Section A-Research paper
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Safe and Reliable Fruit and Vegetable Tracking Using Blockchain Technology

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ABSTRACT— Centralised administration, lack of transparency, unreliable data, and the simple creation of information islands are only some of the issues plaguing the conventional traceability system. This study creates a blockchain-based traceability system for storing and querying product information in the agricultural supply chain to address the aforementioned issues. By using blockchain technology's decentralised, tamper-proof, and traceable properties, the transparency and reliability of traceability data were significantly boosted.

To ease the burden on the chain and allow for more effective information queries, a hybrid database-blockchain storage structure is built. Safe and secure private data exchange on the blockchain network is suggested using a combination of blockchain technology and cryptography. We also create a reputation-based smart contract in order to encourage nodes in the network to provide traceability information. In addition, we provide performance analysis and real-world implementation; the results demonstrate that our system enhances query efficiency and privacy, ensures the veracity and accuracy of data in the management of supply chains, and conforms to the needs of real-world applications

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INTRODUCTION

China is a big agricultural nation with favourable climatic conditions and an abundance of species resources, making it an ideal location for the development of fruit and vegetable agricultural goods.

Agricultural goods derived from fruits and vegetables accounted for 54.48 percent of China's total agricultural production (1826.55 million tonnes) in 2019, according to statistics from the National Bureau of Statistic of China. People have a strong affection for products such as fruit and vegetables since they are green, beneficial, and rich in nutritional content However, problems involving food safety are more probable due to the short storage period and low storage temperature of requirements for storage for fruit and vegetable agricultural goods .

There have been issues in recent years involving the local and international safety of agricultural goods including fruits and vegetables.

Adnan Abid was the associate editor in charge of overseeing this manuscript's evaluation and giving final publishing approval. The "poisonous ginger" event in China, the listeria contamination of Hami melons in the United States [5] and the E. coli epidemic in Germany are just a few examples that have had devastating effects on the health of the general population. Therefore, governments place a premium on being able to track where their food comes from, and many have passed laws and regulations to improve traceability management. The European Union's 2002 General Food Law mandates the establishment of a thorough traceability system in the food sector for the purpose of achieving recall objectives in a timely and accurate way and transmitting information to consumers. China's Food Safety Law, which went into effect in 2009, mandates the creation of a food safety traceability system by the food industry. "Traceable" is now a buzzword in the food industry, and the traceability system has shown to be an efficient tool for quality monitoring in the agricultural product supply chain .

Fruit and vegetable agricultural product traceability covers a wide range of topics. So far as the company claims connection, it is possible to classify those involved in the supply chain as either internal or external. Businesses involved in manufacturing, processing, cold chain logistics, sales, etc., fall under "internal entities," whereas businesses dealing with customers and government agencies are under "external entities" . Supervision and tracking of food safety is made more challenging in practise by the multiple production sites and sales points, lengthy production chains, and large production regions that characterise the whole supply chain . Data in conventional traceability systems is accumulated in one place, and the system's database is administered by a governing body . The corporate management of supply chain node traceability makes data manipulation simple. As a result, there is a need to improve the consistency of data transmission throughout the agricultural supply chain.

Blockchain is a distributed database that is immutable, transparent, and impossibly difficult to alter [18]. A cryptographic technique is used to arrange data blocks into a linear chain. In order to realise sharing of data and information monitoring across multiple parties, prior permission from all parties is required in accordance with accepted regulations . P2P networks, cryptography, smart contracts, consensus methods, timestamps, blockchain architecture, etc. are only some of the technology that blockchain incorporates .

As a result, it doesn't need an external source to provide data verification or administration. The present conventional traceability system for agricultural goods has flaws that can be fixed by using blockchain technology. Public chains, Consortium chains, and Private chains are the three basic types of blockchains.

Consortium chains are forms of blockchain in which many entities work together to create, update, and secure the ledger. Consortium chains sit between Public chains and Private chains in terms of privacy, with data being available exclusively to those of the consortium. The transaction efficiency of Consortium chains is also greater than that of Public chains.

Traceability systems for agricultural goods place primary accountability on the collaborative interaction between supply chain actors.

However, we cannot put all of our faith in these accountability institutions.

In fact, the supply chain's primary accountability structures are first linked by either horizontal contact or vertical transaction. Therefore, the Consortium chain was selected as the foundational network for this article.

This paper's focus is on elucidating the use of blockchain technology for agricultural product tracing. We have developed and deployed a blockchain-based traceability solution for fresh produce using its distributed storage, hash encrypting it and customizable smart contract capabilities. We'll go into depth about the system's design process and explain its most innovative features, including as its on-chain and off-chain storage structure and its use of encryption to ensure users' anonymity. For the sake of performance testing and real-world application, we will develop a Hyperledger Fabric-based blockchain environment for the agricultural product tracking system to demonstrate its viability.

This paper's primary contributions are as follows: • We expanded upon the most pressing problems with the existing system of agricultural product tracing and offered potential remedies.

In this work, we suggest remedies to the current blockchain technology's issues with high load, sluggish query speed, and private data protection, and we apply this technology to the traceability of agricultural goods. A significant portion of the study will focus on the specifics of designing the on-chain and off-chain storage structure for privacy data protection.

To realise the process of storing and querying information on the provenance of agricultural products, we have built a distributed ledger based on Hyperledger Fabric and implemented a traceability system written in the C# programming language. And by use of a system that tests the system's functionality and assesses real-world applications.

The remainder of the paper follows this structure: Section II provides an overview of the research on agricultural product traceability; Section III describes the system's detailed design; Section IV details the system's implementation, analyses its performance, provides its application results, and compares it to traditional traceability systems. In Section V, we draw some final findings and provide some ideas for moving forward.

Related work:

“The capacity to track the origin of produce,”

Today, everyone in the food industry, including those who grow and sell fruits and vegetables, must constantly address customer concerns about food safety and traceability. Regulation 178/2002 lays forth the concepts and legal criteria of traceability for the EU. However, there is currently no information on analytical traceability tools in the law. Furthermore, as markets become increasingly globalised, competition is developing for fruit and vegetable traceability systems. Actors in this industry face the present issue of being competitive without sacrificing safety, quality, or traceability. Isotopic analysis, DNA fingerprinting, and metabolomic profiling paired with chemometrics are examples of modern traceability methods that meet these criteria while also being adaptable, inexpensive, and effective.

“Traceability system modelling and rollout in the fresh produce industry”

The many different people and organisations involved in a traceability system need to be catalogued. The most crucial step in creating a reliable traceability system is deciding what data needs to be captured. During vegetable shipping and processing, most of the identifying data is lost or muddled. In this study, we take a systemic approach to formulating a technique for enforcing traceability across the vegetable supply chain. It's important to note that the primary challenges raised appear at different abstraction levels during the development of traceability systems. Second, a collection of appropriate patterns are presented with a Unified Modelling Language model for traceability. Unified Modelling Language (UML) class diagrams are created to brainstorm a strategy for modelling the vegetable supply chain's product, process, and quality data. After that, we'll talk about the right kinds of technology to use when getting started, registering, and facilitating business partnerships. Finally, a case study on vegetable supply chains and a comparison with the European Union's General Food Law will be used to illustrate the installation of a traceability system.

“Monitoring China for the Emergence of Food-Related Illnesses"

The spread of food-borne illness continues to be a significant global health concern. Data submitted to the National Foodborne Disease Outbreak Surveillance System in China from 2003-2017 were analysed to better comprehend the epidemiology and development of foodborne diseases in the country. There were a total of 19,517 outbreaks throughout this time, resulting in 235,754 cases of disease, 107,470 admissions to hospitals, and 1457 fatalities. Thirty-one percent of the 13,307 outbreaks with an identified cause were due to toxic mushrooms; the next most common cause was Vibrio parahaemolyticus (11.3 percent), followed by saponin (8.0 percent), Salmonella (6.6 percent), nitrite (6.4 percent), pesticide (4.8 percent), Staphylococcus aureus (4.2 percent), and Bacillus cereus (3 percent). Of the 18,955 recorded outbreaks, 46.6% were linked to food produced at home, 22.5 % to food prepared in restaurants, and 18.5 % to food served in canteens. Fungi (primarily poisonous mushroom), meats, vegetables, aquatic animals, condiments, poisonous plants (such as saponin, tung oil or seed, aconite), and grains (such as rice, noodle, rice noodle) accounted for the majority of the 13,305 outbreaks linked to a single food category. Analysis of foodborne disease outbreaks can help public health agencies pinpoint high-risk aetiology and food pairs, specific points of contamination, and settings, as well as identify the most common causes of foodborne illness.

"A review of ProMED articles on the evolving epidemiology of listeria monocytogenes outbreaks, sporadic cases, and recalls around the world,"

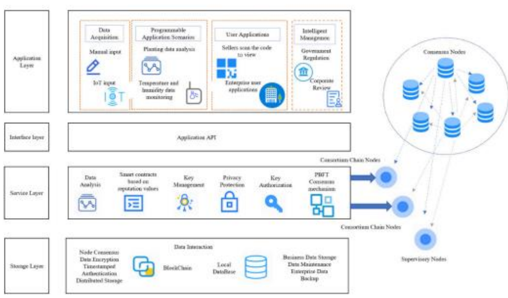
Background: The goal of this research was to use ProMED information to find patterns in the worldwide spread of Listeria monocytogenes. ProMED is an open-source, worldwide system for reporting outbreaks that draws from both unofficial and official sources. Listeria is an example of an outlier in the context of ProMED's reporting, which includes abnormally high case numbers, uncommon origins, and global outbreaks. Methods: The ProMED database was searched using the terms "Listeria" and "listeriosis" for articles published between 1996 and 2018. Date of issue, countries affected, suspected and confirmed case numbers, and deaths were taken from the source. Information specific to each occurrence, such as expert opinions, was considered. The most recent report used when numerous reports on the same outbreak or recall were acquired. A normal approximation to the Poisson distribution was used to compare the rates of Listeria occurrences throughout time.

METHODOLOGY

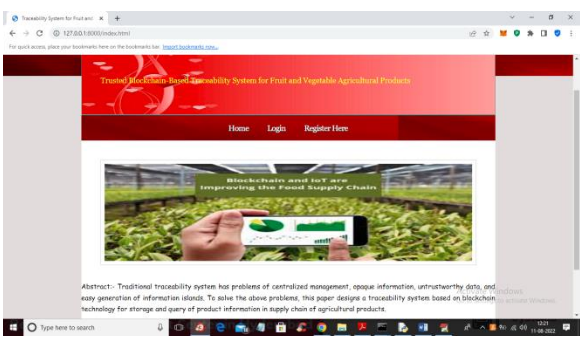
In this study, we dissect the supply chain for agricultural goods from farm to fork to supermarket.

Key data, including seedling data, planting process data, environmental data, and product transaction data, are recorded throughout the production cycle, which includes the planting, transplanting, watering, fertilising, and picking activities of fruits and vegetables. The processing link involves capturing the product information, processing procedure, processing environment, product transaction, and other crucial data as well as sorting, weighing, packing, pasting a two-dimensional code, and other activities on the harvested fruits and vegetables. When discussing the manufacturing, processing, shipping, and sales processes, the transportation connection refers to the conveyance of (such as the Internet of Things). Consumer confidence in the safety of agricultural goods may be boosted by using a traceability system to present comprehensive product information.

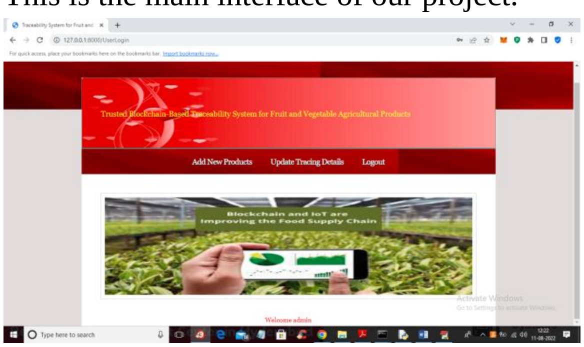
Accidents involving agricultural goods' quality and safety may be investigated by law enforcement by following the chain of custody back to the source of the issue. For the purposes of ensuring the authenticity and candour of traceability information in agricultural products traceability systems, and thereby achieving effective and reliable traceability, blockchain traceability refers to the use of blockchain-based technology in traceability systems. The data storage scheme in the blockchain-based fruit and vegetable crop traceability system manages the cultivation information, processing information, logistics information, and sales information of fruit and vegetable agricultural products in order to track the entire production, processing, transportation, and sales cycle. Storage layer, services layer, interface layer, and application layer were the primary divisions in the architecture of the blockchain traceability system for agricultural goods.



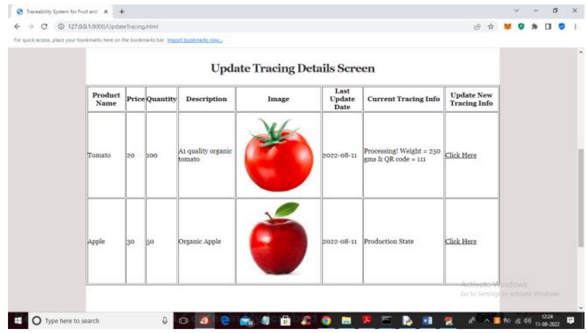
RESULT AND DISCUSSION



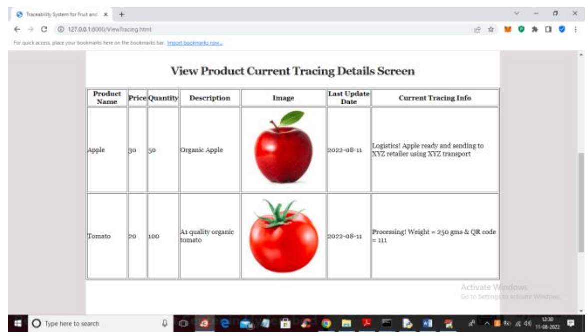
This is the main interface of our project.



This is the admin login page.



In above screen admin can view all product details and to update tracing details from current state, admin will click on 'Click Here' link to get below screen.



In above screen user can view all product details and in last column he can see current tracing data of each product

CONCLUSION

In this article, we use the immutable and trackable properties of blockchain to create a system for tracking agricultural goods like fruits and vegetables, and we talk about how that system's data is stored and queried. An off-chain and on-chain information storage technique employing "database + blockchain" is presented as a solution to the growing pains experienced by the blockchain traceability system, namely excessive data load strain and insufficient private security. The hash value computed using the SHA256 technique that stores the public information shown to customers is uploaded to the bitcoin system. Private data encrypted using the CBC algorithm and shared with appropriate businesses over the blockchain. This study proposes a storage technique that combines the current state of affairs, with consideration given to the requirement for encryption of company private information and the necessity for public monitoring of supply chain information that is public, in order to lessen the burden on the information load on the chain. The link between the distributed ledger and the database is made possible by recording the block number of the publicly available data. Scan the QR code for access to the database's public information; if the system detects any discrepancies, it will check the block number in the database to see whether the data has been interfered with. As blockchain evolves, multi-chain is the route that it eventually will go to better address the demands of real businesses. We want to investigate new types of consensus mechanisms that are well-suited to traceability, as well as the cross-chain technology that allows several chains to communicate with one another.

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