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

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ABSTRACT

The traditional method of traceability suffers from the issues of centralised administration, opaque information, questionable data, and the simple creation of information islands. This article develops a traceability system based on block chain technology for the storing and querying of product information in order to tackle the difficulties that have been outlined above in the chain of distribution of agricultural goods. Taking use of the traits of decentralisation, tamper-proofing, and because block chain technology enables traceability, there has been an improvement in both the transparency and reliability of traceability information. A dual storage system consisting of both on-chain and off-chain traceable information, referred to as "database plus blockchain"is built to alleviate load strain on the chain and achieve effective information querying via its construction.

Block chain, it has been suggested that technology paired with encryption may be used to enable the secure exchange of confidential information in the network built on the block chain In addition to this, we provide a reputation-based smart contract as an incentive for network nodes to participate. Upload traceability data. In addition to this, we provide performance analysis as well as practical application, the outcomes of which demonstrating that our method increases both the effectiveness of queries and the safety of confidential information, as well as ensuring that ensuring the validity and reliability of data in supply chain management, as well as ensuring that it complies with real application needs.

I. INTRODUCTION

Fruit and vegetable agricultural goods have strong production advantages in China, which is a vast agricultural country with superior climatic conditions and abundant species resources. These factors contribute to China's competitive edge in international agricultural markets. According to information provided by the National Bureau of Statistics of China [1,] the overall production of agricultural goods consisting of fruits and vegetables in 2019 was 995.03 million tonnes, which accounted for 54.48% of all agricultural products (1826.55 million tons). People have a profound affection for agricultural items that come from the fruit and vegetable sector since these goods possess the qualities of being green, nutritious, and rich in nutritional content [2].

However, the short storage duration and the low storage temperature of storage requirements for fruit and vegetable agricultural goods both

contribute to an extraordinarily high likelihood of food safety events occurring [3].

In recent years, there has been an increase in the number of food safety events involving local and foreign agricultural goods including fruit and vegetables. Examples include the "poisonous ginger" event in China [4, the contamination of hami melons by listeria in the United States [5, and the epidemic of E. coli in Germany [6], all of which have significantly damaged the health of the vast majority of people.

As a consequence of this, the state places a significant emphasis on the food supply chain's capacity to be tracked, and nations work to improve the management of food supply chain tracking by passing laws and regulations in this area. In accordance with the General Food Law that was enacted by the European Union in 2002 [7], the food industry is required to implement a comprehensive traceability system in order to meet the requirements of the law in terms of recalling products in a timely and accurate manner and communicating information to customers.

According to China's Food Safety Law [8,] which went into effect in 2009, food producers and operators are required to set up a food safety traceability system in order to guarantee food traceability. "Traceable" has developed into a significant obstacle for all food and food-related businesses, and the system of traceability has developed into an efficient method of quality control in the supply chain for agricultural products [9–11].

There are many different aspects that go into ensuring the traceability of fruit and vegetable farm products. It is possible to classify these companies as either internal or external to the supply chain, depending on the business connection that they have [12, 13]. The enterprises that fall under the category of "internal entities" include production enterprises, processing enterprises, cold chain logistics enterprises, sales enterprises, and so on.

The enterprises that fall under the category of "external entities" include consumers and regulatory agencies, among other things [14]. The entire supply chain has the characteristics of many production points and sales points, long production chains, and wide production areas, which makes supervision and tracing of food safety particularly difficult in practise [15]. In addition, long production chains and wide production areas make it difficult to track down specific production locations.

Data in conventional traceability systems are centralised in practical implementations, and authoritative organisations administer the core database of the traceability system [16], [17]. Because enterprises are responsible for managing the traceability data of each node in the supply chain, it is simple to manipulate such data. For this reason, there is a need to improve the dependability of information transfer among the many roles that comprise the agricultural supply chain.

A blockchain is a kind of distributed database that cannot be altered in any way, can be traced back to its original owner, and is managed by a number of different entities [18]. It does this by using a cryptographic technique to create a chain structure that is made up of data chunks that are ordered chronologically. In order to implement information sharing and information supervision among various parties, every party must first get the approval of all other parties in advance in accordance with

the norms that have been agreed upon [19]. In addition, blockchain is capable of incorporating a wide range of technologies, including peer-to-peer (P2P) networks, cryptographic technologies, smart contracts, consensus mechanisms, timestamps, and the structure of blockchains, amongst others [20], [21].

As a result, it is able to conduct data management and self-verification without having to depend on the services of a third party. The adoption of blockchain technology for the purpose of tracking agricultural goods may provide solutions to the issues that plague the conventional traceability system that is now in place. Public chains, consortium chains, and private chains are the three primary classifications that may be used to blockchains [22].

The term "consortium chains" refers to the distributed ledger that several organisations work together to administer and participate in. When it comes to privacy, Consortium chains are somewhere in the middle between Public chains and Private chains. The data on these chains can only be accessed by members of the consortium that created them. In addition, the transaction efficiency of Consortium chains is much greater than that of Public chains.

The primary responsibility bodies of the supply chain of agricultural goods are connected to the cooperative connection that exists between the various players in the supply chain when using a system that enables product tracing.

However, one cannot put their whole faith in these organisations of duty.

In point of fact, the primary responsible entities that make up the supply chain are initially connected to one another via either a vertical transaction link or a horizontal interaction relationship. As a result, for the purposes of this article, the Consortium chain will serve as the fundamental network.

The primary objective of this research study is to provide an explanation of how blockchain technology might be used to improve the trackability of agricultural goods. We have built and implemented a traceability system for agricultural items such as fruits and vegetables that is based on a blockchain that can be trusted. This system makes use of blockchain technology's characteristics such as distributed storage, hash encryption, and programmable smart contracts. In the following, we will provide an in-depth description of the system's design process as well as a clarification of its most important breakthrough technologies. Some of these technologies include the on-chain and off-chain storage structure as well as the combination of cryptography and privacy data protection.

In order to demonstrate that the agricultural product traceability system can be implemented in a realistic manner, we will construct the blockchain environment on the basis of Hyperledger Fabric for the purpose of performance testing and practical deployment of the system.

The following are some of the most important contributions made by this paper: • We expanded on the most important flaws in the existing system for tracing agricultural products and provided alternatives.

We provide answers to the problems of high load, sluggish query speed, and privacy data protection that are present on the current blockchain technology, and we use blockchain technology to the traceability of agricultural goods. A significant portion of

the study will focus on the in-depth planning and design of the on-chain and off-chain storage structures, as well as the security of personal information.

We create a blockchain environment based on Hyperledger Fabric, and we utilise the C# programming language to construct and implement a traceability system. This allows us to actualize the process of storing and accessing information pertaining to agricultural product tracing. In addition, via the use of the system's real application case assessment as well as the system function test

II. RELATED WORK

The capacity to retrieve any and all information pertaining to anything throughout its entire life cycle by way of documented identifications is what is meant by the term "traceability" [22]. Traceability for agricultural products ensures that, in the event that quality issues arise, the raw materials or processing links that are causing the issues can be checked in a timely and efficient manner, that product recalls are carried out when necessary, and that targeted penalties are implemented in order to improve the overall quality and safety of agricultural products.

Traceability has become a difficulty for all food and food-related enterprises, and a traceability system has become an effective way of quality control in the agricultural supply chain. Traceability systems have also become a challenge for the government. In recent years, a great number of academics have been doing exploratory study in the topic of agricultural product tracability. In order to design and implement a Wheat Flour Milling Traceability System (WFMTS), Qian et al. [24] combined the technologies of 2D barcodes and RFID tags. The QR code label was pasted on the wheat package to link to its processing information, and the RFID label was pasted on the storage box to record the logistics information.

The centre database is used to handle the information in the flour mill, from the raw materials to the completed products, and it allows for the monitoring of the whole process, from the source to the circulation to the sales. The information included inside the typical traceability system is, however, handled by the businesses that are involved in each chain link, and there is a lack of openness about the information as well as an ease with which it may be modified.

The emergence of block chain as a new technology with the characteristics of decentralisation, invulnerability to tampering, and traceability offers the opportunity of finding solutions to the issues that now exist in the present mechanism for tracing agricultural products using conventional methods.

The topic is starting to get the attention of an increasing number of academics. the use of block chain technology in tracking and tracing agriculture produce and goods. In the context of integrating applications combining the technology of block chain with that of the Internet of Things, Bumblauskas et al. [25] used a combination of Internet of Things and block chain technologies to trace items from the farm to the consumer .to the dinner table in the nick of time.

Taking into consideration the egg supply chain of a Take for instance a corporation based in the Midwest of the United States, and the use of block chain technology in the supply chain. This is a summary of the chain system from the farm to the consumer.

Specifically, Feng [26] constructed a food supply chain that allows for real-time tracking of orders. a tracing system based on HACCP, Block chain, and Internet of Things technology, as well as presented a brand new idea called Bigchain DB to find a solution to the issue of scalability in blockchain technology.

Liao and Xu, position 27a block chain-based tea quality tracking system based on intelligent agriculture and wireless sensor networks has been built. The management of food safety, including with an analysis of food riskas well as a safety traceability technology that is based on risk considerations to exercise effective command over the items' quality and safety.

Starting with block chain on the level of the multi-chain framework. Zhao et al. [13]developed a big data version of a fresh food traceability platform based on a dual-chain architecture consisting of the account block chain (ABC) and the transaction block chain (TBC), conducted an analysis of the results, and presented the findings. demands of users seen through the lens of information ecology, and presented a risk compensation scheme that tracks who is engaging in the plan. entities.

An anti-counterfeiting traceability system (TSPPB) was developed by Liu et al. [28], and it makes use of dual block chain as well as IPFS.systems. The TCDBB technology is applied to address the issue of product label copying, and the TSPPB block chains, both public and private, were deployed in order to do this also, spam.

At the level of improvements made to the design and mechanism. [29] Li et al. presented a use for block chain technology. the addition of technology to the database layer as well as the communication layer with the use of the block chain-based food safety traceability system investigation of the degree of technological architecture, and demonstration of the results the design, as seen by the efficacy of the ham and sausage the software itself.

Dwivedi and colleagues [30] conceived of a pharmacological system for management of the supply chain (PSCM) by integrating block chain technology with the conventional medicine supply chain, and suggested a system for the general dissemination of all encryption keys. to each and every participant using the technologies of a smart contract.

In the creation of the block chain storage model, which many academics utilised on-chain and off-chain data storage to alleviate some of the strain on-chain storage is available. Lin et al. [31] designed and put into operation method for the tracking of food that is built on block chain and EPC Information Service (EPCIS), which also suggested an on-chain and off-chain data storage structure that operates off-chain to alleviate the pressure issue of.

V. RESULTS AND ANALYSIS

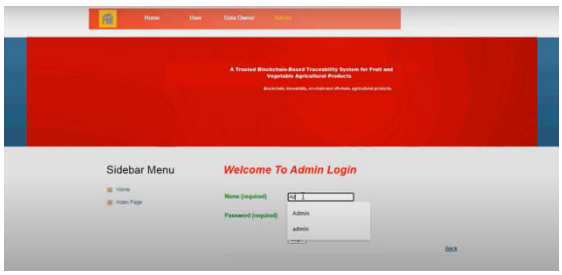

Fig-1: Home page

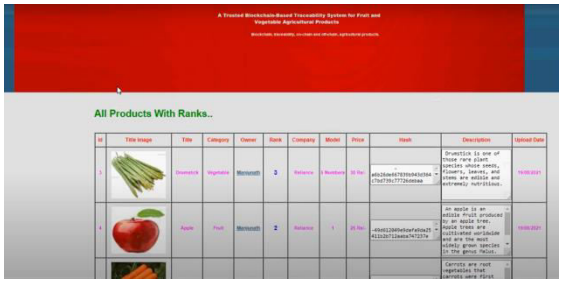

Fig-2: Product with Ranks

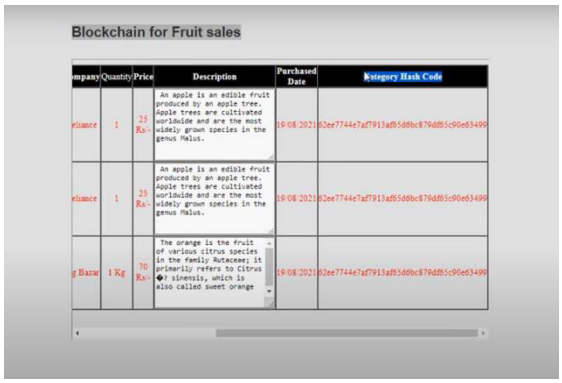

Fig-3: Blockchain for Fruit sales

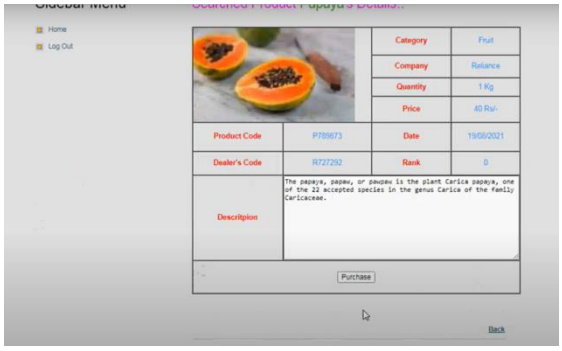

Fig-4: Fruite purchase

VI. CONCLUSION

In this work, we created and built a system for the traceability of agricultural items such as fruits and vegetables, basing it on the non-tampering and traceable qualities of blockchain. Additionally, we examined the architecture of the system's storage and query capabilities.

An on-chain and off-chain data storage method that uses "database + blockchain" has been proposed as a solution to the issues of high data load pressure and poor private security posed by the growing data in the blockchain traceability system. These issues are caused by the exponential growth of the data.

The information that is exposed publicly to customers is saved in the supply chain to the local database; the hash value of this information, computed using the SHA256 technique, was then uploaded to the blockchain system.

The CBC encryption technique is used to encrypt private information, and then that information is saved on the blockchain so that it may be shared with appropriate businesses. The method of storage that is proposed in this paper combines the actual situation, taking into account the need for encryption of corporate private information as well as the need for public supervision of supply chain public information, and reducing the pressure of data load that is placed on the supply chain.

Realization of the relationship between the block chain and the database is made possible by the saving of the block number of the publicly available

information on the database. By scanning the QR code, the consumer is able to receive public information from the database. The system then checks the information using the associated block number that is kept in the database to verify whether or not the product information has been altered.

With the advancement of block chain technology, the multi-chain architecture is the direction in which future development should go in order to satisfy genuine business requirements. In the course of our future study, we want to investigate the technology that enables cross-chain communication across numerous chains as well as a novel kind of consensus mechanism that is suited to traceability.

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