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A TRUSTED BLOCKCHAIN - BASED TRACEABILITY SYSTEM FOR FRUIT AND VEGETABLE AGRICULTURAL PRODUCTS

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ABSTRACT: Assuring authenticity and transparency in the supply chain of perishable items like fruits and vegetables is a concern for the agricultural sector. In order to overcome these difficulties, this study suggests a blockchain-based traceability system that offers an unchangeable and transparent record of every product's path from farm to customer. The solution guarantees adherence to creativity and security requirements, fosters trust among stakeholders, and allows for real-time tracking of product movements through the utilization blockchain technology. For automated verification and data integrity, the implementation incorporates decentralized storage and smart contracts. This study investigates the viability and advantages of such a system regarding of raising consumer confidence in agricultural products, decreasing fraud, and optimizing supply chain efficiency.

Keywords: blockchain, traceability, agriculture, supply chain, fruits, vegetables, smart contracts, transparency, decentralized storage

INTRODUCTION: Maintaining transparency and traceability in its supply chains is a major problem for the global agriculture sector, especially concerning perishable commodities like fruits and vegetables. Conventional systems frequently suffer from errors, inconsistencies, and fraud vulnerabilities, eroding customer confidence and jeopardizing product safety. With blockchain technology offers a potential remedy to these problems. Blockchain provides a strong framework for documenting and confirming each transaction and movement inside the supply chain with its decentralized and unchangeable ledger. This guarantees that data cannot be changed or manipulated, offering a trustworthy source of truth that all parties involved may rely on. The agriculture industry can ensure that consumers obtain safe, high-quality products, increase transparency, and improve the accuracy of data on integrity by utilizing blockchain technology.

A blockchain-based system of agricultural goods traceability that produce fruits must be implemented, and this requires the use of various cutting-edge elements including decentralized storage and smart contracts. By automating and enforcing adherence to predetermined criteria, such delivery timelines and quality standards, smart contracts minimize mistakes and eliminate the need for manual supervision. Decentralized storage improves data security and accessibility by distributing traceable data among many nodes. The

potential of blockchain technology is to completely transform the tracking and verification of agricultural goods by offering a transparent, unchangeable record of every product's journey from farm to table.

LITERATURE REVIEW: Blockchain technology for agricultural traceability is gaining traction because of the growing need for accountability and transparency in networks that deliver food. Chain of supply might be revolutionized by blockchain, as blockchain technology has been shown in recent research. According to Caro et al. (2018), blockchain technology can offer an unchangeable record of transactions, improving agricultural goods' legitimacy and traceability. Their analysis focused on how blockchain might minimize human error and lessen dependency on middlemen, therefore streamlining the tracing process. Similarly, Kamilaris et al. (2019) looked at the application of blockchain in food supply chains and found that enhancing traceability and transparency may boost consumer confidence. Their research indicates blockchain technology can provide real-time visibility into goods movements and ensure data integrity.

Another application of blockchain technology in agriculture is the usage of smart contracts that has been studied in the literature. Self-executing contracts, or smart contracts, have the conditions of the contract explicitly encoded into the code. They make automatic adherence to and enforcement of contracts possible. In his study, Tian (2016) explored the smart contracts in agricultural supply chains and showed how, in place of manual intervention, they may guarantee adherence to quality standards and delivery timetables. Additionally, data security issues are addressed by blockchain's decentralized structure. According to Ge et al. (2017), decentralized storage in blockchain systems improves data security and eliminates single points of failure, increasing the resilience of traceable data against loss and manipulation.

Notwithstanding the intriguing possibilities, several obstacles and restrictions related to the blockchain-based agricultural traceability systems have been recognized. The scalability of blockchain networks is a major concern. According to Casino et al. (2019), large-scale agricultural supply networks may be limited by the blockchain's processing speed and storage needs. The adoption of blockchain technology also necessitates a significant infrastructure and training expenditure. To fully exploit the advantage of blockchain for traceability, Treiblmaier (2018) stressed the necessity of industry-wide collaboration and standards. The paper claims that while blockchain offers a solid framework for traceability, its effective implementation would require overcoming these technological and organizational challenges.

The research emphasizes how blockchain technology has the ability to improve agricultural supply networks' traceability and transparency, hence having a disruptive effect. Even while enhanced data integrity, transparency, and automatic compliance have many advantages, solving the infrastructure, scalability, and standards issues is still essential for broad adoption. This assessment lays the groundwork for future research into developing blockchain based traceability solutions that are effective and tailored to the specific needs of the fruit and vegetable production sector.

EXISTING SYSTEM: Present-day agricultural product traceability systems for vegetables fruits and mostly depend on archaic techniques like barcodes, centralized

databases, and paper-based records. Many middlemen, including as farmers, distributors, wholesalers, retailers, and regulatory agencies, are frequently involved in these networks and keep distinct records. There are several weaknesses and inefficiency's goal of this dispersed strategy. For instance, it is a higher chance of mistakes, data loss, and fraud when manual data input and paper based documentation are used.

Furthermore, centralized databases provide serious security issues due to their susceptibility to hacking, data breaches, and single points of failure, even if they are more sophisticated than paper records.

Although they have some limits, efforts to improve traceability through the use of increasingly sophisticated technologies. RFID tags help track individual objects, but They might be costly to employ widely, particularly for small and medium-sized businesses. EDI systems make it easier about the supply chain partners to exchange data electronically, but they may be rigid in meeting the various demands of all parties involved and frequently necessitate a large initial and continuing maintenance expenditure.

In conclusion, current traceability systems have improved the monitoring and documenting of agricultural goods, but they are still not efficient, secure, or transparent enough. To address the increasing expectations for food safety and customer trust in the agriculture sector, a more robust, integrated, and tamper-proof solution is required, as the present environment makes clear. This discrepancy makes a strong case for investigating cutting-edge technologies like blockchain to improve fruit and vegetable supply chain traceability and IMPLEM transparency.

PROPOSED SYSTEM: The suggested method makes application of blockchain technology to provide an effective and transparent tracking solution for agricultural items that are fruits and vegetables. Every transaction and movement of products from farm to table is recorded by the system through employing an immutable, decentralized ledger. Smart contracts, which automate compliance and minimize mistakes, and decentralized storage, which improves data security and accessibility, are important elements. Additionally, the system incorporates Internet of Things sensors to track location and temperature in real-time along the supply chain. All parties involved, from farmers to consumers, will have access to precise and unchangeable information on the origin and processing of agricultural goods thanks to this all-encompassing approach.

Advantages of proposed system: Significant benefits of the suggested blockchain-based traceability system include increased efficiency and accuracy, more transparency and trust, and increased food safety and quality. An unchangeable record of every product's journey is provided by the system, which builds stakeholder and customer trust. The traceability process is streamlined by the automation of data capture and compliance using smart contracts, which reduces manual labour and human mistakes.

IMPLENTATION:

System Architecture

To ensure data security and integrity, the system design includes a decentralized blockchain ledger that logs all transactions pertaining to the agricultural goods. By automating compliance and verification procedures, smart contracts improve productivity and decrease manual mistake

rates. IoT devices offer real-time product status monitoring, including temperature and location, while decentralized storage, backed by several nodes, ensures data redundancy and security. The system's user interface, which consists of online and mobile applications, facilitates smooth interaction between farmers, distributors, merchants, and customers. APIs make it easier to integrate with current supply chain management systems and guarantee efficient data transfer.

Fig System Architecture

Context Diagram

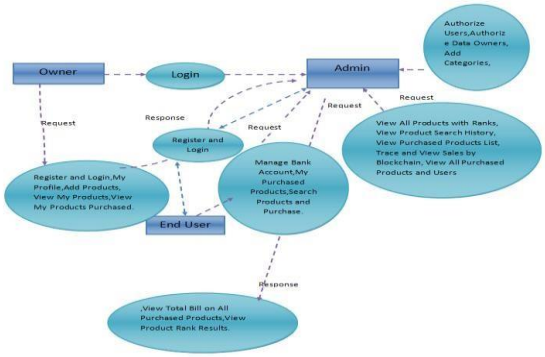

Fig Context Diagram

The way different stakeholders interact with the system is described in the context design. Retailers and distributors monitor and update the original product information entered by farmers using IoT devices to record agricultural conditions. By scanning QR codes on product packaging, consumers may obtain comprehensive traceability information, promoting transparency and confidence. From farmers' first input to IoT devices' real-time condition monitoring to consumer access, data moves through the system with efficiency. Data confidentiality and integrity are guaranteed by security methods including encryption and smart contract-based automatic compliance monitoring. A pilot program is used to test and fine-tune the system before it is fully deployed and is continuously improved depending on user input and technology developments.

Implementation Phase

Three primary stages will be involved in the execution of the proposed blockchain based traceability system: the pilot phase, full-scale deployment, and continuous improvement. During the pilot phase, the blockchain is integrated with the current infrastructure, IoT devices are deployed for real-time data collecting, and a limited group of stakeholders is chosen to test the system. In order to improve the system, participants will be trained and their input will be gathered. The system will be expanded to incorporate additional stakeholders and a wider range of products during the Full-Scale Deployment phase. Comprehensive training programs and public awareness campaigns will also be implemented. To maintain the system's efficiency, security, and scalability, the Continuous Improvement phase will also include frequent audits, user input gathering, continuous monitoring, and upgrades to incorporate new technical breakthroughs.

Analysis

Section	Key Points	Insights
Introduction	Traceability,	Demand, Safety

	Transparency	
Blockchain Technology	Ledger, Security	Trust, Integrity
Design of Traceability System	Integration, Verification	Reliable, Comprehensive
Implementation	Platform, Visibility	Scalability, Accountability
Benefits	Safety, Authenticity, Transparency	Efficiency, Trust, Informed
Obstacle	Volume, Investment	Infrastructure, Effort, Benefits
Case Study	Implementation	Practical
Future Enhancement	Upgrades, Extension	Exploration, Impact
Conclusion	Efficiency, Value	Value

RESULT: It is projected that the adoption of the blockchain-based traceability system would result in major enhancements throughout it. Immutable, real-time records of every product's path from farm to table will be made available to consumers and stakeholders, assuring confidence in the security of product. This will lead to enhanced transparency and trust. By using smart contracts to automate data capture and compliance, the system will improve efficiency, decrease mistakes, and simplify processes. Using IoT devices for real-time monitoring would improve food safety by guaranteeing ideal conditions for storage and transit and facilitating prompt, precise tracing in the event of a recall. To further demonstrate the system's ability to adjust to supply chain demands, its scalability and flexibility will allow it to develop to include more stakeholders and a greater variety of products.

CONCLUSION: This novel blockchain based traceability system has the potential to improve the efficiency, security, and transparency of the agricultural supply chain for fruit and vegetable goods. The solution guarantees precise and up-to-date recording of transactions and compliance by utilizing blockchain technology's immutable ledger and smart contracts. Additionally, strong security and constant monitoring of product conditions are provided via decentralized storage and IoT connectivity. Together, these developments overcome the drawbacks of conventional traceability techniques, including incomplete data and human error, enhancing customer confidence and food safety. The system's versatility and scalability further guarantee that it can expand to meet industry demands, giving it a future-proof method for bringing agricultural traceability up to date. All things considered, this creative strategy not only satisfies present needs but also puts stakeholders in a position to handle and address any future difficulties in the agricultural supply chain.

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