator maintains the system's data integrity.

4. IMPLEMENTATION

The implementation of the decentralized food supply chain management system is divided into multiple stages, aligning with the system's modular architecture and development goals. Each stage focuses on building a secure, traceable, and transparent ecosystem for managing food products using blockchain technology.

4.1 Visual Studio Code

The development of the Decentralized Food Supply Chain Management System is carried out using Visual Studio Code (VS Code) as the primary Integrated Development Environment (IDE). VS Code is chosen due to its lightweight design, rich extension ecosystem, and robust support for the project’s technology stack, including JavaScript, Solidity, HTML/CSS, and Node.js. It offers built-in Git integration, a powerful terminal for running commands like npm, truffle, or hardhat, and IntelliSense for smart code suggestions.

4.2 Frontend Technology: React.js

The frontend of the decentralized food supply chain system is implemented using React.js, a popular JavaScript library known for building fast, interactive user interfaces. React enables a component-based architecture, making the UI modular, maintainable, and scalable. Each role in the system—producer, distributor, retailer, and consumer—is provided with a dedicated interface tailored to their specific operations.

4.3 Backend Technology: Node.js, Express.js

The backend of the Decentralized Food Supply Chain Management System is implemented using Node.js with the Express.js framework, providing a robust and scalable server environment for handling API requests and managing off-chain operations. It facilitates user authentication, role-based access control, and interaction with the Ethereum blockchain via libraries like Web3.js or Ethers.js, allowing the backend to read from and write to smart contracts.

4.4 Database: MongoDB

MongoDB, a NoSQL database, was chosen for storing user data, product details, orders, and feedback. Its document-oriented structure offered flexibility in managing data without a fixed schema, making it suitable for evolving requirements. MongoDB's ability to scale and its compatibility with Node.js also contributed to efficient data handling.

4.5 Blockchain Integration

To implement and test the blockchain functionalities of the system in a controlled environment, Ganache is used as a local Ethereum blockchain. Ganache provides a personal blockchain that runs locally and mimics the behavior of the Ethereum network, offering a fast and safe way to deploy and interact with smart contracts during the development phase. It also provides pre-funded accounts, which helps in testing transactions and contract calls without incurring actual gas fees.

The development and deployment of smart contracts are handled using Truffle or Hardhat, two popular Ethereum development frameworks. These tools provide a suite of functionalities such as contract compilation, migration (deployment), unit testing, and script automation. Developers can write test cases using JavaScript or Solidity to ensure the correctness and security of smart contracts before deploying them to a testnet or mainnet.

In addition, smart contracts emit events like ProductAdded and OwnershipTransferred upon successful execution of specific actions. These events are logged on the blockchain and are programmatically captured using Web3.js to reflect real-time updates on the user interface. For example, when a product is registered or its ownership is transferred, the frontend listens for these events and dynamically displays confirmation messages or updates the product history. This seamless integration ensures transparency, traceability, and a responsive user experience across the entire supply chain system.

5. RESULTS AND DISCUSSION

The implementation of the decentralized food supply chain system successfully demonstrated the ability to enhance traceability, security, and transparency in food logistics. Using blockchain technology, each product’s lifecycle—from production to consumption—was immutably recorded, ensuring that no unauthorized changes could be made to the supply chain records. This enabled stakeholders to verify the authenticity of food items and track ownership transfers at each stage, thus effectively addressing issues like counterfeit products and fraudulent activities.

The integration of smart contracts played a critical role in automating core functionalities such as product registration, ownership transfer, and feedback submission. These contracts enforced business logic without the need for centralized intermediaries, thereby reducing delays and operational costs. The real-time event handling, enabled through Web3.js, ensured that users received immediate feedback for every blockchain transaction. Additionally, the use of access control mechanisms allowed only verified participants (producers, distributors, retailers, and consumers) to perform specific actions, which safeguarded the system from unauthorized activities.

User testing with the frontend interface revealed that the system was user-friendly and effective in displaying transaction history, product details, and immutable consumer reviews. Consumers appreciated the ability to verify product authenticity before purchasing, while retailers and producers benefited from reduced costs and improved trust in the supply chain. Overall, the system proved to be a scalable and efficient solution, showcasing the potential of blockchain to transform traditional food supply chains into more secure and transparent ecosystems.

I. ACKNOWLEDGMENT

The authors gratefully acknowledge the guidance and support provided by A. Aishwariya throughout the development of this project. Her insights and feedback played a crucial role in shaping the system architecture and ensuring its practical relevance.

Sincere thanks are also extended to Dr. Sandeep Bhat, project coordinator, for his consistent encouragement and timely suggestions, which helped streamline the research and implementation phases. The team also appreciates the leadership of Dr. Suresha D, Head of the Department, and Dr. Shrinivasa Mayya D, Principal, for fostering an environment that encourages innovation and hands-on learning.

This work was carried out as part of the final-year undergraduate project in the Department of Computer Science and Engineering at Srinivas Institute of Technology. The team thanks all faculty and staff who contributed indirectly to the successful completion of this system.

References

[1] Kshetri, N. (2018). *1 Blockchain's roles in meeting key supply chain management objectives*. International Journal of Information Management, 39, 80-89. https://doi.org/10.1016/j.ijinfomgt.2017.12.005

[2] Tian, F. (2016). *An agri-food supply chain traceability system for China based on RFID & blockchain technology*. 13th International Conference on Service Systems and Service Management (ICSSSM), 1–6. https://doi.org/10.1109/ICSSSM.2016.7538424

[3] Caro, M. P., Ali, M. S., Vecchio, M., & Giaffreda, R. (2018). *Blockchain-based traceability in Agri-Food supply chain management: A practical implementation*. 2018 IoT Vertical and Topical Summit on Agriculture - Tuscany (IOT Tuscany), 1–4. https://doi.org/10.1109/IOT-TUSCANY.2018.8373021

[4] Casino, F., Dasaklis, T. K., & Patsakis, C. (2019). *A systematic literature review of blockchain-based applications: Current status, classification and open issues*. Telematics and Informatics, 36, 55–81. https://doi.org/10.1016/j.tele.2018.11.006

[5] Buterin, V. (2014). *Ethereum White Paper: A Next-Generation Smart Contract and Decentralized Application Platform*. Ethereum Foundation. Retrieved from https://ethereum.org/en/whitepaper/