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Hyperledger Fabric Implementation for a Transparent Food Product Supply Chain

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Abstract: *Blockchain technology came into existence because of bitcoin and has seen an extensive set of applications in recent times. In the last few years, numerous projects have been taken up to make use of the efficient features provided by this technology. The main focus of the blockchain is to maintain trust among the users. Farmers of the country are facing huge issues because of the corruption in the supply chain involved due to which they are not getting the proper market price for the goods produced. With the help of the Blockchain we can make the contract transparent and make the payment systems automatic which in return will help the economic situation of the farmers and reduce corruption in the system.*

Keywords: *blockchain, supply chain, Hyperledger, agricultural, transparency*

I. INTRODUCTION

The farmers in the agriculture industry in India are affected by less marginal prices of the product. The food chain involves multiple actors such as farmers, shipping companies, wholesalers, retailers, distributors, and groceries and consumers in the end. At present the goods produced from the farms to the users are not traced and the system is very much disturbed. A technology like Blockchain can make the system that involves numerous transactions more efficient and increases the supply chain transparency using Hyperledger Fabric.

II. BLOCKCHAIN AND HYPERLEDGER

A. Blockchain

Blockchain technology has paved the way for solving issues regarding privacy, integrity and security of data through distributed ledgers [5]. One of the main features of blockchain is that it is decentralized, which means it is not owned by only one entity [6]. Some other features are immutability and transparency. In simple terms, blockchain can be explained as an easy way to send data very securely from A to B, in the form of a ledger [6]. A blockchain is a type of distributed system. A distributed system can be defined as a system that connects several computers irrespective of their physical locations, where all the computers work together in coordination. Most systems have a database supporting them, and in terms of blockchain, the database can be considered as an enormous ledger [7]. The distributed ledger is at the centre of blockchain technology, it is a record of all the transactions of information that happens over the network [8]. Every participant in the network owns a copy of the ledger. Blockchain can be called a set of records that are shared between different computers and maintained over a peer-to-peer network. A peer-to-peer network consists of nodes or computers which are interconnected. This network enables the distribution of data among all the participants or peers [6]. Every block is chained to the previous block with the help of cryptographic hash functions. The first block is called the "Genesis Block". The second block produces a hash that comprises the genesis block and a hash produced by the third block comprises the first two blocks and so on [8]. Blockchain has found its applications in many sectors like financial services, health care, governance, supply chain auditing, smart contracts, file storage, prediction markets, IoT, neighbourhood microgrids and stock trading, etc [5][6][9].

B. Hyperledger

There are different types of blockchains namely, Ethereum, Cosmos, Cardano, Hyperledger, and EOS. The Hyperledger project was launched in the year 2015 by The Linux Foundation[6]. Unlike all the other blockchain platforms, Hyperledger is a permissioned blockchain [10]. Hyperledger consists of many distributed ledgers, namely, BESU, BURROW, FABRIC, SAWTOOTH, IROHA, and INDY [10]. Hyperledger Fabric, which is supported by IBM, is one of the numerous projects within Hyperledger. It is a flexible blockchain framework. It enables confidential transactions where one can choose what part of the data should be shared and which parties it must be shared with. Hyperledger Fabric has a modular architecture. In modular architecture networks, organizations, channels, servers, chain codes are developed as different modules. It delivers a very high degree of scalability, resilience, and confidentiality [12].

It was also the first blockchain to make use of standard general-purpose programming languages to develop distributed applications [13]. To be a part of a Hyperledger Fabric network, one must enrol through the Membership Service Provider (MSP)[8]. The usage of a framework like Hyperledger Fabric proves to be a good choice for the proposed system because it facilitates the development of a full-fledged chaincode for protection based design, unlike the Hyperledger Composer, which helps in developing a very generic chaincode. Fabric provides enhanced Transport Layer Security(TLS) when compared to the Composer.

III.LITERATURE SURVEY

S. Kamble et al, International Journal of Production Research, 2018,[14] presents the need of taking on the blockchain innovation in the stockpile and upsetting the inventory chain by building a model for understanding the view of clients on blockchain reception. Digitization of the store network has been a basic improvement over the most recent few years moving towards an information-based economy where a shift from customary assembling to a period of worldwide and feasible assembling is noticed. Various highlights of blockchain get an improvement in 1/3 rd of the most widely recognized store network processes. The decentralized record and chain-like engineering is valuable in better detectability and straightforwardness of exchanges and moderating trust issues in the store network. The paper proposes a model in light of the coordination of three reception hypotheses, - the innovation acknowledgment model (TAM), the innovation status list (TRI), and the hypothesis of arranged conduct (TPB) and the tested using structural equation modelling.

Bhagya Hegde et al, 2020, 'Farming Supply Chain Management Using Blockchain Technology'[4], examines the different obstacles looked by the agrarian makers and how blockchain can be used in the store network. The horticultural store network is exceptionally divided and correspondence of the right data is regularly not found or is incredibly sluggish. The paper expresses a couple of benefits of fusing blockchain into the farming inventory network. It states how makers will actually want to settle on very much informed choices considering various elements influencing the harvests, merchants can wipe out rivalry. Every one of the information assortment, confirmation and capacity, and move will be submitted in a straightforward and solid configuration and in general industry will work on in a diminishing in wastage and expansion in by and large effectiveness.

Saikat Mondal et al, 2018, [3] in 'Blockchain Inspired RFID based Information Architecture for Food Supply' proposes internet-of-things design inspired by the blockchain for making a straightforward food inventory network. This design utilizes a proof-of-object-based verification convention which is similar to evidence of-work in digital money. The engineering totally depends on incorporating a RFID-based sensor at the actual layer and blockchain at the digital layer. In the wake of taking agreement from partaking terminals in the organization prior to refreshing the blockchain information inside the production network utilizing the continuous sensor information when the food bundles are examined at different retailers, planned operations, or capacity stages. Blockchain innovation is useful in building a carefully designed data set of food bundles carefully. A security examination is additionally executed to test the proposed engineering against any weakness or digital assaults of any sort.

Dr.V. Sudha and Dr.R Kalaiselvi [13] examine about the difficulties looked by the Indian farmer in the store network of their produce and how the current inventory network makes it unthinkable for ranchers to follow the situation with their products. They propose a framework which used blockchain innovation to accomplish the straightforwardness and permanence that the ranchers long for having. Since blockchain innovation makes all the interaction apparent to ranchers and authorities participating. The framework includes IoT to monitor the produce , sensors, for example, temperature, humidity and gas sensors are utilized to know the situation with the merchandise at various stages in the store network and a front end that is created with JavaScript. Strength language is utilized to compose the brilliant agreement fundamental for the framework.

W. Lin *et al.*: Blockchain Technology in Current Agricultural Systems discussed in detail the multiple ways blockchain could be cultivated in the field of agricultural products.[15] Numerous concepts of blockchain technologies is explained in depth and the disadvantages of the blockchain technology present at the moment a few of them being challenges with regard to scalability , integration and security and privacy.

Yuhui Huang et al in the paper,[1] Design of horticultural item recognizability stage in light of 5G-IoT and blockchain,2021,proposed a procedure in view of blockchain and semantic division to relieve the weaknesses of the customary discernibility framework like low security, murky data and simple altering of information. The idea introduced, "The picture semantic division innovation can be utilized to section and improve the two layered code region and recognize and follow the source". For a semantic division network an encoder-decoder structure is proposed in this paper. "The unravelling highlight first uses the memory module to compel, and afterward the semantic division model is streamlined to finish the semantic division of the dataset picture"

K. Salah, N. Nizamuddin, R. Jayaraman and M. Omar, in the paper “Blockchain-Based Soybean Traceability in Agricultural Supply Chain”, [16] proposes a methodology that uses the Ethereum blockchain and brilliant agreements proficiently to perform deals for soybean following and discernibility across the horticultural store network. The proposed arrangement wipes out the requirement for a confided in incorporated power, go-betweens and gives exchanges records, improving effectiveness and wellbeing with high respectability, unwavering quality, and security. The proposed arrangement centres around the usage of savvy agreements to administer and control all collaborations and exchanges among every one of the members required inside the inventory network environment. All trades are recorded and taken care of in the blockchain’s perpetual record with associations with a decentralized report system (IPFS), and consequently providing for all of the an obvious level of straightforwardness and obviousness into the creation network climate in a strong, trusted, trustworthy, and successful way

Shangping Wang et al, [17] propose an item recognizability framework in view of blockchain innovation, in which all item moving accounts are never-endingly recorded in a dispersed record by utilising smart contracts and a chain is shaped that can follow back to the origin of the items. Specifically, they plan an event response system to check the identity of the two players of the exchange, so the legitimacy of the exchange can be ensured. And all occasions are for all time put away as logs as a reason for dealing with questions and following dependable substances. Also, a system model is implicit light of the testing design of Truffle. The agreement code is conveyed on a test network TestRpc that runs in adjacent memory, and a decentralized site page point of collaboration is completed taking into account the model. At last, the framework security examination and trial results show that the answer is achievable.

Papa Semou Faye in “Use of Blockchain Technology in Agribusiness: Transparency and Monitoring in Agricultural Trade”, [18] shows that Agricultural area has an incredible requirement for data that help recognizability. Every single one of the actors concerned should go to the next piece of the chain to more readily comprehend conceivable outside factors and problematic arising technologies. The point of this paper is to consider the use of the blockchain into the rural business. It is seen that it will encourage more straightforwardness and discernibility in agribusiness and in this manner restore the certainty of shoppers in rural items. All things considered, this multitude of guarantees are joined by uneasiness from various entertainers connected with the dematerialization of records or the utilization of energy.

IV. SYSTEM DESIGN

In the proposed methodology , only the authorized personnel can upload the records of the particular consignment, which are then verified and issued. In the other proposed solutions , we will have a network of participants in the supply chain , where entity of supply chain will be able to issue the details of the particular consignment , whereas the other entities would get the issued details in their respective ledgers with the help of the DLT technology. This ensures that the information issued may not be tampered and the details will be among the participants itself which in turn helps to maintain the privacy of agreement secrets. Only the participants who are in the network would get the records of a particular consignment in their respective ledgers because of which, a transparent supply chain is achieved.

The main participants considered for this system are: Farmers, Logistics, PriceAuthority, SriEnterprises – a corporate for buying food products which is described in Figure 1.

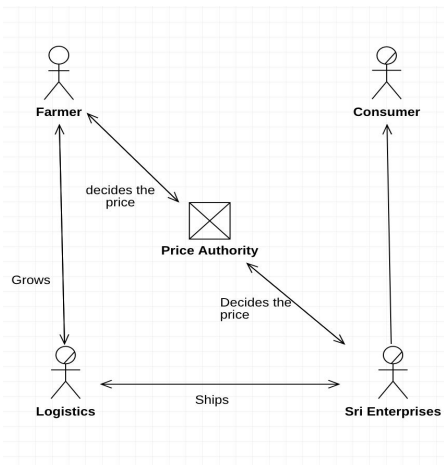


Figure 1: System Components

These 4 actors can represent most supply chains. Even though the customer is also part of the supply chain, it does not take part in the system as a full member, because it only consumes what the supply chain has to offer. In the current supply chain, the flow of good would start at the producer and end at the customer, but for the design of this system, we will assume that any organization can interact directly with any other organization, thus enabling a circular economy.

The proposed architecture in this paper consists of two components, the blockchain network layer and a web page layer. The web application page is to have an interactive atmosphere for the user and build a connection between the two layers using the state database. The farmer sets up the network based on the information provided by the organizations and their respective login credentials are given to the organisations.

Once the farmer is ready with the products that is to be dispatched he communicates with the logistics organisation and details of the product, its BatchID, DateOfDispatch and PlaceOfDispatch is recorded in the blockchain network. Logistics organisation will then update few details such as farmerID, DateOfArrival, DateOfDispatch and PlaceofArrival onto the blockchain network. An enterprise enters into the blockchain network a set of records like BatchID, ProductID, DateOfArrival and Quantity as and when a consignment is received from the logistics. The price authority updates the price of the products when there is change in global market.

By the gossip data dissemination protocols, the organization will get the transactions that takes place in the network into their respective ledgers, which gives them access to their ledger through the login page. For every new consignment dispatched or arrived the details of that particular consignment are published onto the blockchain network by the respective organisations through their respective chain codes. So each organization is represented as a peer in the network which is the fundamental part of the network. As every new consignment details are published in the blockchain network, the other organisations can view the records of that consignment in their login page, which will be stored in a state database, preferably CouchDB.

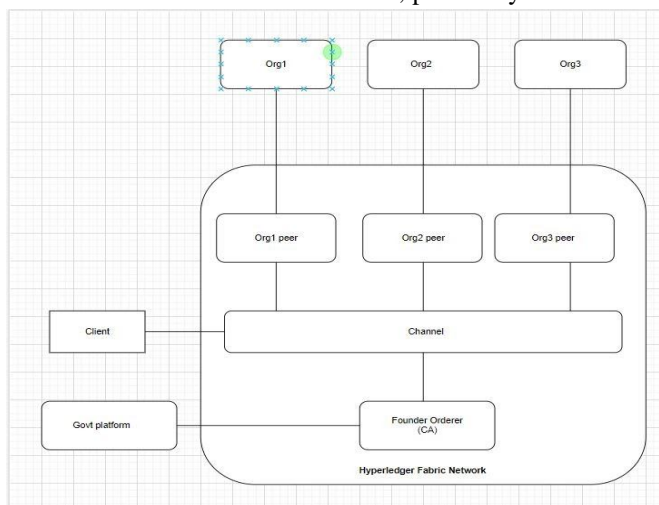


Figure 2: System Architecture

In the above figure, the architecture of the proposed system is designed, org1, org2, org3 represents farmers organisation, logistics organisation and SriEnterprices respectively In this the government’s platform i.e., Price Authority peer and other organisations peer are joined to the channel and the end-consumer can retrieve the complete details of the particular consignment.

V. PROPOSED ALGORITHM

The proposed algorithm is mentioned, which gives a detailed explanation of the working of the system in the form of steps

- 1) Step1: Farmers organisation sets up a blockchain network and generates user credentials, like username and password for the enrolled organizations.
- 2) Step2: Price Authority logs in to the website using user credentials like username and password and the price details of a particular product from Price Authority is published onto the blockchain network Break
- 3) Step3: Farmers Organisation logs in to the website using user credentials like username and password and the details of the consignment from farmers organisation is verified and published onto the blockchain network.

- 4) Step4: Logistics organisation logs in to the website using user credentials like username and password and the details of the consignment from logistics organisation is verified and published onto the blockchain network.
- 5) Step5: SriEnterprises logs in to the website using user credentials like username and password and the details of the consignment from SriEnterprises is verified and published onto the blockchain network
- 6) Step6: If new consignment of the goods is produced then go to step 3
- 7) Step7: If the product price is reduced or increased due to various reasons go to step 2.
- 8) Step8: QR code is produced
- 9) Step9: End consumer can track it.
- 10)

VI.CONCLUSION

The aim of this paper is to make the supply chain transparent to avoid the confusion and miscommunication that the Indian agricultural supply chain is facing lately. The aim is achieved with the help of blockchain technology and Hyperledger fabric. Implementation of blockchain is an extremely necessary for the country and market to move on. It is fundamental to profoundly change the way of life and the political will to set up an effective and straightforward rural framework that guarantees a sound and economical nourishment for all. The implementation of blockchain to this disturbed supply chain ecosystem is going to be much more efficient and bring transparency to the system.

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