Supply Chain Management In Agriculture Using Blockchain

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Abstract: Supply chain management in agriculture is a cohesive network of processes such as cultivating, harvesting, processing, transporting, storing, and distributing the agricultural produce from farmer to consumer in a systematic manner. The supply chain supervises and manages the overall activities to ensure smooth workflow of the system. Traditional supply chain management methods have failed in areas which mainly include incorrect handling of agricultural goods, non-transparency and non-traceability which has made it extremely difficult for the supply chain management in agriculture to improve over the years. There exists a problem of improper communication amongst the various participating entities in abovementioned supply chain. The participating entities have no clear idea regarding the whereabouts of the product in question. A more transparent and traceable supply chain may result from the usage of blockchain, which offers a secure and decentralized platform for transaction recording and tracking. In order to effectively integrate blockchain with supply chain, the proposed system bridges the user interface in React JS and smart contract in Solidity with the help of Web3 and MetaMask in a Truffle test environment.

I. INTRODUCTION:

Supply Chain Management in Agriculture is defined as the supervision of the overall timeline of supply chain ranging from sourcing of the product to its selling in the market. The essential task in this process is to mainly keep track of the product flow from its source to destination. This process can be achieved by organizations, provided they monitor and manage their supply chain process thoroughly. However, the current Supply Chain Management fails at being transparent to all intermediaries involved within it. We cannot trace the produce back to its original source, neither is the process transparent to all participating entities. The Supply Chain Management in agriculture is ineffective for farmers and consumers and hence failure-prone. Introducing Blockchain to the Supply Chain Management would help resolve a variety of problems. ensure the integrity of source of produce. Blockchain is a distributed/decentralized database or ledger which provides a platform for computation and information sharing. It assists in co-operation and collaboration, making rational decisions, transferring values or assets without any need for an intermediary.

II. LITERATURE SURVEY:

[1] Explains the need of tracking, traceability, transparency and security in Supply Chain. It describes a complete system for supply chain management in Agriculture using Blockchain. Their proposed system is a three-layered solution which uses smart contracts written involving Ethereum and relies on an Interplanetary File Storage System (IPFS), which ensures traceability, being deployed over Rinkeby. It also uses Remix IDE, Ganache & Metamask.

[2] gives a brief idea about recent trends in the system, how sustainability is achieved in Supply Chain Management. Blockchain increases transparency in the system and builds the trust between management entities. Social challenges include convincing the farmers in rural areas to adapt to required supply chain technology and diminish their hesitation regarding exploitation of data.

[3] elaborates how the current agricultural producers face many obstacles like the challenges posed by variations in seasons, easier handling of data, etc. Proposed Blockchain System tries to reduce involvement of third party and make transactions more transparent and secure.

In [4], the paper introduces tracking and tracing of origin of food products in supply chain from provider to consumer. They have used BigChainDB (MongoDB) for database, Linux (Ubuntu) as Operating System, Monit, Python 3.6 and code was written in Solidity language in the form of smart contracts.

Authors in [5] stored the data using blocks of blockchain system which are simultaneously connected to IoT-powered devices to get updated information about the product. Using this approach, system was made more traceable and point-to-point communication was achieved.

In [6], “Agri-BlockIoT”, a decentralized system was deployed using Hyperledger Sawtooth which focuses on traceability and the architecture ensures consistency and correctness.

[7] is an explanation of how the agriculture is getting affected by the industrial revolution taking place in the world. They are integrating the systems in a single chain in order to make work more transparent and efficient. The smart objects are beneficial in terms of speed, better output, virtual reality, etc.

Authors in [8] focus on understanding big data and using it in agricultural applications for minimizing agricultural wastes and enhancing farm yield. Big data is beneficial in guaranteeing that the supply chain is sustainable. The process involves 5 major steps: goal, data architecture, sustainability analysis, sustainability visualization and decision.

[9] explains the basic concepts of Blockchain technology and how its beneficial for Supply Chain Management and its challenges. It explains how traceability of product is possible through Supply Chain Management. Use of Blockchain provides high security to data, high tolerance to tampering, its easily visible to all the entities in the chain, provides authentication and one-to-many data integration.

[10] emphasizes on the current systems being centralized and relying on third parties to make transactions. Thus, the current systems are not trustworthy, cannot provide the required transparency to the cause. Thus, Blockchain was introduced in the system which are immutable, trusted and decentralized ledgers which make use of events and logs for providing transparency, traceability and tracking. The paper proposes a general solution using Blockchain for the PoD of physical objects irrespective of the number of transporters. The system makes use of IPFS for ensure integrity and eliminates use of third parties by introducing smart contracts.

[11] implements a system using Hyperledger Fabric that combines database and blockchain. The proposed system aims to provide a structured way to query information that also minimises load pressure. This also results in lesser manual work and fortification of data.

The aim in [12] is to mention various attacks like DNS, FAW, DDoS, Selfish mining attack, etc. on Blockchain Systems. They have explained two forms of inconsistencies which are Stale Block and Orphaned Block. They mostly explore attacks on public Blockchain systems.

[13] brings forward the relationship between the challenges in agri-food supply chain and the current patterns observed in 4.0 technology. It includes digital platforms (DP) and technological platforms.

[14] has focused on making the Supply Chain system decentralized using smart contracts, as centralized control fails to correctly supervise and manage incoming data. Ethereum smart

contracts are used to demonstrate Blockchain usage in the supply chain for soybeans. The participating entities in the system are (i) seed company (ii) farmer (iii) grain elevator (iv) grain processor (v) distributor (vi) retailer and (vii) customer. Every participating entity in the system communicates using their specific EA (Ethereum Address) and GPS Sensors are used to detect continuous monitoring of transactions happening.

[15] focuses on the safety and security of supplied grains, as well as fixing storage issues while using Blockchain. The proposed system was put to test for a wheat flour supply chain in Shandong, China. Five links of grain production, storage, processing, transportation and marketing were identified in the grain supply chain When the grains get owned by another link in the chain, a new code is created at that point to uniquely encode the current link and product. The paper has also proposed better storage of data using two databases, a node database, and an information database.

Authors in [16] go into detail about the issues faced by the current agricultural practices and then mention how DLTs would increase the safety, efficiency, transparency and traceability of the system. The paper suggests the use of QR codes, advanced RFIDs and crypto-anchors to help track the provenance of goods. It mentions that Blockchain would also help in the trade and shipping of agricultural goods by reducing the paperwork of documents/contracts.

III. METHODOLOGY

The proposed system involves four layers. In the first layer there exists user interface, whereas the second layer acts as a bridge to connect user interface with backend, the third layer is the backend which stores all the data while the fourth layer is used to track the product which provides the current phase of the product.

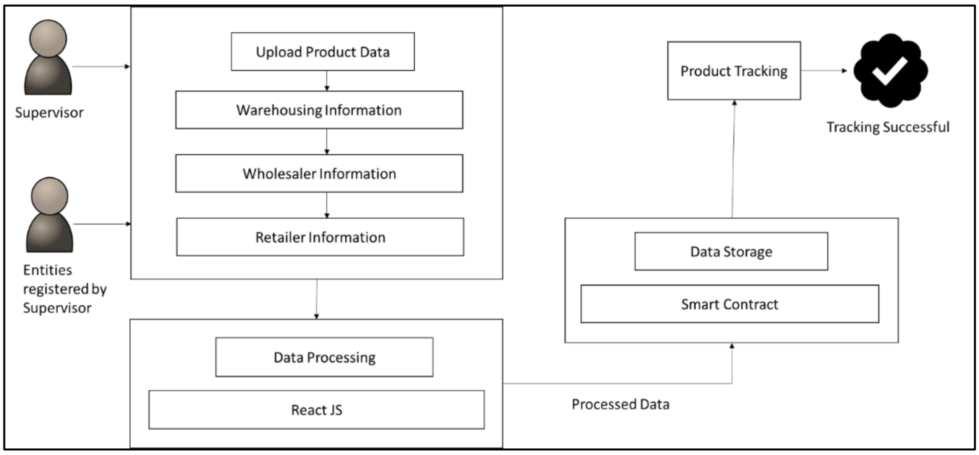

Fig 1. Proposed System Methodology

Layer 1 is the user interface which navigates through overall system. This is where the supervisor initializes the process of supply chain by registering all the necessary entities and supplying product information in the system.

Entities in the system:

a. Farmer:

It is the initial participant in the supply chain to use proposed interface after being registered by the supervisor. He supplies the product to be taken in next by the warehouser.

b. Warehouser:

In this case, the warehouse is used to store products supplied by the farmer before supplying them to other wholesalers. Usually, the products stored in warehouse exist in bulk.

c. Wholesaler:

Generally, the quantity of products stored by wholesaler is lesser than warehouse. Wholesaler buys the products from warehouser and keeps them ready for retailer.

d. Retailer:

Retailers buy products from wholesaler and stored them in their inventory. When the stock gets purchased by customers, the retailer marks them as sold.

These entities while being registered in the system provide their Ethereum address, name and location to the supervisor. The entities use their registered Ethereum address to gain access to their respective controls in the system.

Implementation of a Pharmaceutical Supply Chain using Blockchain was done in [17]. Using a similar approach, we have created the proposed system for our Supply Chain Management in Agriculture using Blockchain.

Layer 2 consists of the React JS framework along with Truffle and MetaMask. It ensures that transactions are carried out systematically and securely.

The React JS framework connects the user interface with smart contract and allows MetaMask to enable transactions using Web3.

The Truffle framework provides system with 10 test accounts along with their Ethereum addresses and private keys for demonstrating the system flow.

MetaMask acts as a bridge to connect Truffle framework and system environment to deploy transactions using test Ether.

Layer 3 is the data storing area. Here, all the product data for blockchain resides in blocks using smart contracts written in Solidity. The smart contract contains structures to store information about all entities as well as product details in a specific order. These structures are mapped and stored permanently on the blockchain. The contract also contains functions, one for the supervisor to add registered entities and another for the registered entities to trade products among themselves. This blockchain layer provides traceability, integrity, transparency to the system.

Layer 4 is the product tracking layer. Here, the product ID acts as tracking number which is mainly used to fetch the information about product regarding its current phase ranging from crop selection, crop harvesting, storage at warehouse and wholesaler, purchasing by retailer and selling of the product.

IV. RESULTS AND DISCUSSION

The performance of the proposed system was analysed using various evaluation parameters.

These include:

a. Loading Time: It describes the time taken by the page of a website to load.
b. Scripting Time: Time taken by the website to load, analyse and implement the JavaScript code is known as Scripting time.
c. Rendering time: Time taken by the website to load enough for the users to interact with is termed as Rendering time.
d. Painting Time: it is the time until the browser renders anything other than the default background.
e. System Time: It denotes the time needed for CPU and RAM utilization.
f. Idle Time: It is the time when the user is not interacting with the system.
g. Memory Utilization of the System: It represents the overall memory used by the proposed system.

Based on these parameters following result was obtained:

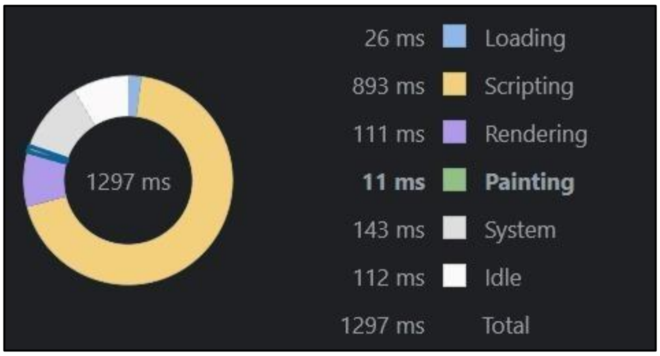

Fig 2. Performance Evaluation of Proposed System

The website is said to be good if the ideal website load time lies between 1-2 seconds. The proposed Supply Chain Management system website takes minimum 1.29 seconds to load. Thus, it can be said that the website is performing with moderate speed. The total amount of memory used by website is 17,797 kB i.e., 0.017 MB.

V. CONCLUSION:

The proposed Supply Chain system provides traceability to all participants in the system. Coordination is achieved between all members and transparency is ensured throughout the process. A user interface made with ReactJS allows easy access to the system and provides a clear display of the product with its current phase tracked. The system ensures participation of only authorised users and transactions are rejected if any anonymous users try to intervene.

Future additions to the system could involve availability of more languages other than English, for Indian usage. The system could involve security mechanism to prevent attacks on main blockchain storing the information. Data from blockchain could also be stored in additional storage space for added security.

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