Blockchain Based Agri-Food Supply Chain

Abstract:

Supply chains are evolving into automated and highly complex networks and are becoming an important source of potential benefits in the modern world. At the same time, consumers are now more interested in food product quality. However, it is challenging to track the provenance of data and maintain its traceability throughout the supply chain network. The traditional supply chains are centralised and they depend on a third party for trading. These centralised systems lack transparency, accountability and auditability. In our proposed solution, we have presented a complete solution for blockchain-based Agriculture and Food (Agri-Food) supply chain. It leverages the key features of blockchain and smart contracts, deployed over ethereum blockchain network. Although blockchain provides immutability of data and records in the network, it still fails to solve some major problems in supply chain management like credibility of the involved entities, accountability of the trading process and traceability of the products. Therefore, there is a need for a reliable system that ensures traceability, trust and delivery mechanism in the Agri-Food supply chain. In the proposed system, all transactions are written to blockchain which ultimately uploads the data to Interplanetary File Storage System (IPFS). The storage system returns a hash of the data which is stored on the blockchain and ensures an efficient, secure and reliable solution. Our system provides smart contracts along with their algorithms to show interaction of entities in the system. Furthermore, simulations and evaluation of smart contracts along with the security and vulnerability analyses are also presented in this work.

Existing system:

Food safety in recent times is a growing concern for commercial and academic industries. Most of the solutions till date are centralised and result in serious problems such as fraud, tampering and man-in-the-middle attack. Therefore, literature has introduced several blockchain-based traceability and information security in Agri-Food supply chain systems. Hereof, the author in has proposed a traceability scheme based on Hazard Analysis and Critical Control Points (HACCP), blockchain and IoT. Furthermore, blockchain along with its advantages has some disadvantages as well, i.e., it lacks scalability when data increases to a certain level. In this regard, BigChainDB is used to fill the gap which provides a scalable solution. The proposed solution is then applied to an example scenario to show the significant transparency and efficiency and how it favours HACCP regulations. However, the proposed scheme does not specify the current ownership details of products. In addition to this, a case study on product traceability is presented. According to the authors, tracing the provenance of products in the supply chain must be transparent, tamper-proof and adaptive to the changing environments.

Hence, we proposed a system which provides transparency, immutability and traceability.

Proposed System:

We have provided a traceability scheme for digitally tracking Agri-Food products from origin to end consumers. Our system introduces a trading and delivery mechanism to allow secure trading between entities of the Agri-Food supply chain. A reputation system is also used for the credibility assurance of these entities. The proposed model follows a layered architecture and is categorised into three layers. The first layer, i.e., data layer, handles the interactions between entities of Agri-food supply chains. These interactions involve the trading of products along with a proof of an auditable delivery. The second layer is the blockchain layer that handles the transactional data of the trading and delivery events. Also, it keeps track of the reputation of the entities involved in the system. To improve storage capabilities, the blockchain layer only keeps the hashes of the data and the actual data is stored on the third layer, i.e., storage layer. The blockchain layer enforces strict access control strategies to prevent unauthorised reads and writes to the storage layer. The third layer is essentially the storage layer and is solely responsible for storing the transactions' and events' data of blockchain on IPFS. As, IPFS is a decentralised storage medium, it leverages the proposed system with high throughput, low latency and scalability.

Software Tools:

1. Ganache
2. Truffle Suite
3. Metamask
4. Ethereum
5. Solidity
6. Web3.js
7. NodeJS
8. NPM

Hardware Tools:

1. Laptop
2. Operating System: Windows 11
3. RAM: 16GB
4. ROM: 4GB
5. Fast Internet Connectivity