BLOCKCHAIN'S BENEFITS FOR SUPPLY CHAINS: AN ANALYSIS OF THE FOOD SUPPLY CHAIN

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ABSTRACT

The current supply chain either directly or indirectly satisfies supply needs; it is a linear economy model. However, this model has a few drawbacks. such as the connections amongst supply chain participants or the dearth of information available to consumers regarding the products' place of origin. We present a novel supply chain model using block chain technology in this paper. With the help of this new model, the concept of circular economy and gets rid of a lot of the supply chain's drawbacks. For this paper, a multi-agent system is developed to coordinate all the supply chain transactions that occur.

Keywords: Block chain; agriculture supply chain; smart contract; circular economy; multi-agent system;

INTRODUCTION

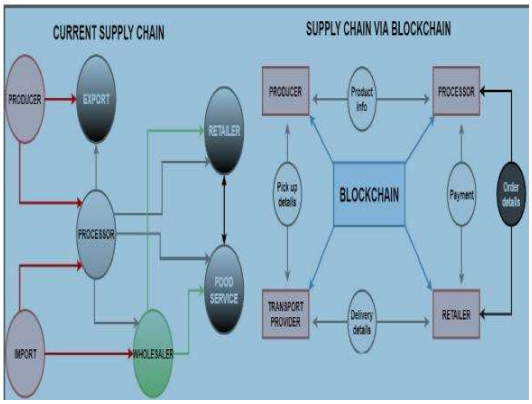
Numerous industries, including finance [1][2], healthcare [5], other sectors [37], utilities, and the government sector, are now showing interest in block chain technology. The cause of this increasing curiosity is: A block chain could be used to run apps that previously required a reliable middleman. They can now accomplish the same functionality with the same level of reliability by operating decentralized and without the requirement for a verification system. Prior to the creation of the block chain, this was not feasible. As block chain technology was put into practice, trustless networks emerged. This is made possible by the fact that block chain-based networks allow for transfer operations to be completed without requiring user trust [8]. When there are no middlemen involved, user transactions happen more quickly. Furthermore, the block chain's use of cryptography guarantees the security of the data[20]. Block chain is a massive accounting ledger that keeps track of every user transaction. This prompts Internet of Things (IoT) researchers and developers to explore for methods to integrate IoT with block chain[23][29]. These days, a company's supply chain, which deals with moving goods between parties, is its main focus. The issue with this industry, though, is that it is so large that it can cause other problems in addition to delays and defaults in the delivery of goods. To meet all of the demands of stores, large distributors also require a large number of workers. All of this could lead to significant delays in order processing and raise the risk of order loss [20]. Companies have automated all of their processes in an effort to address this issue, which has led to a notable rise in the number of companies and distributors in the supply chain. But as more information becomes digitalized and as Internet businesses grow, there is a higher chance that their databases will be attacked. Data may be modified, stolen, or deleted by hackers[7][36].

We propose an alternative approach to this problem. In our case study, which focuses on the supply chain for agriculture, we will examine two distinct situations[21].First, by using block chain technology, we secure the data of the businesses participating in the supply chain. Second, the organization's problem will be solved by multi-agent systems[22]. Multi-agent systems have been shown to offer effective solutions for a wide range of issues [39]. These include, but are not restricted to, real-time issues [6], decentralized network control [27], Internet of Things applications [15], and the use of agents for image classification [16][14]. We offer a novel supply chain model in this paper. Utilizing the circular economy in supply chains is made possible by this new model. Further to MASs are made in order to manage all activities within the supply chain. Agents are designated in each supply chain member to oversee all activities and transactions conducted by that supply chain member.

RELATED PROJECTS

A distributed data structure that is shared and replicated by network participants is called a block chain[26].It was first presented with Bit coin [28] in order to address the issue of double-spending [12]. Because of the way the nodes. The Bit coin

block chain identifies the owners and specifies what they own, and users, known as miners, mutually validate the agreed-upon transactions [13]. Cryptography is used to create a block chain. Every block is uniquely identified by a crypto graphic hash, and every block makes reference to the hash of the block before it. As a result, a block chain is formed, linking the blocks together [2][7]. Because of this, A set of public and private keys can be used by users to communicate with a block chain. In a block chain, miners must concur on the transactions and their chronological order. If not, there may be a fork in which case the separate copies of this block chain diverge, giving miners conflicting perspectives on the transactions that have taken place. Until the fork is resolved, a single block chain cannot be maintained [30][32]. Every block chain network needs a distributed consensus mechanism to address this [37]. Each block chain node can link to the next block, which is how block chain resolves the fork issue. All that needs to be done is find the right random number using SHA-256 [1][8], [19], so you have the number of zeros that block chain anticipates. The next block in the chain can be shaped by any node that can solve this puzzle and generate the so-called proof-of-work (pow) [10]. Because a one-way cryptographic hash function is used, it is simple for any other node to confirm that the provided response meets the criteria. Keep in mind that a network fork could still happen if two rival nodes mine blocks nearly at the same time. Usually, these forks are automatically fixed by the following block. Smart contracts are included with the block chain implementation to speed up and improve the efficiency of user-to-user transactions [17]. A smart contract is "a computerized transaction protocol that executes the terms of a contract," according to Nick Szabo, who introduced the idea in 1994 [34]. Szabo proposed transferring contract clauses to code, which would eliminate the need for middlemen in party transactions. A script that is kept on a block chain is referred to as a smart contract in the context of block chains [35]. Smart contracts are part of blocks that are uniquely identified by hashes, giving them a distinct address on a block chain. By providing the block chain address in a transaction, we can activate a smart contract. It is carried out on each network node autonomously and automatically in accordance with the information in the triggered transaction . A computerized system made up of several intelligent agents interacting with one another is called a multi-agent system. With excellent outcomes, multi-agent systems are used to solve complicated problems. Multiple applications make use of multi-agent systems. A multi-agent system for the intelligent use of electricity is presented by the authors in [33].in a smart home, increasing its energy efficiency as a result. Multi-agent systems have also successfully addressed the issue of sound monitoring in a range of scenarios [24]. Implementing a multi-agent system



Current agriculture supply chain model (Fig. 1) is a linear model derived from producers, importers, retailers, and foodservice providers. Supply chains are now decentralized and all transactions are recorded in the block chain; each chain member is able to enter their transaction on the block chain; members of the supply chain can only read those blocks on the block chain that directly relate to them. Current agriculture supply chain model (Fig. 1) is a linear model derived from producers, importers, retailers, and foodservice providers. Supply chains are now decentralized and all transactions are recorded in the block chain; each chain member is able to enter their transaction on the block chain; members of the supply chain can only read those blocks on the block chain that directly relate to them

Since the problem of logistics is not new, in [25] a multi-agent system is proposed to solve the logistical problem. Additionally, in [3], the problem of distributed computing is another successful application of multi-agent systems. Therefore, some of the proposals that we find in the literature combine the advantages of block chain and multi-agent systems. The work of [40] is noteworthy because it proposes the use of both

technologies to increase security and privacy in decentralized energy networks. In [38], authors propose a model that uses both block chain and agents for a real-time sharing system. There are additional applications of both block chain and multi-agent systems. This paper describes a case study that verified the proposed model, with a focus on the agriculture supply chains sector. In [11], the authors propose an innovative block chain model for the Internet of Things. However, after examining the state of the art, we believe that the current block chain and multi-agent system models have some shortcomings. We therefore propose a new model that leverages smart contracts and multi-agent systems, with the goal of increasing efficiency in the logistics system management.

APPROACH AND CASE STUDY

This paper presents a new model for tracking food in the agriculture supply chain. The proposed model uses block chain, smart contracts, and MAS to coordinate the tracking of food in the supply chain. By implementing this new model, the current agriculture supply chain has improved based on the block chain's version. The current supply chain and supply chain architectures via block chain are shown in Fig.1. The advantages of the new supply chain model are discussed below. 1) Current supply chain: The current model starts with the producer and the retailer. These two supply chain members send their products and data to the next layer of the supply chain. At this next layer are the export, The middle layer comprises the processor and the wholesaler, processing the basic products received by the supply chain. The final layer consists of the retailer and the food service, which provides the products. The primary drawback of this model is that data is centralized within each supply chain element, making it impossible for other elements to see transactions. This primarily means that consumers are unable to verify the source of the food they are purchasing or ensure the reliability of their data.2) Supply chain via block chain: This new model corrects the disadvantages of the current supply chain. The data is decentralized and each member can read important data for its operations in the block chain. For example, the producer can view the product info of the processor and the pick-up detail from the transport provider. The model changes with the addition of block chain to the agriculture supply chain. Now, all members of the supply chains save all of their transactions in the block chain, enabling a higher security in the transactions.

This new model can be accessed through blockchain. To manage all the participants in the supply chain,

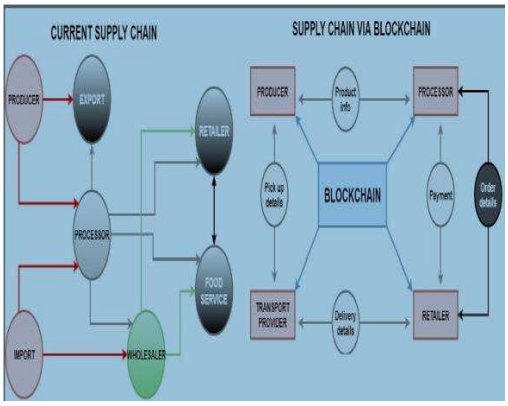


Figure 2: Block chain-based MAS architecture for supply chain. Data from each layer's transactions is sent to the block chain. Furthermore, smart contracts are used to facilitate communication between the layers that oversee the articles. The purpose of these smart contracts is to buy and sell goods.

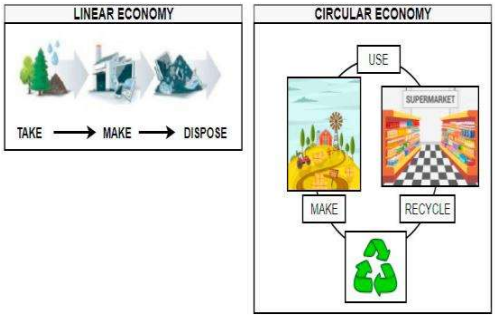


Figure 3. The linear and circular economy concepts are depicted in the figure. The use of block chain makes this modification to the market model possible.

The creation of MAS (see Fig.2). Five layers make up the MAS: The producer agent is located in the producer layer. This agent handles all of the producer's tasks, including purchasing supplies and marketing finished goods. 2) The processor agent is located in the processor layer. All of the activities carried out in this layer, such as purchasing raw materials, marketing goods, hiring transportation companies, etc., are coordinated by this agent. 3) The transport provider agent is located in the transport layer. All transportation between the other participants in the supply chain is coordinated by this agent. 4) The retailer agent is located in the retailer layer. The purchasing of materials from the processor and the sale to the customer are coordinated by this agent. Mt. This agent maintains synchronization with the agents of the other tiers to ensure accurate block chain storage of all transaction data. Through block chain technology, this new supply chain makes possible the circular economy, a new market paradigm. Figure 3 shows how the market model has changed. whereas the Take-Make-Dispose paradigm is used in the current supply chain. Block chain-enabled supply chain makes the circular economy model possible. The Make-Use-Recycle model is the foundation of this new market model. The economy is now able to sustain itself thanks to this new model. All products can be tracked using block chain technology, from the point of origin to the point of sale and recycling.

CONVERSATION AND NEXT STEPS

The novelty of this paper lies in a block chain to store all transaction information in the supply chain of the proposed case study. Additionally, the multi-agent system uses smart contracts to manage the entire supply chain process more efficiently, as smart contracts eliminate middlemen and enable the circular economy market. This paper presents a new block chain approach to improving the current supply chain. Since our model is automated by the agent system, it can be used to improve any supply chain. The case study conducted for this proposal focuses on the agriculture sector. By integrating block chain, we provide the agriculture system with robust security features, such as the ability to track shipments, authenticate origins and destinations, and store and unmanaged proof of transactions.

Agents who check that both parties follow the terms of a smart contract are another novel feature of this paper. If the agents discover that one of the parties is not meeting the agreed-upon conditions, they will impose a penalty and the agents will keep the money in the entity until the conditions are met. This makes our model more efficient than existing models and allows for the tracking and authentication of orders. Additionally, a ranking and award system will be introduced via block chain into the supply chain to recognize and reward members who most closely fulfill this new supply chain model. Future research directions include developing new agents to monitor procedures in the multi-agent system and integrating a case-based reasoning system (CBR) to improve our model.

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