FOOD SUPPLY CHAIN MANAGEMENT USING SMART CONTRACTS IN BLOCKCHAIN TECHNOLOGY

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Abstract: Food is the most important factor in everyone's life. Before the technology had got introduced in agricultural sector, everyone used to cultivate the food products in traditional methodologies. This ensures that the food bought and consumed by the customers are healthy and safe to eat. But when the technology got entered this sector, adulteration got increased in the food and other things. Many people claim that the product is 100% health and safe to consume but most of the time they are not true. So transparency in the production of food product may play a vital role in controlling the adulteration. And customer should also be given freedom to check the product, look into the quality test reports so that he could buy the product with more confidence.

Keywords: *Food Supply Chain, Digital Ledgers, Smart Contracts, Blockchain Technology, Food Safety.*

1. Introduction

The Management of supply chain is a collection of actions taken to turn raw materials into finished goods while maximizing Adding value to the consumer and securing a sustainable competitive advantage It can also be seen as a network of organizations that make up the entire system, from manufacturing to trading. "The supply chain network as a whole is broken down into various stages. These stages frequently include lengthy processes that go on for months." [1][2] In such a scenario, it becomes quite challenging to identify the primary cause of the issue if the final product is of poor quality.

Consumer interest in data provenance and demand for high-quality goods are both rising quickly. Every supply chain system now needs to monitor the flow of goods from their point of origin to their final users.

"Failure of the global food supply chain has evolved to represent any issue with the supply systems. You only need to look back two years to see how poorly supply chains have affected the food business. One tool that could enhance future food system rules, traceability, and the efficiency and success of these supply chains is blockchain technology. The food business could employ Blockchain Technologyto increase consumer trust, manufacturing speed, and product efficiency right now."[3][4] By enabling quicker and more cost-effective product deliveries, increased supply chain transparency and traceability, upgrading real-time trade partner coordination, and significantly improving record-keeping by all parties involved, Block chain Technology may significantly improve global food supply chains.

"The supply chain authorities must be effective and precise in their information delivery in order to win the trust of end users. Improvements in farm output and productivity, improved use of agricultural inputs, appropriate marketing infrastructure and assistance, as well as effective food management, are all necessary for agriculture growth."[5][6] Yet, traditional agriculture supply chain management is currently struggling with a number of issues related to a centralised network, a lack of trust, a lower-than-expected product, and a lack of communication.

The issue that traditional agriculture's supply chain now has will be solved by introducing blockchain. Blockchain is a safe system that, because to its intrinsic characteristics like decentralisation, transparency, and immutability, has a substantial impact on the evolution of the supply chain.

With the aid of block chain technology, systems can be instantly checked for food fraud and product tampering, wasteful products can be identified and categorized within supply chains, food contamination problems can be quickly identified, assisting in quick product recalls, and transit security can be improved, thereby reducing food spoilage.

2. Literature Survey

Currently, "The agricultural supply chain management system is encountering numerous challenges. This article describes how blockchain technology can be advantageous for the supply chain management to securely transfer information. By implementing a reliable and tamper-proof data ledger, third-party intervention in this regard can be prevented. The article examines various methods by which blockchain technology can be integrated into the agricultural supply chain as a trustworthy and dependable means of conducting transactions."[7]

"A completely decentralized system based on blockchain technology can be used for traceability in agriculture. This system allows for the creation of blocks that constantly interact with IoT devices from the provider to the consumer. In order to put this into action, we have introduced the Provider-Consumer Network, which is a hypothetical food traceability application that covers the entire process from start to finish. The goal is to establish a distributed ledger that can be accessed by all users in the network, thereby increasing transparency."[8]

"Every transaction is recorded on the blockchain and then the data is uploaded to the Interplanetary File Storage System (IPFS). The storage system then generates a hash of the data which is saved on the blockchain, thus providing a dependable, safe and efficient solution. The system is equipped with smart contracts that incorporate their algorithms to demonstrate the interaction of different entities within the system. Additionally, there are simulations and assessments of smart contracts, along with security and vulnerability analyses."[9]

"The aim of the study is to explore how blockchain technology is used in the agricultural industry, both in terms of techniques and applications. Firstly, the technical components, such as data structure, cryptographic methods, and consensus mechanisms, are thoroughly explained. Secondly, current agricultural applications of blockchain technology are classified and evaluated to illustrate the use of blockchain techniques. The popular platforms and smart contracts are also presented to demonstrate how industry practitioners utilize them to develop agricultural applications. Thirdly, the main challenges faced by potential agricultural systems are identified, and potential solutions are discussed. Finally, an example of an improved food supply chain is provided to show the effective use of blockchain technology in the post-COVID-19 pandemic economy."[10]

"There is a requirement for a reliable centralized authority and intermediaries to keep transaction records and improve efficiency and safety with a high level of integrity, dependability, and security. The suggested solution concentrates on the use of smart contracts to manage and regulate all interactions and transactions between participants in the supply chain ecosystem. All transactions are documented and kept in an immutable ledger on the blockchain, with connections to a decentralized file system (IPFS), ensuring a high degree of transparency and traceability throughout the supply chain ecosystem in a secure, trustworthy, dependable, and efficient manner."[11]

"The current agricultural supply chain in India is extensively divided and consists of many agents or intermediaries involved in the marketing channel to earn profits while shifting losses to the producer. This system has been in place for a long time and has undergone several years of modifications."[12]

"Blockchain technology can offer a solution to the limitations of transparency, efficiency, security, and tracking by utilizing smart contracts that are automatically triggered when certain pre-defined conditions are fulfilled. Smart contracts have the ability to reduce or eliminate the need for intermediaries. Essentially, a smart contract is a digital contract that self-executes when specific predetermined conditions are satisfied."[13]

"Ethereum is unique among other blockchains because it utilizes self-executing code-based contracts that enable predetermined actions, such as payments, to happen instantly and without the need for intermediaries once the terms of the contract have been fulfilled. This is one of the primary features that distinguishes Ethereum from other blockchains."[14]

"The primary focus of research and development efforts is to create records that are tamper-proof and immutable, which fosters trust and dependability even among untrusted peers within the financial technology industry. This concept has led to many sectors recognizing Blockchain Technology as a potential platform for

transformative change. In order to ensure the reliability of data, the Prov-Chain approach examines the use of Blockchain Technology in the field of Cloud Storage, which verifies the validation, storage, and collection of data."[15]

"A smart contract is an agreement between parties that binds each party to their responsibilities in a transaction, much like a conventional contract, and ensures that the contract is enforced. The use of smart contracts enhances the transparency, traceability, and efficiency of a supply chain, making it more flexible in building stronger relationships between parties. Every smart contract is allocated a distinct 20-byte address."[16]

"The Ethereum Platform is an openly accessible initiative that consists of two networks: a user account, which is managed by a private key and address, and a Smart Contract account, which is governed by a built-in code. This code is compiled and executed through the Ethereum Virtual Machines (EVM), which runs on individual nodes. Interactions between contracts are referred to as transactions, which modify the state of smart contracts and allow the state to be modified and observed transparently by interacting with individual smart contracts."[16]
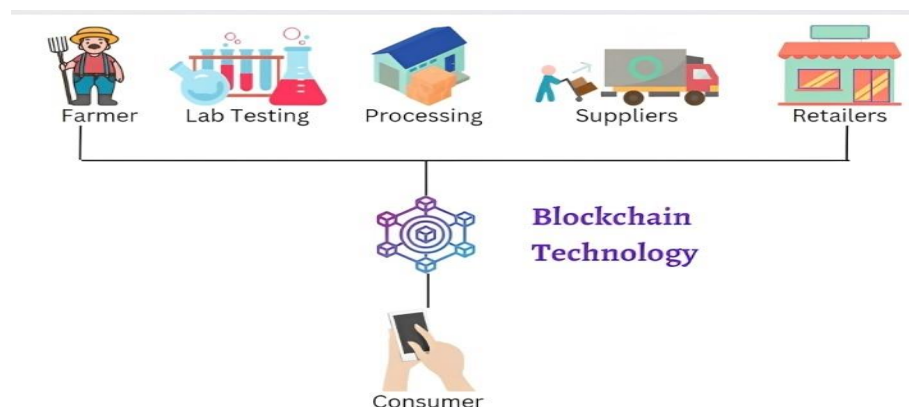
3. System Architecture

Figure1. System Architecture

The system architecture gives a brief explanation about the "Food Supply Chain Management using Smart Contracts in Blockchain Technology." It represents the entities involved and the flow of how the management works. In the system all the data related to the product are recorded into the blockchain which is a immutable in nature. Hence no one can able to modify, manipulate or destroy the data.

1. Algorithm

The system that we suggest is called " Food Supply Chain Management using Smart Contracts in Blockchain Technology." This involves several phases,
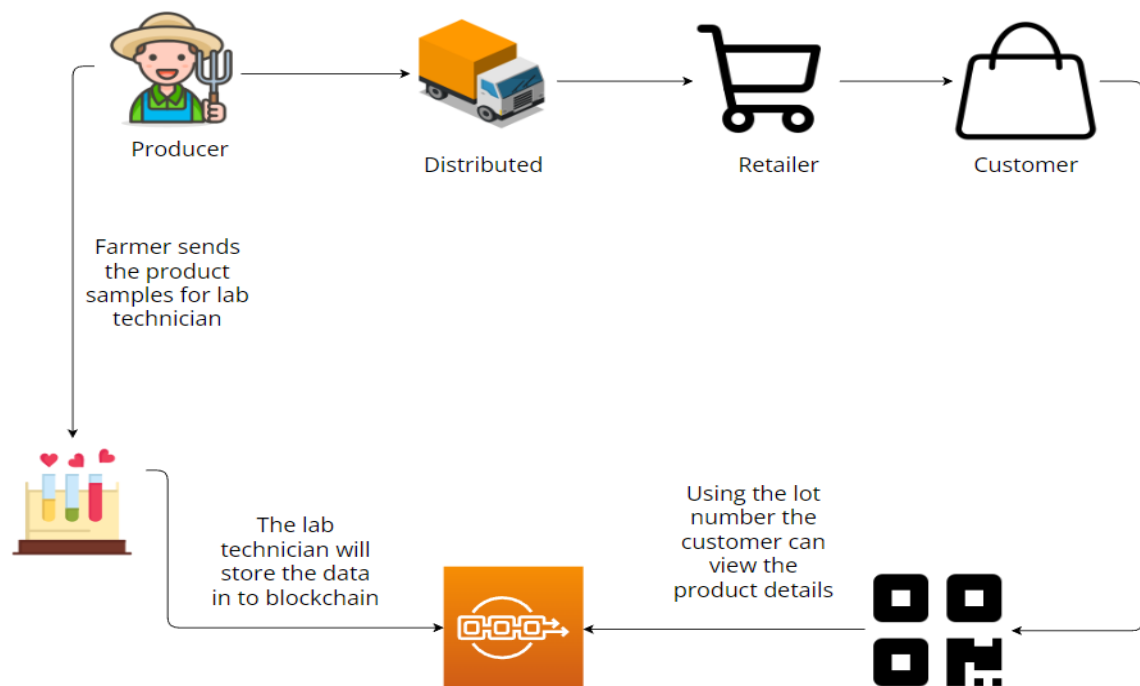
Figure 2. Workflow of the process

5.1 Farmar Phase

In this phase, farmers are given the highest priority. It is the farmer who starts the cultivation of the farm. He will cultivate the farm by the help of various agriculture practices such as Soil preparation, sowing seeds, Manuring, Irrigation, Weeding, Harvesting and Storing the food products in storages.

After the farmer cultivates the farm it's his responsibility to get his farm tested. There are several organizations that help farmer with testing the farmer's farm. The farmer sends the soil and food samples for lab testing and here on the next phase begins.

5.2 Lab Testing Phase

In this phase, the highest priority is given to the Lab Technician. There are several organizations such as Seed Testing Laboratory, Quality Control Laboratory which will test the soil and crop that were produced by the farmers. Once the farmers fill the required documents and submits the samples, the lab technicians will perform several test on those samples. The results of the tests are record on the blockchain.

A blockchain is a decentralized, distributed, and open digital ledger that is used to log transactions across numerous computers in a way that prevents changes from being made retrospectively without affecting all blocks behind them and the network's consensus.

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Advantages of Blockchain Technology:

- ✓ Immutability of data
- ✓ Enhanced Security
- ✓ Greater Transparency
- ✓ Instant Traceability
- ✓ Increased efficiency and speed

An interface will be given to the lab technician. A lab technician must enter the necessary properties in the interface. The backend smart-contract and the transaction are activated after the he/she submits. Moreover, a lot number will be provided to the product, assisting customers in tracking down and verifying the product information. If this is implemented using a traditional database system, the data will be vulnerable to malicious activities such as hacking the database which will lead to the data losing its integrity.

Whereas, when this is implemented using blockchain technology, the risk of the data being compromised is eliminated because blockchain stores the data in encrypted decentralized format which is difficult for attackers to hack and modify the data. Given that the data will be stored in a distributed way, if a hacker updates one node, we may prove the transaction with the help of a majority of the transactions on the other nodes.

5.3 Market-place phase

After the lab technician uploads the product test details in to the blockchain, the related links and metadata are also shared with the farmer. Using these links and metadata, farmer will upload the product images and price of the product into the market-places. From this point the products are open for sale, now anyone can buy product from farmer.

5.4 Retailer or Customers phase

We can discuss this phase with two use cases keeping in mind.

5.4.1 Customer use case

Customer can able to login into the website, when he checks the product details he will be displayed with a hyperlink or a QR code, with them he could verify that products are safe and healthy. Now the customer can able to purchase the product with more confidence.

5.4.2 Retailer use case

Retailer will also be able login into the webpage, when he checks the details of any product he will displayed will a hyperlink or QR code. With the help of this QR code he can able to verify that the products are safe and healthy. He can purchase the product with more confidence.

4. Conclusion

In the existing system, all the details related to the product are recorded on a physical book with which we had many issues like losing the record, not having proper security for the data and many issues with the traceability and transparency.

But we can reduce these issues with the help of blockchain technology that could give good security to the records and data, ease in traceability with good level of transparency.From the farmer's perspective, he may demonstrate the caliber of his goods, bargain appropriately, and earn healthy profits.

From the standpoint of the retailer and the customer, they can distinguish between healthy and unhealthy products and can confidently purchase the healthy products. By providing additional funding, the customer can also fund or purchase directly from the farmer. The relationship of trust between the farmer, retailer, and customer will improve as a result.

As a future enhancement, there are several areas where we can think of applying blockchain technology such as voting system, managing the data of huge organizations.

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