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BLOCKCHAIN ENABLED IOT FOR ORGANIC FOOD SYSTEMS

Chittineni Aruna [1], Gogineni Pallavi [2], Chimala Devi Siri Chandana [3], Dronadula Jyothi Sindhura [4], Duggineni Tejaswi [5]

[1] *Professor, Department of Computer Science and Engineering, KKR & KSR Institute of Technology and Sciences, Guntur, Andhra Pradesh, India*

[2-5] *B. Tech Student, Department of Computer Science and Engineering, KKR & KSR Institute of Technology and Sciences, Guntur, Andhra Pradesh, India*

ABSTRACT: The Organic Food Processing System using Blockchain utilizes a shared, immutable ledger to ensure transparency, traceability, and authenticity in the organic food supply chain. Blockchain technology enables secure recording and tracking of assets across the network, making it ideal for maintaining the integrity of organic food processing. In the current scenario customers face significant challenges, including lack of transparency, limited traceability, and trust issues between producers and consumers. These shortcomings hinder the reliability of organic food processing and create doubts about product authenticity and quality. Our proposed system overcomes these drawbacks by leveraging blockchain to document the entire product journey, from quality testing at the source to delivery. This ensures transparency, enhances trust, and provides complete traceability, offering consumers confidence in the organic food they purchase.

Keywords: QR code, Blockchain, IOT, Organic Food

I. INTRODUCTION

Blockchain is a decentralized digital ledger that securely stores records across a network of computers, ensuring transparency, immutability, and resistance to tampering. Each block in the blockchain contains specific data, such as text, files, or transactions, linked in chronological order. By leveraging these features, our Organic Food Processing System aims to address inefficiencies in the traditional organic food supply chain.

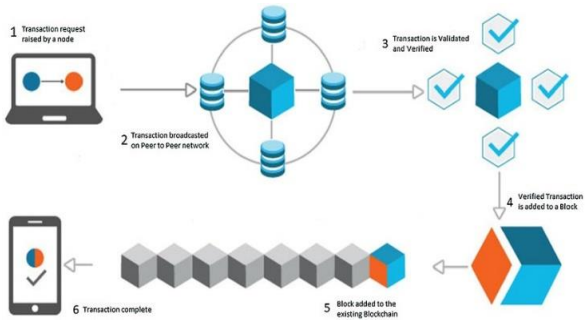

Fig 1: Traditional Organic food supply chain

In the current scenario customers face challenges such as lack of transparency, limited traceability, and trust issues caused by fraudulent practices like mislabelling and inconsistent quality checks. These problems reduce consumer confidence and decrease the overall growth of organic food markets. Our proposed solution leverages blockchain technology to overcome these challenges effectively.

In our system, every organic product is assigned a unique identifier, such as a QR code, enabling its journey to be tracked from the source to the consumer. This includes quality testing, storage conditions, and delivery updates. Blockchain records each step of this process in a transparent and immutable manner, ensuring the authenticity of the product and fostering trust among consumers. Additionally, our system ensures that every process, from sourcing and testing to delivery, complies with organic standards. Consumers can access detailed product information through the QR code, ensuring complete transparency and accountability. This approach not only enhances the integrity of the organic food supply chain but also promotes healthier food choices and supports sustainability.

By integrating blockchain technology, the entire system ensures transparency, traceability, and trust, transforming the way organic food is processed, tracked, and delivered to consumers.

a. Problem Statement

Existing systems have lack of transparency, leading to issues with product authentication and traceability, including unclear origins. Trust and quality concerns arise due to missing product journey details and potential damage during delivery, and it can't maintain temperature sensitive

products. Logistic challenges, especially in remote areas, cause delays and affect product freshness.

b. Research Gaps

- Current research focuses majorly on energy optimization, integration, and storage of carbon capture technologies.
- The reason of repurposing captured CO_2 for agricultural applications, for soil enrichment, is largely overlooked.
- Limited attention is given to enhancing soil fertility while reducing dependence on chemical fertilizers using CO_2.
- Integrating industrial CO_2 capture with agricultural repurposing remains an underexplored solution
- for dual environmental and agricultural benefits.
- The need for innovative frameworks supported by block chain for transparency and carbon reward incentives is critical for implementation.

II. LITERATURE REVIEW

ISURU WIJESOORIYA et.al. (2024) in this article authors were proposed a Blockchain based food supply chain management system, they proposed a Vetted Algorithm within smart contracts for automated verification and validation of crucial data such as product origin, certification status and handling procedures. This algorithm provides the information about the product origin and verifies the authentication to ensure the security and privacy.

MILON BISWAS et.al (2021) in this article authors were proposed a Organic food chain traceability using Blockchain technology, they proposed a system to verify the authenticity of organic food using a laboratory and provides a quality assurance certificate to ensure product quality to the customer. Here it utilises the facility of the laboratory to verify the authenticity of organic food. It also assures the quality of the product by providing the Quality assurance certificate.

Cong Doanh Duong et.al (2021) in this article authors were proposed a, they proposed a system to verify the authenticity of organic food Blockchain-enabled food traceability system and consumers' organic food consumption, A moderated mediation model of blockchain knowledge and trust in the organic food chain. They proposed Hybrid Consensus mechanism which combines Proof of Authority and Federated Byzantine Agreement which aims to incorporate community level trust by validating transactions.

QIJUN LIN et al. (2024) proposed a blockchain-based food safety traceability system aimed at addressing the challenges of data invisibility, tampering, and sensitive information disclosure in traditional systems. The authors introduced a management architecture for on-chain and off-chain data to tackle the blockchain data explosion issue in IoT applications. This design enterprise-level smart contracts to secure information interactions among participants and prevent data tampering.

Jafar Azizi et.al. (2024) This article tried to propose an e-commerce model for fresh agricultural products, which can not only maximize producer and consumer satisfaction, but also reduce waste, increase marketing efficiency, and provide environmental protection and sustainable development. The proposed model is based on a coherent and real-time monitoring system, designed by managers and clarification for producers and consumers. The components of this system are manufacturers, retailers, banks, sales and purchase brokers, logistics systems, supervisors and management of the e-commerce system. This system manages information flow, money flow and goods flow accurately and transparently. This model paves the way for the future of sustainable food and preserving the environment with two functions, reducing waste and increasing consumer satisfaction through the supply of unprocessed and fresh products.

DUNG-YING LIN et.al. (2019) This study aims to design a safe and sustainable food supply chain with food safety mechanisms so that confidence-dependent demand can be positively affected by centralized, decentralized and combined supply chain contracts. To determine the optimal order quantity, buy-back price, rebate/penalty and sales target with the proposed framework, we derive the optimality conditions of corresponding models and use the results to analyse the lard oil supply chain. The contracts together with the food safety mechanism can drastically improve food safety, consumer confidence and the resulting profits of a food supply chain.

S.no	Year	Author's	Article Title	Key Findings
1	2024	J.M.I Wijesooriya et.al.	Block chain based food supply management system	• Vetted algorithm for automated verification • Provides certification status • Decentralised system to ensure transparency
2	2024	Jafar Azizi	The optimal Model of E-Commerce of Fresh food products	• E-commerce model for fresh agriculture products • Provide environmental protection and sustainable development
3	2024	Cong Doanh Duong	Blockchain-enabled food traceability system and consumers' organic food consumption	• SEM algorithm is used to analyse complex relationships • Consensus algorithm which includes proof-of-work and Byzantine fault tolerance which helps in validating transactions
4	2023	Abubakar Mohammed et.al.	Blockchain Adoption in Food Supply Chains: A Systematic Literature Review on Enablers, Benefits, and Barriers	• Provides RFID tags Used for sharing and acquiring data in agri-food value chain • Cryptographic algorithms are used to ensure security
5	2023	Munis Abdullayev et.al.	Strengthening of Food Security Through Development of Digital Technologies in The Food Production and Processing Chain	• Concentrates on smart agriculture and smart industry to increase efficiency of production through modern digital technologies • Used OLS methodology to analyse this model
6	2023	Arwa Abougharib et.al.	Remaining shelf-life estimation of Fresh Fruits and vegetables during transportation	• White box shelf-life estimation model • It is non-destructive, non-invasive, and cost-effective as it doesn't require any additional sensors besides a temperature and humidity sensors.
7	2021	Milon Biswas	Organic Food Supply Chain Traceability using Blockchain Technology	• Provides authentication • Provides Quality assurance certificate • Utilizes smart contract ensures security
8	2019	Huiling Fan	Theoretical Basis and System Establishment of China Food Safety Intelligent Supervision in the Perspective of Internet of Things	• Establish a food safety traceability System • conduct full-process monitoring and dynamic supervision • Provides item tracking
9	2019	Dung-Ying-Lin et.al.	Managing food safety with pricing, contracts and coordination in supply chains	• To establish an analysable, efficient food supply chain to extend a basic newsvendor problem • This paper incorporates consumer food safety confidence into a convenience supply chain contract mode
10	2019	Qijun Lin et.al.	Food Safety Traceability System Based on Blockchain and EPCIS	• implementation of traceability system based on blockchain technology and EPCIS in the literature alleviate the data explosion problem • we use collaborative management of on-chain and off-chain data

III. Methodology

A. Objectives

The Organic Food Processing System using Blockchain is an innovative solution designed to ensure transparency, trust, and traceability in the organic food supply chain. By leveraging blockchain technology, the system securely records and tracks every step of the product journey, from initial quality testing at the source to final delivery. It addresses the shortcomings of existing systems, such as the lack of transparency and limited traceability, by providing consumers with detailed and reliable information about their purchases. This project aims to deliver authentic organic food while fostering consumer trust and promoting healthier lifestyles.

In this system, products are collected from farmers and tested by Quality Assurance Specialists using certified testing equipment. Only products meeting organic standards are approved for sale and listed on the platform. Certifications and quality results are securely stored in the blockchain ledger, making the data tamper-proof and trustworthy. The blockchain stores critical information such as product certifications, quality test results, origin details, manufacturing and expiration dates, and transportation conditions. This data is easily accessible to stakeholders, ensuring complete transparency across the supply chain.

Consumers interact with the system through a web or mobile application, where they can browse and purchase verified organic products. Each product is assigned a unique QR code that links to its blockchain record. By scanning the QR code, consumers can view the entire product journey, including quality test results, certifications, transport logs, and source information. This transparency builds consumer trust and provides assurance of the authenticity and quality of the products they purchase.

B. Used Methodology

Here we prefer Agile methodology for the development of our Organic Food Processing System as it emphasizes iterative development, continuous testing, and stakeholder collaboration. By breaking the project into smaller sprints, Agile ensures steady progress, adaptability to changing requirements, and timely delivery of functional features. This approach enables effective implementation of blockchain, QR code tracking, and smart contracts while addressing the transparency, traceability, and trust issues in the organic food supply chain.

Steps involved in Agile methodology:

1. Concept and Planning: Define project goals, key features, and timelines while involving stakeholders for clarity.
2. Requirements Gathering: Collect and prioritize requirements from producers, consumers, and other stakeholders.
3. Iterative Development (Sprints): Develop key features like blockchain setup, QR code integration, and smart contracts in cycles.
4. Continuous Testing: Test each sprint deliverable for functionality, security, and traceability.
5. Deployment and Feedback: Deploy the application in phases, gather user feedback, and refine the system.
6. Maintenance and Updates: Monitor the system, fix issues, and introduce new features based on user needs and advancements.

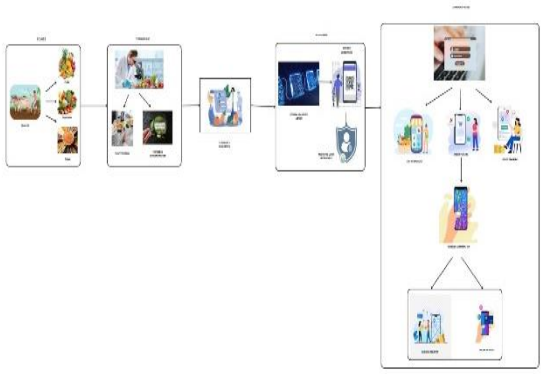

Fig 2: Steps involved in Organic Food Processing Methodology

IV. Results & Discussions

- Members of block chain system can track the products state at any time and track the source of raw materials. This obviously ensures the end users expectation of products genuineness.
- Our system enables consumers to trace the entire journey of food items from farm to fork through blockchain data and QR code-based tracking.
- Our proposed system provides certification of product's authenticity or organicity. A thirdparty quality assurance organization provides these quality index.
- Blockchain can offers Transparency enhancement, increased scalability, in which Blockchain allows stakeholders to access the supply chain system from almost every endpoint and improved security, in

order to enable Blockchain to protect the system from damage and data alteration throughout its product life cycle.

- Our proposed system does secure transaction among the participant of block chain through cryptography.

V. Conclusion

The Organic Food Processing System using Blockchain ensures transparency, trust, and traceability in the organic food supply chain. By leveraging blockchain technology, it records and secures every step of the process, from quality testing and certification to transportation and delivery. This guarantees consumers receive authentic organic products with detailed insights into their journey. The system bridges the gap between producers and consumers, fostering trust while promoting sustainable farming practices.

In the future, the project can integrate advanced IoT devices and AI for real-time monitoring and predictive analytics. Smart contracts can automate transactions and compliance checks, enhancing efficiency. Expanding to global markets and collaborating with regulatory authorities for standardized certifications will further strengthen its impact. The system has the potential to redefine the organic food industry, empowering consumers with reliable data and promoting healthier, more sustainable lifestyles.

REFERENCES

[1] Mifta Ul Jannat, Raju Ahamed, Al Mamun, Jannatul Ferdaus, Ritu Costa, Milon Biswas," Organic Food Supply Chain Traceability using Blockchain Technology", Volume 2021, IEEE Conference, DOI: 10.1109/ICSCT53883. 2021.9642543.

[2] Abdullayev Munis, Yusupov Mukhiddin, Mardonov Aziz, Mirzaaxmedov Nodirbek, Allayorov Ravshan, Khakimov Boburbek, "Strengthening of Food Security Through Development of Digital Technologies in The Food Production and Processing Chain", Volume:2023, Page no:304-313, DOI: https://doi.org/10.1145/3644713.364475

[3] Miaomiao Zheng, Shanshan Zhang, Yidan Zhang and Baozhonghu," Construct Food Safety Traceability System for Peoples Health Under the Internet of Things and Big Data", Volume:9,2021, DOI:10.1109/ACCESS. 2021.3078536

[4] HUILING FAN- "Theoretical Basis and System Establishment of China Food Safety Intelligent Supervision in the Perspective of Internet of Things" Volume:7,2019-Page no:-71686-71695, DOI:10.1109/ACCESS.2019.2919582

[5] Abubakar Mohammed And Wendyhui, Vidyasagar Potdar , Mohammed Quaddus- "Blockchain Adoption in Food Supply Chains: A Systematic Literature Review on Enablers, Benefits, and Barriers", VOLUME 11, 2023,Page no:14236-14255, DOL:10.1109/ ACCESS.2023.3236666

[6] Qijun Lin, Huaizhen Wang, Xiaofu Pei, And Junyu Wang-"Food Safety Traceability System Based on Blockchain and EPCIS",VOLUME 7, 2019, DOI-10.1109/ACCESS.2019.2897792, 2019.

[7] Dung-Ying Lin, Chieh-Ju Juan, Andching-Chih Chang,-"Managing Food Safety With Pricing, Contracts and Coordination in Supply Chains", VOLUME:7, 2019-,DOI-10.1109/ACCESS. 2019. 2946137, 2019.

[8] Cong Doanh Duong, Thanh Tung Dao, Trong Nghia Vu,Thi Viet Nga Ngo, Minh Hoa Nguyen- "Blockchain-enabled food traceability system and consumers' organic food consumption: A moderated mediation model of blockchain knowledge and trust in the organic food chain",Volume-8,20,DOI: ttps://doi.org/10.1016/j.sftr.2024.100316,2024

[9] Isuru Wijesooriya - "Blockchain-Based Organic Food Supply Chain Management System for Enhance Traceability and Transparency", volume 2024.