STUDY ON TRANSPARENCY AND TRACEABILITY OF AGRICULTURE-BASED PRODUCTS USING BLOCKCHAIN

Prof. Nikita Y. Kapadnis*1, Sanket Makh*2, Kedar Koshti*3

*1Assistant Professor, Pune Institute Of Computer Technology (PICT), Pune, India.

*2,3Student, Computer Engineering, Pune Institute Of Computer Technology (PICT), Pune, India.

ABSTRACT

Agri-product supply chains are currently inefficient due to a number of factors, including climatic conditions and problems with traditional supply chains related to centralised management, lack of storage, without proper practices, increase in counterfeiting a brand, faults in shipment, hoarding of products by distributors, transportation problem, number of intermediaries in the market, malpractice, lack of grading, untrustworthiness, selling of product by shopkeepers after shelf life and lack of security in agriculture product, which have caused problems for farmers. Despite the fact that climatic conditions are mostly beyond human control, other factors such as supply chain management can be improved.

By using Blockchain as a solution for the above problems, we can create a traceability system of immutable blocks that can trace the entire life-cycle of a food product from its production to its delivery to the customer, which can be accessible to everyone using smart contracts inside Hyperledger Fabric. The technical components of this work are cryptographic technique (SHA-256), authentication, structural data, and consensual processes. In the referred system, a generic framework for decentralized application is built between a network of computers to ensure immutable trustworthy, and secured transactions. Due to blockchain's properties, transaction records are tracked more effectively, security as well as immutability are enhanced, minting is made possible and faster settlement is made possible. The purpose of our work will be to improve the loopholes in recent research papers.

Keywords: Blockchain, Smart Contracts, Supply-Chain Management, Agricultural Food Products, Traceability, Transparency, Ethereum.

I.   INTRODUCTION

A supply chain management (SCM) activity involves the movement of goods from a producer to a consumer. Basically, it is the process of managing the goods from the production to the final product. In this network, manufacturers, suppliers, retailers, and clients are all independent or semi-independent businesses that work together in order to manufacture and distribute goods. It covers all from item improvement, sourcing, generation, coordination, and the data frameworks required to facilitate these exercises. Since early times, supply chains have occurred, starting with the first item shaped or service formed and sold. The success of the SCM depends upon how well each component in the process interact. But with industrialization and globalization, SCM got to be more refined, permitting companies to do more proficient work of creating and conveying merchandise and administrations. Organizations can now identify failure before it occurs and take proactive measures to prevent it, such as in agriculture, every phase in the supply chain is vital as the goods are sensitive to the temperature and time. They make an exact estimate that supports meeting client requests and monetary goals simultaneously. Every node in the supply chain network must be concurred upon and flexible in response to the needs of the consumer and competent in dealing with issues such as tracking, exchange approaches, shipping modes, and so on. Organisations can now identify/predict failure before it occurs and take proactive measures to prevent it. Every node in the supply chain network must be concurred upon and flexible in response to the needs of the consumer and competent in dealing with issues such as tracking, exchange approaches, shipping modes, and so on. They make an exact estimate that supports meeting client requests and monetary goals simultaneously. So, while discussing the SCM, we discover that there are few issues with present SCM, those are -

1) Present blockchain (BC) in centralized, hence time-consuming, expensive and it lacks essential functionality for market analysis.

2) The complexity of supply chains and value networks adds a high cost to supply chain players, which the customer eventually absorbs. The data in the majority of the documents are kept on BC, which is an expensive procedure.

3) Currently businesses use a single warehouse, with managers that are responsible to keep track of information, where this data is not beneficial for company's growth, and can be misinterpreted easily, which can result in venture's mistrust of the companies. Also, there is no pricing transparency because of middlemen.

4) Goods only travel in one direction in today's supply chain management, which make faulty products.

These issues can't be fully resolved, but we can use decentralized databases to tackle a few of the issues, like building decentralised networks for decentralising the stages in SCM and building trust over the system.

Distributed databases or ledgers shared among computer network nodes are known as blockchains. The blockchain stores digital information electronically as a database. Cryptocurrency systems, such as Bitcoin, rely heavily on blockchains to maintain decentralized and secure records of transactions. In a blockchain, fidelity and security are guaranteed, and trust can be generated without the need for an intermediary.

To more effectively manage the supply chain, blockchain supply chains can allow participants to record and maintain price, date, temperature, location, quality, and certification information. Before adding a transaction to a block, the transactions are verified by all the parties. A block is linked to the other block in the network by including the hash value of the previous block. In addition to improving transparency and compliance over outsourced contract manufacturing, blockchain can also enhance a company's position as a leader in responsible manufacturing by increasing traceability of its material supply chain, reducing counterfeit and grey market losses, and improving visibility and compliance over outsourced contract manufacturing.

The Blockchain, the transaction can be successfully created only if the constraints specified in the applications are satisfied. The Ethereum Virtual Machine (EVM) is the execution unit of the Ethereum network. The EVM contains details about all live accounts and smart contracts. It is responsible for maintaining a deterministic state at any given time in the blockchain. The smart contract contains the code for all the agreements. EVM executes this program line by line. The initiation of a transaction is done by invoking the program in a smart contract. All the agreements to be executed are in the form of condition statements. When all the requirements are satisfied, the action followed by it takes place. When the transaction is successful, next, it must be added to a block. Miners are responsible for this action. More than one miner competes to add a transaction to the block. Among them, the miner solving the puzzle adds the transaction to the block and notifies the solution to others. They will verify the work and if it is correct, the transaction is added to the block. This job is known as Proof of Work (PoW). Thus, by increasing the size of the Blockchain, the security of the transaction is increased. This paper confirms the significant advantages of employing the blockchain technology with IoT in agriculture domain. In addition, it outlines the effort that should be taken to employ this kind of new technology in age old but essential services like agriculture.

Here are some of why BC technology has gained so much popularity.

1) Unalterable/anti-tampering transactions: BC guarantees the inalterability of all operations by registering transactions in chronological sequence. When a new block is added to the existing BC, it cannot be withdrawn or customized. This increases openness and ensures that all transactions are permanent.

2) Fraud prevention: The ideas of shared knowledge and consensus help to reduce fraud and embezzlement losses. BC as a monitoring tool reduces expenses in logistics-based companies.

3) Reliability: Because a copy of the original BC is available to each participant, the distributed ledger (DLT) technology stays operational even if a substantial number of other nodes fail.

4) Time reduction: BC can play a critical role by enabling faster trade settlement since it eliminates the need for a lengthy process of verification, settlement, and clearing because all parties have access to a single version of agreed-upon data from the shared ledger.

5) Collaboration: Facilitates direct communication between parties without the need for a third party to serve as a middleman.

6) Security: The identities of the interested parties are certified and verified via BC. This eliminates duplicate records, lowers rates, and speeds up transactions.

7) Transparency: The BC provides more transparency, and all transactions are irreversible. We can trace everything from orders to payments to accounts to manufacturing with a BC network. So when we look at the BC, we can see everything about a transaction, from beginning to end, providing us more confidence and additional efficiencies and possibilities.

II.   RELATED WORK & EXISTING SYSTEMS

In order to improve the traceability of mangoes, Wal-Mart created a method that reduces the time it takes to trace mangoes from farm to store from seven days to just two seconds [1].

Using BC and smart contracts, the authors of [2] improved soybean supply chain transparency and traceability using business transactions.

"Blockchain ready manufacturing supply chain using distributed ledger"[3]:This paper gives an insight on how blockchain can be used for developing supply network globally.

Authors in [4] demonstrated a BC-enabled system for monitoring COVID-19 vaccination registration, storage, distribution, and self-reporting unfavourable effects.

Authors of [5] created and tested an Ethereum-based BC system for effective drug traceability in the Pharma supply chain, using smart contracts and decentralised off-chain storage.

[6] presents a shopping e-commerce platform for clients to buy source-verified goods, as well as the traceability of the food's reliable resume. The environments in which the meal's ingredients are sourced such as temperature, humidity, etc and the logistics and distribution environment that the food supply chain travels are also discussed in this article.

In 2015, Shigeru Fujimura, Hiroki Watanabe, et al. developed a BC-based distributed permission management system for recording the identities in the nodes of supply chains through BC and provide permission verification feature for the information exchange between different nodes [8].

In 2016, Feng Tian, et al. built an agricultural product-supply chain traceability system based on BC technology and RFID technology. This system achieved automatic collection and storage of information through RFID systems and blockchain technology [9].

Another solution called as the AgriBlockIoT solution was proposed by Miguel in 2018, which integrated IoT and BC technologies, implemented by both Ethereum and Hyperledger Sawtooth to realize a food traceability system. AgriBlockIoT could provide data transparency, fault-tolerance, immutability and auditability for Agri-food traceability system. [10]

Sudhan et al. [11] presented a BC system that employs BC technology to promote transparency about the status of commodities, resulting in a healthy connection between the producer and the customer.

For privately exchanging information in the supply chain of pharmacy, a BC-based system with smart contracts and a consensus mechanism was introduced by [7].

III.   PROPOSED WORK

Methodology approach: In our work we have followed this research stages:

1) Formulation of research problem and objective: We analysed problems faced by middle-class farmers and tried to identify their difficulty in current market.

2) Paper reviews: We reviewed more than 20 research paper published recently related to SCM agri problems and technologies for immutable persistence. Part of this revision included research paper about 'Blockchain technology in SCM'.

3) Architectural definition: Brainstorm different solution for our problem.

4) Results and Conclusion: At the end, we analysed the result we obtained some observation and future scope of this solution.

A product which is consumed by a consumer goes up in one direction through a chain of market. A good is first produced by farmer, farmer than sell it to trader and then the trader sells it to wholesale retailer, the retailer than distribute the product to different sellers and afterwards the consumer buys it. The tradition supply chain management has many flaws such as faults in shipment, hoarding of products by distributors, transportation problem, number of intermediaries in the market, malpractice, lack of grading, untrustworthiness, selling of

product by shopkeepers after shelf life and lack of security in agriculture product, which have caused problems for farmers. These centralized systems lack transparency, accountability and auditability. Currently the SCM is a slow and manual process. Although current supply chains can handle large and complex data sets, many of their processes, especially those in the lower supply-tiers, are slow and heavily rely entirely on paper—based such as is still common in the shipping industry.

How can blockchain help in improving the current supply chain management?

Using blockchain in the supply chain can help participants record price, current market price, date, location, humidity, size, colour, defect free, natural/manure free/organic, time of cultivation, quality, certification, and other relevant information to more effectively manage the supply chain. Blockchain can help improve supply chains greatly by enabling faster and more cost-efficient delivery of products, enhancing products traceability and improving coordination between partners.
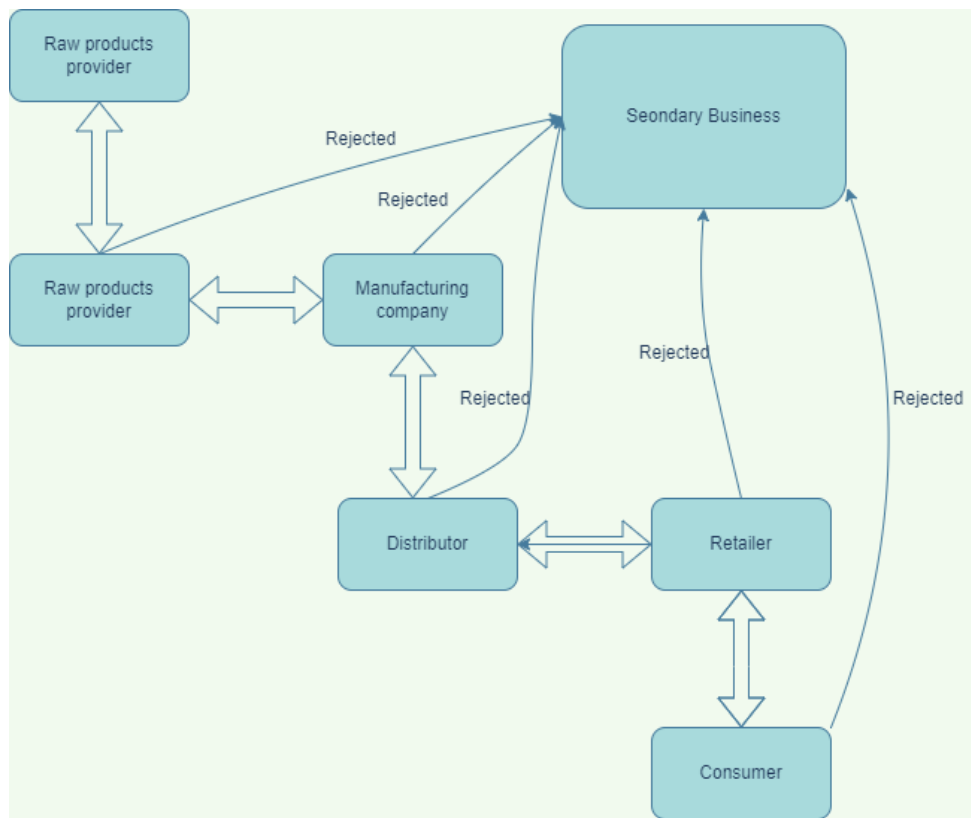

Fig 1: Expected SCM flow

OUR PROPOSED WORK includes matching of expected and received chain of transaction. A group of farmers can sell their products to a group of selected traders or distributors. On matching the block data id with the expected value, we can validate the transaction. For dissimilar block data id and expected value, we can divert this unauthenticated product to secondary businesses instead of throwing the product away in limited time period. Secondary businesses here refer to animal husbandry, creation of fertilizers etc. The trader and the distributors can distribute/sell their product to the wholesale retailers by following the same previous approach/principle of authentication.

The above principal can be applied using a QR code which hold the entire data for the authentication. The front end of the proposed system is developed using JavaScript. The farmer uses this app to store the actual goods details in the blockchain. Transactions that help to store the goods details get verified by the verifier. The smart contract contains the conditions that are needed to be verified in the system. This data is stored in the blockchain blocks & this data can't be altered by any of the intermediary except the administrator/central body.
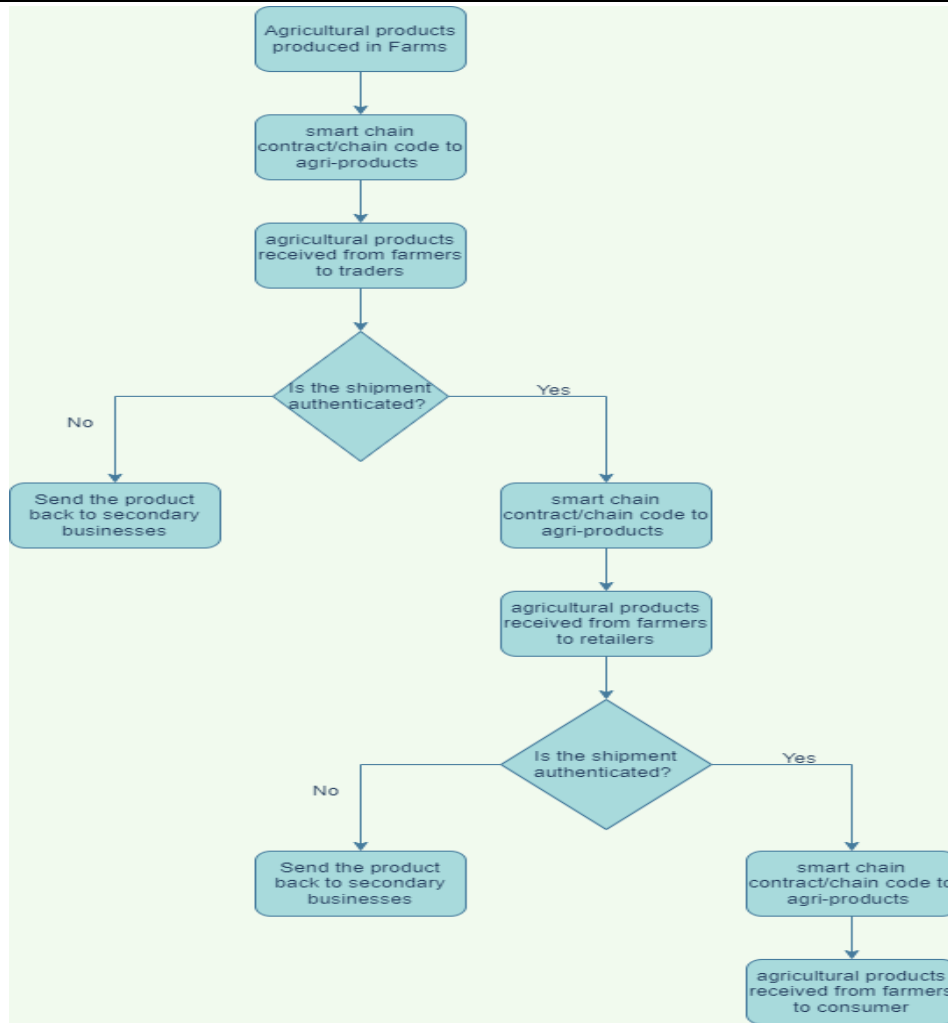
Fig 2: Flowchart

IV.   CONCLUSION

Thus, Blockchain helped us to track and trace the entire supply chain management in agricultural food products. Moreover, smart contracts can reduce paper handling delays and waste currently incurred due to manual processes.

ACKNOWLEDGEMENT

V.   REFERENCES

[1]   L.-W.Wong, L.-Y. Leong, J.-J. Hew, G.W.-H. Tan, and K.-B. Ooi,``Time to seize the digital evolution: Adoption of blockchain in operations and supply chain management among Malaysian SMEs,'' Int. J. Inf. Manage., vol. 52, Jun. 2020, Art. no. 101997.

[2]   K. Salah, N. Nizamuddin, R. Jayaraman, and M. Omar, ``Blockchain based soybean traceability in agricultural supply chain,'' IEEE Access, vol. 7, pp. 7329573305, 2019,
doi: 10.1109/ACCESS.2019.2918000.

[3]   J. Leon Zhao Shaokun Fan, Jiaqi Yan; "Overview of business innovations and research opportunities in blockchain and introduction to the special issue". [15 December 2016].

[4]   C. Antal, T. Cioara, M. Antal and I. Anghel, ``Blockchain platform for COVID-19 vaccine supply management,'' IEEE Open J. Comput. Soc.,vol. 2, pp. 164178, 2021, doi: 10.1109/OJCS.2021.3067450.

[5]   A. Musamih, K. Salah, R. Jayaraman, J. Arshad, M. Debe, Y. Al-Hammadi and S. Ellahham, ``A blockchain-based approach for drug traceability in healthcare supply chain,'' IEEE Access, vol. 9, pp. 97289743, 2021, doi: 10.1109/ACCESS.2021.3049920.

[6]   M.-J. Lee, J.-T. Luo, J.-J. Shao and N.-F. Huang, ``A trustworthy food resume traceability system based on blockchain technology,'' in Proc. Int. Conf. Inf. Netw. (ICOIN), Jan. 2021, pp. 546552.

[7]   R. Singh, A. D. Dwivedi, and G. Srivastava, ``Internet of Things based blockchain for temperature monitoring and counterfeit pharmaceutical prevention,'' Sensors, vol. 20, no. 14, p. 3951, Jul. 2020.

[8]   Hiroki Watanabe, Shigeru Fujimura, Atsushi Nakadaira, "BRIGHT: A concept for a decentralized rights management system based on blockchain", 2015 IEEE 5th International Conference on Consumer Electronics - Berlin (ICCE-Berlin), 2015.

[9]   Feng Tian, "An agri-food supply chain traceability system for China based on RFID & blockchain technology", 2016 13th International Conference on Service Systems and Service, 2016.

[10]   Miguel Pincheira Caro, Muhammad Salek Ali, Massimo Vecchio, Raffaele Giaffreda. "Blockchain-based Traceability in Agri-Food Supply Chain Management: A Practical Implementation," 2018 IoT Vertical and Topical Summit on Agriculture - Tuscany (IOT Tuscany), 2018.

[11]   V. Sudha and R. P. K. Shanmughasundaram, blockchain based solution to improve the supply chain management in Indian agriculture", Proc. Int. Conf. Artif. Intell. Smart Syst. (ICAIS), pp. 1289-1292, Mar. 2021.