SUPPLY CHAIN MANAGEMENT FOR AGRICULTURAL PRODUCTS USING BLOCKCHAIN

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Abstract

Supply chain management is a crucial component of contemporary businesses., but traditional supply chain systems face several data integrity, transparency, and security challenges. However, with the advent of Blockchain technology, these challenges can be addressed effectively. Blockchain technology offers a solution to these issues with its decentralized, immutable, and transparent ledger. By using blockchain, stakeholders can securely record transactions and track products, improving transparency and trust while reducing fraud. By incorporating blockchain, businesses can securely record transactions and track products, significantly improving transparency and trust while minimizing fraudulent activities. Additionally, blockchain can enhance various supply chain processes, including product traceability, provenance tracking, inventory management, and contract execution. This paper explores the utilization of blockchain technology to enhance supply chain management processes for businesses.

INTRODUCTION

Supply chain management involves the management of the movement of goods and services from the point of origin to the point of consumption. Supply chain management's main goal is to track and relate the production, delivery, and shipping of goods and services. Supply chain stakeholders collaborate to optimize resources, streamline processes, eliminate redundancies, and minimize inventory. Main goal of any business is to minimize supply chain costs and to bring in transparency. Approximately one-third of Agricultural products such as fruits and vegetables are wasted every year. The absence of authenticity and intervention middlemen make managing the supply chain difficult for these products. Incorporating Blockchain technology in the supply chain of agricultural products eradicates all these challenges.

Satoshi Nakamoto created Bitcoin in 2008, which led to the rise of blockchain. Independent stakeholders in the network have access to a shared set of data, without having to interact directly with each other. This creates a system where users don't have to rely on trusting each other, resulting in a trust less system that operates based on a consensus mechanism. In a blockchain system, all nodes are responsible for verifying and distributing data, rather than relying on a single centralized database.

A block in a Blockchain refers to a single unit of information that contains a set of transactions and other important details. These blocks are linked together in a linear chain and are secured using cryptography. The blocks are connected linearly by carrying the hash of the previous block, which is used to compute the current block hash. The first block in a blockchain, with no previous block hash, is called the "Genesis Block." The Blockchain network utilizes consensus mechanisms, such as proof of work (PoW) and proof of stake (PoS), to add new blocks to the network. Blockchain technology uses distributed ledgers to bundle transactions in cryptographically linked blocks, enabling peer-to-peer networks without a central middleman. Computational logic enhances security and ensures systematic protocols, boosting confidence in work process automation. Users can remain anonymous, and the ledger's immutability ensures records cannot be secretly altered.

Smart contracts can be securely conducted using blockchain technology due to its immutable and secure data storage. Smart contracts are contracts whose terms are directly coded into lines, which enables them to be self-executing on a blockchain network, thereby replacing traditional contracts. It is beneficial to establish pre-defined rules for a business relationship and codify the transaction protocol on a blockchain platform. This way, transactions can be executed automatically without intermediaries.

LITERATURE REVIEW

1. Dr Chetanpal Singh, Dr. Rahul Thakkar and Jatinder Warrinch et.al, The main objective of this paper is to examine how blockchain technology can affect the management of supply chains. The paper particularly focuses on the difficulties faced by global companies in this regard and the potential of blockchain to address these issues. In this paper, the research methodology, study selection, and evaluation processes have been outlined, along with the findings and discussions related to the implementation of blockchain technology in supply chain management. The paper also discusses the potential benefits and challenges of blockchain-based solutions and highlights the need for further research and integration with other emerging technologies. Moreover, it provides a comprehensive review of

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related literature, offering insights into the potential impact of blockchain technology on supply chain management, and emphasizes the importance of continued exploration and integration with other emerging technologies.

2. Ilham A Omar et.al, Discusses a proposed blockchain-based solution for inventory sharing in supply chains, using Ethereum smart contracts and decentralized storage. It addresses the challenges of information sharing in supply chains, such as system interoperability, information quality, confidentiality, and trust. The proposed solution aims to increase transparency, trust, and security in supply chain transactions. It includes smart contracts for secure information sharing, detailed algorithms, testing and validation, cost analysis, and security vulnerabilities. The proposed solution captures the main interactions between retailers and suppliers, aiming to reduce inefficiencies, improve information connectivity, and enhance trust among participating entities. It also discusses the changing role of retailers in the supply chain, the benefits of inventory sharing, and the challenges with existing sharing mechanisms. The proposed solution is validated through detailed testing and validation, and a cost and security analysis is provided to demonstrate its feasibility.

3.Yash Madhwal et.al, Development of a Proof of Delivery (PoD) smart contract using blockchain technology for supply chain management is discussed in this paper. It explores the use of Ethereum and alternative architectures to enhance flexibility and capabilities for supply chain management objectives. The study emphasizes the potential of blockchain and smart contracts to make delivery processes more efficient and reliable, reduce transaction costs, and improve performance measurements. It also highlights the need for further development of smart contracts and digital aids to handle qualitative inspections and proof of delivery generation during the delivery process. The document concludes by suggesting future research directions, including the digitalization of supply chains and the assessment of cost-investment implications.

4.Muhammad Nasir Mumtaz Bhutta et.al The primary focus of this project is to implement a secure supply chain management framework using Blockchain and Internet of Things (IoT) technologies. This framework will enable the traceability and real-time tracking of agricultural food supply during transportation. The system proposes a digital ledger to record and control individual shipments equipped with unique digital identification tags for tracking and tracing items.The project also introduces a machine learning-based architecture for predicting customer backorders. It compares the performance of different algorithms such as Support Vector Machine, K-Nearest Neighbours, Random Forest, and AdaBoost. The proposed Supply Chain Management system aims to ensure transaction integrity, immutability, and transparency throughout the supply chain. It addresses the challenges of contemporary mechanisms and presents the experimental and performance metrics of the proposed system.

EXISTING SYSTEM AND DRAWBACK

Traditional databases are widely used by organizations, including governments, retailers, e-commerce companies, healthcare organizations, and the automotive sector for supply chain management. They play a crucial role in storing, managing, and retrieving information related to inventory, orders, suppliers, logistics, and other critical aspects of the supply chain.

Major drawbacks of traditional databases are:

1. Centralized Database Systems: Traditional supply chain management systems typically rely on centralized databases that store and manage inventory, orders, shipments, and other relevant information. These databases are usually hosted on organization-managed servers.

2. Limited Transparency; Supply chain partners often face challenges due to limited transparency and controlled access to information in traditional databases, which results in difficulties in real-time visibility and collaboration.

3. Data Security Concerns: Organizations must prioritize security measures to safeguard sensitive information as it moves through the supply chain, due to the vulnerability of centralized databases to unauthorized access and data breaches.

4.Manual Processes and Paperwork: Many traditional supply chain management systems involve manual data entry and paperwork. This manual intervention can result in errors, delays, and inefficiencies in processes such as order processing, inventory management, and documentary

5. Limited Traceability: Traceability of products and components may be limited, making it challenging to quickly identify and address issues such as product recalls or quality concerns. The lack of a comprehensive audit trail can hinder accountability.

6. Challenges in Compliance Management: Meeting regulatory and compliance requirements can be challenging due to the fragmented nature of data and the need for manual documentation. This may result in a higher risk of non-compliance and regulatory issues

OBJECTIVES OF THE PROJECT

The agricultural industry faces supply chain challenges with transparency, traceability, and efficiency. Blockchain technology provides a solution to these challenges by creating an immutable ledger that enhances transparency and traceability. This makes it easier for consumers to verify the origin and quality of the products they purchase while optimizing operational

processes for farmers, distributors, and retailers. The integration of blockchain technology can streamline the supply chain by automating inventory tracking, order management, and payment processing.

PROPOSED WORK

This supply chain management project leverages the power of Ethereum blockchain and Web3 technology to address inefficiencies in traditional supply chain systems. Smart contracts, deployed on the Ethereum blockchain using Truffle, enable transparent and traceable transactions, fostering trust and security. The integration with a web application using Web3.js facilitates real-time communication with the blockchain, offering stakeholders a seamless and efficient platform. Through decentralized and automated processes, the project enhances provenance tracking, reduces counterfeiting risks, and improves overall supply chain visibility. The user interface provides stakeholders with intuitive access to product information, further streamlining interactions. A smart contract is a self-executing contract with the terms of the agreement directly written into code. These contracts are built on blockchain platforms, such as Ethereum, and they automatically enforce predefined rules and conditions without intermediaries.

SOLIDITY- Solidity is an object-oriented programming language designed by the Ethereum Network team for constructing smart contracts on Blockchain platforms. Smart contracts are utilized to execute business logic and create a chain of transaction records in the blockchain system.

WEB3: The concept of a decentralized internet constructed on blockchains, which are distributed ledgers managed collectively by participants, is gaining popularity. This new, blockchain-based internet, also known as Web3, is considered the future of the internet. It encompasses a vision that includes cryptocurrencies, dnon-fungible token, Decentralized Autonomous Organizations, decentralized finance, and other related technologies.

GANACHE: This tool allows developers to create a local blockchain network for testing and development, facilitating the simulation of various scenarios and troubleshooting of errors. Essentially, it is a decentralized application that runs on Ethereum and Corda, providing a safe environment for developers to work on their projects.

METAMASK: It is a key used to access Ethereum. It is a wallet that safely stores data and helps access the internet and next-generation applications securely.

TRUFFLE: Truffle is a robust tool designed to simplify the work of developers. It is a comprehensive framework for blockchain asset pipeline, testing, and development environment based on Ethereum Virtual Machine. When used with Drizzle, a front-end development kit, and Ganache, a personal blockchain, the entire Truffle toolkit serves as a complete App development platform.

Workflow

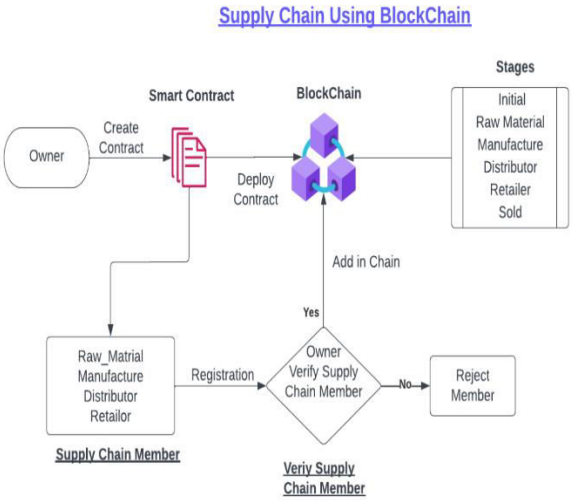

Figure 2: Flow Diagram of the proposed model

In the proposed system each member in the supply chain should register in the blockchain. The members are namely supplier, retailer, distributor, consumer.

Each member has a metamask wallet through which transaction takes place.Once the transaction is done the information is updated in the blocks and sent to all the nodes. Likewise, the transaction and data is entered in the block by subsequent members. Each block is added to the blockchain through consensus mechanism meaning whenever a new block is added it needs the validation of blocks in the blockchain. In the context of supply chains, a blockchain can be used to track the movement of goods and materials from one stage of the supply chain to another. This can help to improve efficiency and transparency, and to reduce the risk of fraud.

Create Smart Contract: A smart contract is a self-executing contract that is stored on the blockchain. It can be used to automate the supply chain process. In this step, a smart contract is created to track the movement of goods and materials.

Initial Stages: The raw materials for the product are identified and registered on the blockchain. The owner of the raw materials is also identified.

Manufacture: The raw materials are manufactured into a product. The manufacturer is then identified and added to the blockchain.

Distributor: The product is shipped to a distributor. The distributor is then identified and added to the blockchain.

Retailer: The product is shipped to a retailer. The retailer is then identified and added to the blockchain.

Sold: The product is sold to a customer.

Add to Chain: At each stage of the supply chain, the relevant information is added to the blockchain. This information can include the location of the product, the condition of the product, and the identity of the person who is currently in possession of the product.

Verify Supply Chain Member: When a product reaches a new stage in the supply chain, the new member can verify the authenticity of the product by checking the blockchain. This helps to ensure that the product is genuine and has not been tampered with.

The diagram displays a registration process that can be utilized to include participants in the supply chain to a blockchain. This method guarantees that only authorized participants can take part in the supply chain. When a member enters data inside a block in a blockchain, the data is transmitted to all members. The entirety of the data is then stored in the blockchain.

Blockchain can revolutionize supply chain management by improving efficiency, transparency, and security, leading to saving costs, reducing risks, and enhancing customer satisfaction.

APPLICATIONS OF THE PROJECT

Blockchain technology has various applications within agricultural supply chains, offering solutions to various challenges encountered by stakeholders at different stages of the production and distribution process.

1. Traceability and Transparency: Tracks agricultural products from farm to fork, ensuring quality compliance and authenticity.

2. Supply Chain Management: Automated supply chain management through blockchain-based smart contracts reduces paperwork and overhead by enabling automated execution of agreements and payments.

3. Quality Assurance and Certification: Stakeholders can maintain the quality and authenticity of agricultural products by recording important information such as farming practices, inspection reports, and certifications on the blockchain. This is especially crucial for products with certifications such as organic and fair trade, which require authenticity.

4. Market Access and Fair Trade: Blockchain can enable small farmers to have better market access and fairer trading opportunities. Transparent and decentralized platforms enable farmers to connect with buyers directly, eliminating intermediaries and ensuring fair compensation for their produce.

5. Risk Management and Compliance: Blockchain can reduce risks from fraud, counterfeiting, and supply chain issues by providing real-time visibility. This enhances compliance and enables timely responses to critical issues such as product recalls or contamination incidents.

CONCLUSION

Blockchain's transparency, immutability, and decentralization can improve supply chain traceability, efficiency, and trust. By implementing blockchain, farmers, distributors, retailers, and consumers can access real-time data about the origin, production processes, and transportation of agricultural products. This transparency not only ensures the authenticity and quality of products but also enables quicker responses to issues such as food safety recalls or supply chain disruptions. Blockchain automates administrative tasks, reduces paperwork, streamlines processes, minimizes human errors, and enhances the security and integrity of supply chain data. Smart contracts automate payment settlements, reduce disputes, and ensure fair compensation for all parties, combating fraud, counterfeit products, and unethical practices in agriculture. The use of blockchain technology in the management of agriculture supply chains has the potential to revolutionize the industry by fostering transparency, efficiency, and trust among all stakeholders. By adopting blockchain, the agricultural sector can overcome its current challenges and create a future that is more sustainable, transparent, and resilient

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