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A Survey on Blockchain-Based Supply Chain Management in Agriculture

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Abstract: India is one of the fifth largest economies in the world by nominal GDP with 70 per cent of the rural households still depending on agriculture as their primary source of livelihood. India is responsible for 7.39 per cent of total world agricultural production. But the agricultural supply chain used in India is inefficient and caters less to the producer. Farmers who are the producers get very less profit from selling their produce. It is estimated that about 80 percent of the profits are secured by the middlemen who have significant control over the agriculture trade in the country. The lack of communication between different stages in the chain and data transparency is also one of the major reasons why the current supply chain in India is flawed. Proper communication is essential in any system to avoid the spread of any misinformation and at each stage in the supply chain sensors are required to share data with the users so that information is collected and made available to everyone concerned with the particular transaction of goods. The combination of blockchain and IoT in the agricultural sector can provide a better supply chain system from the ground up which addresses communication and transparency issues suffered by the latter systems.

Keywords: blockchain, IoT, agriculture, India, supply chain

1. INTRODUCTION

Agriculture is a primary contributor to India's gross domestic product (GDP). According to the yearly stats provided by the government for Financial Years 2017-2021, we can notice that there is an increase in employment for agricultural jobs. In 2017 the employees in the agricultural sector counted 145.66 million and despite the outbreak of the coronavirus pandemic, the number of employees in 2020 increased to 145.88 million, and the next year India witnessed an even steeper increase with 151.79 million employees joining the agriculture sector. There was about a 4.21% increase in the number of employees from the year 2017-2021. Since it is one of the most active sectors in India it is vital that they have an efficient supply chain that is efficient, fair and rewarding.

A supply chain is a network of facilities helpful in getting the product from production to its eventual distribution to consumers. The supply chain plays a vital role in any industry as it helps the company/organization in managing inventory so as to stock the optimal amount of supplies needed to hit their sales target, better forecasting to predict their future sales and profit margins and improve relationships with suppliers. The agricultural supply chain in India has four different entities, producers(farmers), processors, distributors and retailers.

The supply chain currently in use has a lot of issues. Some of these issues are mentioned below:

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- Middlemen in the system pocket most of the profits which makes it less rewarding for the producers and ultimately demotivates them, resorting to growing low quality crops as they could get the same amount of profits from producing lower quality crops rather than spending more money on growing and maintaining higher quality crops.
- Lack of communication between different levels in the supply chain leads to poor information exchange and knowledge transfer. The middlemen in the chain have the most knowledge. The market information known by the distributor is not shared with the producer. This allows the distributor to make more profits as he sells the product directly to the consumer and this information would not be revealed to the producer.
- Lack of proper storage facilities among the producers leads to wastage of harvested crops. Certain crops require constant controlled temperatures if such storage facilities aren't made available then the producer will incur losses.

A Blockchain is a decentralized database with a special digital file called the ledger which is available to every node in a network. In a Blockchain The transactions are recorded and distributed, The nodes in the Network do not hold the privilege to edit this special file. Thus we can say that the ledger is immutable, thereby securing the transactions that are recorded,

they cannot be altered, deleted or destroyed. This is more of an efficient way to allow companies to complete their transactions without the requirement of third parties.

The foundation set by blockchain makes the relationship between vendors and suppliers more transparent and trustworthy. As mentioned in [8] trust and decentralization are the two most important requirements in SCM which can be delivered by implementing blockchain in it. As mentioned in the discussion earlier issues related to SCM are related to distrust, information exchange, commitment, and transparency. Blockchain addresses these shortcomings using the following features:

1. Immutable data documentation
2. Distributed Storage
3. Authorized user permissions

2. PURPOSE

In all of the subjects and motives put forth by the articles Referred, The system proposed by the authors is inadequate to solve all the problems faced in Agricultural Supply chain management, To address problems like Management, Traceability and Storage of data, various solutions are presented and putting it all together and deriving a system capable of eliminating any more shortcomings which is our goal.

3. LITERATURE REVIEW

In this section, we analyze the previous systems proposed in order to understand the current situation of blockchain in the field of agriculture. The authors of [1] portray a system to ensure the traceability of Agri-food items from producers to consumers coupled with a reputation system, the trust of an entity in the blockchain is based on the trust values stored in it. The higher the trust value of the entity more is its reliability. This system provides a trading and delivery mechanism that ensures product authenticity by avoiding the manipulation of information by the Logistic Company(LC) during the transaction. Efficient tracking of the product is explained in [2] by using a unique digital identification tag, location and navigation sensors with every item that helps keep track of them. Sensors can send the real-time data collected continuously to the application by making use of IoT architecture to provide a clear path for data to travel from the sensor to the application for processing. Digital code scanners installed in the entry and exit points of the warehouses inform the application about the product's status, this gives the entities in the supply chain more clarity about the product being shipped and its location in real-time. A more theoretical understanding of implementing blockchain-based agriculture systems is given in the paper [3]. The paper mainly talks about the communication problems between different levels in the supply chain.Market research done by the higher tier entities(retailers, distributors, etc) is not shared with the lower tier entities(producers) and minimal knowledge transfer between the higher and lower level entities in the chain may lead to the disproportionate supply of products which causes unnecessary wastage or shortage of goods. These communication issues in the supply chain are to be solved by using a blockchain architecture that stores each transaction in it with a timestamp so as to avoid the manipulation of data by third parties. The transparency of the system is ensured by the miners and forgers who gather all the transactions taking place in the system and add it to the chain so that the data is made publicly available.There are many individuals in the network working towards their personal goals and these can be achieved by using smart contracts. Smart Contracts are implemented in such a way that the system isn't biased to any one tier in the supply chain but rather a solution to achieve a level playing field. With the decreasing quality of crops being grown on farms due to the use of pesticides, the demand for organic crops has risen in recent times. [4] talks about introducing organic crops with valid and authentic certifications, into a public blockchain. This will ensure better food quality for the consumer and thereby an increased demand for the product. The tracking mechanism of the product in the chain involved the usage of trackers on the container as a whole rather than each product present in it. Thereby the container was tracked rather than the product. The methodology talks about the development of a DApp, wherein smart transaction models were developed on solidity and a QR code model was implemented to validate the products. QR code acted as the point of contact between the physical and digital worlds. The product contract could be deployed only by the farmers in order to indicate a physical product. They need to maintain a minimum reputation level in order to issue a product contract. Each product contract deployed, an address will be returned which will be used to generate a QR code that will help identify the product physically. The history of the product would be added to each smart contract within each transaction. They were then updated with new owners irrespective of whether it was sold. Smart contracts ensure trust between users as it regulates the rules. A major highlight of this paper is its reputation system. At the start of the certification process, persons are identified to take part in the validation process. In order to gain a reputation, the farmer needs to place a request which needs to be validated by agriculture officers and other related people. The motivation for others to take part in validating the farmer's transaction is that they are rewarded with reputation points. All the events would be stored in the blockchain as soon as the validation process would return a success. The paper [5] summarizes the concept of using NFC(Near Field Communication), RF ID (Radio Frequency Identification) and QR codes in product delivery which is to ensure the safety of the product and also that either wholesaler, consumer or retailer knows the complete information and details that they must know about the product. By knowing the characteristics of each of the enhancing features like that mentioned, we can enhance safety in the system. The NFC tag is used to track and trace the product in its current path from the manufacturer till it reaches the consumer. Similarly, in the case of RFID tags, they are used to track the product but also the consumer can detect counterfeit. The next module is the QR code, this is another similar implementation of NFC and RFID. QR Codes also ensure that the product is not duplicated hence maintaining consistency in product delivery. [6] conveys the entirety of the management module of medical equipment, and the difficulties faced by the manufacturers, distributors, suppliers and consumers. This article also delivers the standard requirement to price highly consumable stock and the stock that is stored for a long time unused. Comparing this to the various agricultural products, their management and pricing is also an important aspect that needs to be taken into consideration. Various distributors have facilities not large enough to store the incoming stock which may be returned or sold, this paper gives us a solution to deal with this problem. To effectively cost the product is to the consumer so as to not transmit the loss in the chain of Retailers, Suppliers, Dealers, Distributors, manufacturers and producers, Effective management of these goods also plays a vital role in the pricing of the product along with the charges of its storage, production and processing. In the paper [7] blockchain can be coupled with IoT, to monitor the process and the condition of

goods. Whenever goods are transported by farmers, the qualitative and quantitative details are measured and collected via a form and stored in the blockchain. The obtained parameters are verified by the smart contract. Farmers and consumers are informed about the condition of the goods measured using IoT. Sensors placed at each stage of SCM(in Storage and Transportation vehicles). Changes in market price are also incorporated in the blockchain, when the products are sold, information about the quantity and the profit is added to the blockchain for farmers' understanding of the market scenario.

4. CHALLENGES

Considering the technologies being used in various systems proposed, this survey requires a basic understanding of several domains such as Blockchain, IoT, Computer vision, Agricultural Science, Operations management, logistics, procurement, and information technology. Having such knowledge beforehand helps navigate through all the papers referred to. There are many choices for papers with similar discussions on the chosen topic which led to selecting only those papers which helped give a clearer picture of the said matter. All of the papers that we chose had relevant points to understanding the flaws of the system and how to put right every wrong turn, some papers talk about correcting the system and a few list improvements to the suggested system. we could not pick one way to perfect the system which led us to choose one of the many paths that were laid out before us. Thus we chose to eliminate only the difficulties that might cause the producer i.e the farmer, to face the main issue to address as mentioned in many of the papers we reviewed.

5. FIGURES/CAPTIONS

a) Current System: With reference to the earlier discussion current system of SCM is referred to in “Fig. 1”.

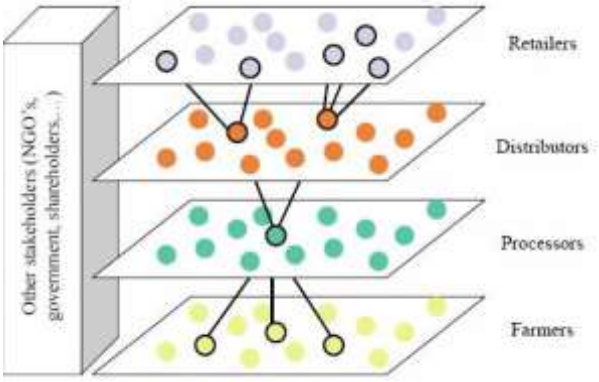

Fig. 1. Note: Systematic flow of Supply Chain in Agriculture from a processor point of view. Reprinted from [9] the issue, pp. 4.

b) Proposed System: As mentioned in [2] the proposed framework of the system with implementing blockchain in Supply Chain Management.

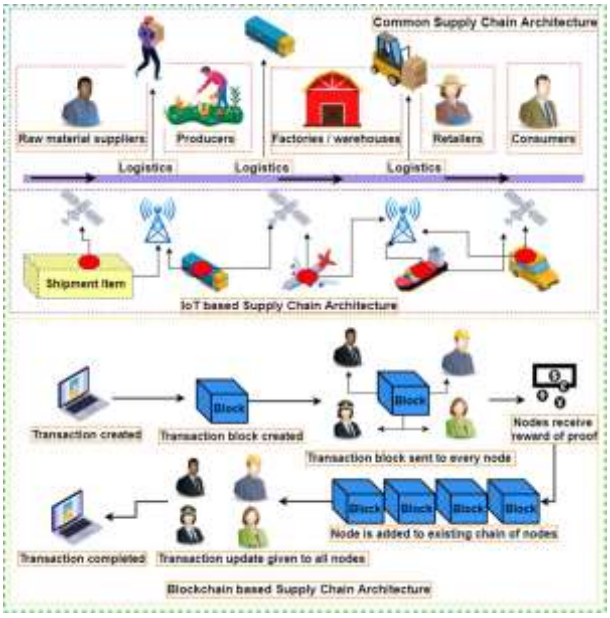

Fig. 2. Note: Blockchain and IoT-based Supply Chain Management Framework Reprinted from [2].

6. CONCLUSION

This survey includes referencing various papers which bring about the detailed architecture of Supply Chain Management and also understand its shortcomings. Some of the research papers like [1], [3], [4], [7] propose a solution to various issues in Supply Chain Management(SCM) like distrust, communication issues, commitment issues and consistency. Addressing all these issues we have concluded that blockchain along with IoT could be a possible solution for the inadequate existing SCM. This proposal is efficient and reliable. Throughout the discussion, in the paper, we talk about various blockchain properties like transparency, decentralization and security addressing those issues mentioned above about the SCM. This survey also follows up with the implementation of the solution with detailed research.

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