IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, June 2023

Food Quality Assurance in Supply Chain Management using Blockchain

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Abstract: *The food industry is increasingly recognizing the need for robust quality assurance measures in supply chain management to ensure the integrity and safety of food products. However, existing centralized systems are susceptible to issues such as fraud, corruption, and lack of transparency. This paper explores the application of blockchain technology in addressing these challenges and enhancing food quality assurance in supply chains. By leveraging the decentralized and immutable nature of blockchain, the proposed solution aims to create a reliable, transparent, and secure system for tracking and verifying the quality of food products throughout the supply chain. Through a thorough analysis of the benefits and challenges of integrating blockchain in supply chain management, this study highlights the potential advantages of increased traceability, transparency, and trust in food supply chains. Real-world case studies and theoretical investigations are used to establish the requirements and feasibility of implementing blockchain-based solutions in the food industry. Overall, this research contributes to the understanding of how blockchain can revolutionize supply chain management in the food industry, offering opportunities for increased efficiency, integrity, and trust in food quality assurance processes.*

Keywords: Food quality assurance, supply chain management, blockchain technology, transparency, traceability, authentication, provenance, real-time monitoring, decentralized system, reliability

I. INTRODUCTION

The integration of blockchain technology into the supply chain has emerged as a promising solution to address challenges related to transparency, traceability, and data management. Blockchain's decentralized and tamper-proof nature offers a reliable, transparent, and secure system for the entire supply chain. Leveraging blockchain enables accurate data collection, secure storage, and immutable transaction records, ultimately enhancing supply chain efficiency. This approach mitigates the risks associated with centralized management systems, such as corruption, fraud, and tampering. This research paper proposes a blockchain-based system to address challenges in ensuring food quality throughout the supply chain. The system aims to enhance transparency, traceability, and compliance by establishing a secure and transparent network for collecting and storing data on product origin, production processes, and handling.

1.1 Study of Existing System:

In the existing system, comprising the farmer, wholesaler, retailer, and customer, there are significant challenges. The absence of quality tracking at each stage and reliance on trust alone are major drawbacks. The system lacks assurance regarding the exact product quality. Furthermore, the price of the product is determined verbally, without considering its attributes. Consequently, there are trust issues in customers' minds regarding the product and its quality. Additionally, difficulties arise in segregating products based on their quality and identifying any defects.

Drawbacks:

1. Lack of tracking the quality of product at each stage.
2. Issue regarding decision of price.
3. Trust issues in customer's mind regarding product and quality.
4. Difficulty in segregation of quality and defected problems.

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II. LITERATURE SURVEY

Paper Name: An Improved Traceability System for Food Quality Assurance and Evaluation Based on Fuzzy Classification and Neural Network

Author Name: Jing Wang, Huili Yue, Zenan Zhou
Description:Numerous challenges are linked to regulatory compliance, internal supply chain operations, and production processes, demanding substantial organizational transformations to fully leverage traceability benefits. This encompasses both tracing and tracking functionalities. The nature of shared data and access permissions are crucial considerations. Insufficient standardization of master data and interfaces impedes automation. The intricacy lies in aligning interfaces and standards across supply chain actors. The research findings emphasize the necessity of organizing the supply chain before implementing blockchain technology effectively.

Paper Name: Web Blockchain Technology for Food supply chains
Author Name: Percival Lucena, Alecio P. D. Binotto, Fernanda da Silva Momo, Henry Kim
Description: The paper addresses the shortcomings of centralized food supply chains and highlights the benefits of implementing blockchain technology in the food supply chain. It examines various industries that have successfully adopted blockchain for their food products. The paper presents a practical example of implementing a smart contract for food supply chains and emphasizes the potential for verifying food items from their origin to the marketplace.

Paper Name: A Case Study for Grain Quality Assurance Tracking based on a Blockchain Business Network
Author Name: Percival Lucena, Alecio P. D. Binotto, Fernanda da Silva Momo, Henry Kim
Description: This study aims to explore the advantages gained from implementing blockchain technology in the agricultural sector. It also examines the lessons learned from previous implementations in agriculture, identifies the challenges in developing blockchain platforms.

Paper Name: A Blockchain-based Supply Chain Quality Management Framework
Author Name: Si Chen, Rui Shi, Zhuangyu Ren, Jiaqi Yan, Yani Shi, Jinyu Zhang
Description: In this paper,the significance of quality management in the supply chain has been highlighted by recent quality scandals. Despite previous studies, the existing technologies struggle to address trust-related issues in supply chains.

III. PROPOSED METHODOLOGY

3.1 System Architecture

In the context of food quality assurance in supply chain management, a system diagram involves four key stakeholders: the farmer, market wholesaler, retailer, and consumer. The farmer is responsible for maintaining quality standards during production. The market wholesaler conducts inspections upon receiving the products and keeps track of traceability information. The retailer performs additional quality checks to ensure compliance with safety regulations. Finally, the end consumer relies on the retailer for information on the quality attributes of the food items. Quality control measures, including inspections and adherence to regulations, are implemented at each stage. This diagram illustrates the flow of food products from the farmer to the consumer, highlighting the crucial role of each stakeholder in ensuring and communicating product quality.
Effective food quality assurance in supply chain management requires the collaboration and commitment of all stakeholders, including farmers, market wholesalers, retailers, and consumers. By implementing rigorous quality control measures and maintaining transparent communication throughout the supply chain, the overall integrity and safety of food products can be enhanced, leading to increased consumer confidence and satisfaction.

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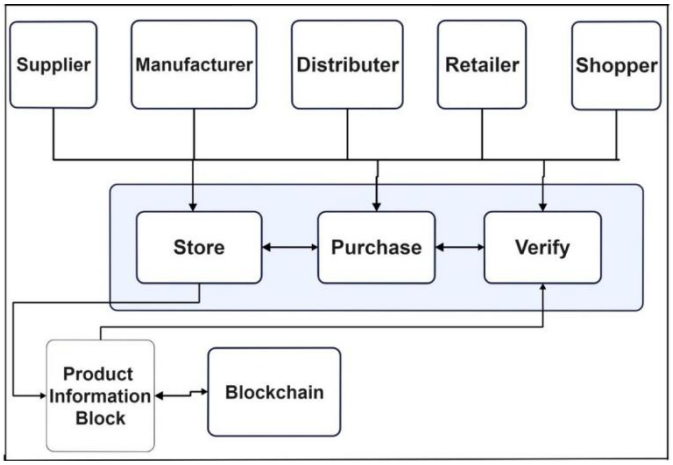

Figure 1: System Architecture of Food quality Assurance in supply chain management.

3.2 Proposed System

Our project aims to address the shortcomings of the current system by introducing a robust solution. Through the implementation of Blockchain technology, we establish a secure and transparent system that enables tracking of product quality at each stage of the supply chain. Leveraging machine learning algorithms, entities in the supply chain can make informed decisions regarding product quality and purchasing decisions. Furthermore, customers are provided with comprehensive reports on the product's attributes and its journey through the supply chain, ensuring transparency and instilling confidence in the system's integrity.

3.2.1 Project Modules

1. Fruit Quality Prediction Module

Our application includes an initial module that performs fruit identification, freshness assessment, and visual representation of the freshness percentage. By utilizing image processing techniques, the module preprocesses and enhances the uploaded fruit image, ensuring standardized input for further analysis. The preprocessed image undergoes feature extraction using a CNN algorithm, enabling the extraction of relevant visual features specific to fresh and rotten fruits. These features are then fed into a trained machine learning model within the module, allowing the prediction of fruit freshness based on learned patterns and relationships. The output of the module provides users with an assessment of fruit freshness, aiding in informed decisions regarding fruit quality and usability.

- Image Processing
- Feature Extraction
- Freshness Prediction

2. Supply Chain Management and Quality Assurance Module

The implementation of our supply chain management and quality assurance module ensures comprehensive control over fruit quality at every stage of the supply chain. By securely storing quality assessments in a blockchain server, access to reliable and real-time data is provided exclusively to authorized personnel, promoting transparency and trust. The module incorporates user input, utilizing deep learning techniques to analyze fruit images and generate accurate predictions regarding freshness. The integration of blockchain technology guarantees the integrity and transparency of the recorded data, enabling efficient supply chain management. Ultimately, this module enhances consumer satisfaction by providing reliable information for selecting fruits with optimal freshness, establishing trust in the supply chain.

- User input
- Supplychain Management
- Display Results

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IV. ADVANTAGES OF PROPOSED SYSTEM

- Detailed tracking of quality of product at each stage.
- Building the trust of customer regarding process and product.
- Transparecy in market mechanism.
- Restriction to frauds and duplicity.
- Proper evaluation of product and deciding price.

V. RESULT ANALYSIS

Our project features a user-friendly interface allowing effortless upload of fruit images for detection of fruit type and freshness using our machine learning model. The model analyzes the images in real-time, delivering quick and accurate results within approximately 4 seconds. We aim to continuously improve the project by enhancing the user interface, optimizing processing time, and further enhancing the accuracy of freshness detection. Incorporating user feedback and iterative development, our goal is to provide an efficient and user-friendly experience to our clients. Through ongoing improvements, we strive to ensure reliable and precise fruit identification and freshness assessment, meeting the needs of our users in the most effective manner.

Comparison between existing system and proposed system

- The system simplifies and enhances project management, providing greater flexibility and efficiency in quality assurance processes.
- Unlike the existing manual system, our solution is accessible online, allowing for real-time access to data and information from anywhere at any time.
- The blockchain technology employed in our system ensures data integrity and security, minimizing the risk of data manipulation or unauthorized access.
- Overall, our system addresses the challenges of food quality assurance in supply chain management by leveraging blockchain technology to enhance transparency, traceability, and trust among stakeholders.

VI. CONCLUSION

Our project focuses on developing a unique blockchain-based architecture designed specifically for managing quality in short food supply chains. Extensive research was conducted to identify the stakeholders, quality requirements, and blockchain capabilities in this context. Existing architectures were reviewed, but none were found to fully address the specific needs of short food supply chains. The proposed architecture encompasses stakeholders, IoT networks, a blockchain layer, data analysis, trust mechanisms, and quality management applications. By leveraging blockchain technology, our solution offers enhanced trust, traceability, provenance, authenticity, and real-time information for quality management in short food supply chains.

VII. FUTURE SCOPE

1. AI Integration: Enhance food quality assessment with AI techniques like computer vision.

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2. Smart Packaging: Use RFID or NFC technology to capture and sync food quality data with blockchain.
3. Regulatory Collaboration: Work with authorities to establish standards for blockchain-based quality assurance.
5. Interoperability: Integrate with existing supply chain systems for seamless data exchange.

These future scopes will drive the project's evolution, addressing emerging challenges and opportunities in food quality assurance and supply chain management, fostering transparency and efficiency in food systems.

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