Blockchain - A Step towards Innovation in Agriculture

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Abstract

Blockchain technology played a major role in the foundation of cryptocurrency and now it is receiving tremendous attraction due to its application and use cases. Blockchain allows us to make the transaction in a secured manner in a decentralized system as blockchain is distributed, decentralized, and public ledger. Blockchain technology can be applied in various fields such as banking, IoT, cryptocurrency, and much more. In today's world, blockchain-based applications can be used as supply chains in various fields such as pharmacy, agriculture, food chain, and many more, as the supply chain is mainly used for tracking. Blockchain in agriculture as a supply chain can be used mainly for tracking of crops, certified seeds, vegetables, and much more. Hyperledger is the open-source umbrella project under which it provides frameworks for the application of blockchain. Blockchain technology provides a secure and fraud-free environment for the supply of various essentials in agriculture. We have research that in India, currently there is not any blockchain based application in agriculture and there is not any secured tracking system also so in this research paper, we will provide you an overview of the blockchain, its history, frameworks that we are using in agriculture, architecture, and how to apply blockchain for a web application and many more. Further, we will also describe the use-cases of blockchain, Stakeholders, the feasibility of blockchain as a supply chain in agriculture, and finally the conclusion.

Keywords[1]

Blockchain, Agriculture, Decentralized, Supply chain, Hyperledger, Tracking.

1. Introduction

Nowadays blockchain technology is mainly used in the fields such as banking, cryptocurrency, etc. Blockchain is basically blocks of data and they are connected with each other through the chain. Firstly, the cryptographically secured chain of blocks was described in 1991 by W. ScottStornetta and Stuart Haber and then the first concept of blockchain was described by a person (orgroup of people) known as Satoshi Nakamoto in 2008. Blockchain is a decentralized, distributed,and public, digital ledger that is used to record transactions across many computers or we can use blockchain as the supply chain for tracking in the supply chain.

With the help of blockchain, we will be able to create enterprise-level applications in which we have the ability to connect theassets through public, private, centralized, decentralized, or distributed networks. Blockchain Inagriculture, we are using blockchain as the supply chain for tracking from the manufacturer tothe farmer.

In the blockchain, data is stored in the blocks and that data is stored in encryptedform. Blockchain is used where there are two or many organizations and they can not trust each other. At this point of time, blockchain comes in the existence [1]. Blockchain provides moresecurity. The probability of

data breaches in this technology is null. As blockchain uses hashingtechniques to store the data and hashes will be unique and it is impossible to un-hash or reverse the process to get the data. Data in blockchain will be stored in multiple nodes, if anyone tries tomanipulate the data then one will not able to do so because with the help of consensus algorithmsdatawill be checked at every node, and manipulating with data may result in a change in theaddress of that node. In the blockchain-based tracking system, there will be transparency [2] fromstarting point to an endpoint which increases the traceability[3] of the products to meet thecorporate standards. Well, according to our survey conducted from 1 April 2021 - 26th April2021, 950 people out of 1100 people want to know from where the product has come andWhether the product they are getting is 100% original or not or the companies are just providingthem the stuff that they have repacked the old product. With the application of blockchain, fraudwill have completely vanished. After the successful implementation of blockchain, all thestakeholders will be connected through the blockchain network and they can easily communicatewith each other. Blockchain can be proved to be the biggest revolution in the Agriculture industry.
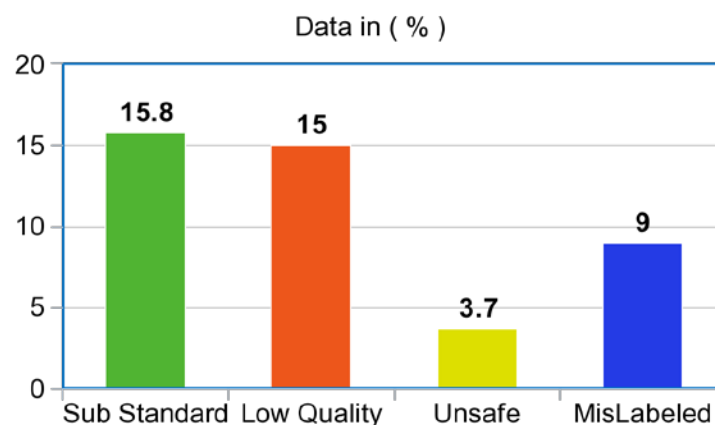

Figure 1: Quality Standard

According to ASPA,15% of samples are of low quality (Whose quality are lower than the expected), 15.8% are sub-standard (they are not following the quality standard), 3.7% of samplesare Unsafe (they are unsafe to consume), 9% are mislabeled (they are not labeled correctly, not original). To tackle these problem scenarios blockchain should come into existence. As blockchain provides security and transparency which helps to track the products from starting point to an endpoint, ultimately which helps us to vanish all these problems completely.

2. Blockchain Frameworks

In the blockchain, there are many frameworks and tools such as Steller, Tazos, Hyperledger fabric, hyperledgersawtooth, ripple, quorum, hyperledgerIroha, Corda, neo, eos, open chain, ethereum etc. But we will be using hyper ledger fabric for our blockchain project. It is under hyperledger which is an umbrella project of an open-source community and created in December of 2015 by the Linux foundation. Hyperledger gets support from many companies or organizations such as IBM, Intel, and Sap Ariba, etc. It is considered to be the best blockchain framework because it allows components like membership service and consensus as a plug-and-play feature. It is based on modular and configurational architecture. It became the only and first blockchain framework that has released its 2.0 version which shows the popularity of this framework. With the help of hyper ledger fabric, we can create public, private, distributed [4] and decentralized enterprise-level applications using plug-and-play components. This is also permission which means all the nodes in the network are known to each other rather than that they are unknown to each other. In this framework, we can create multiple channels which can allow the organizations to utilize the same network with the help of these channels. There is also a membership service provider (MSP) which identifies the user's ID and

authenticates them to join the network. It generally contains four types of peers which are:

2.1.Endorsing Peer

It generally came under the category of committing peer with some special roles i.e. to endorse a transaction which is sent by the client. Each and every endorsing peer owns a copy of the smart contract installed and ledger. The main function of endorsing peers is to initiate the transaction.

2.2.Committing Peer

Peers who have to commit the transactions in the block which is obtained from the ordering service, this block contains that transactions which committing peer have to validate them and it will also check whether the transaction is valid or not and then finally will commit them to the block.

2.3.Anchor Peer

Anchor Peer are the special peer which can communicate across multiple organizations. All the peers have not the power to communicate to the multiple organizations in the fabric network but Anchor peer has.

2.3.1.Leading Peer

On each channel to which member subscribes, each member may own several peers. One of these peers acts as the channels' leading peer and it communicates with thenetwork ordering service on the member's behalf. The ordering service sends blocks to the channels' leading peer(s), who disperse them to other peers in the same participant cluster.
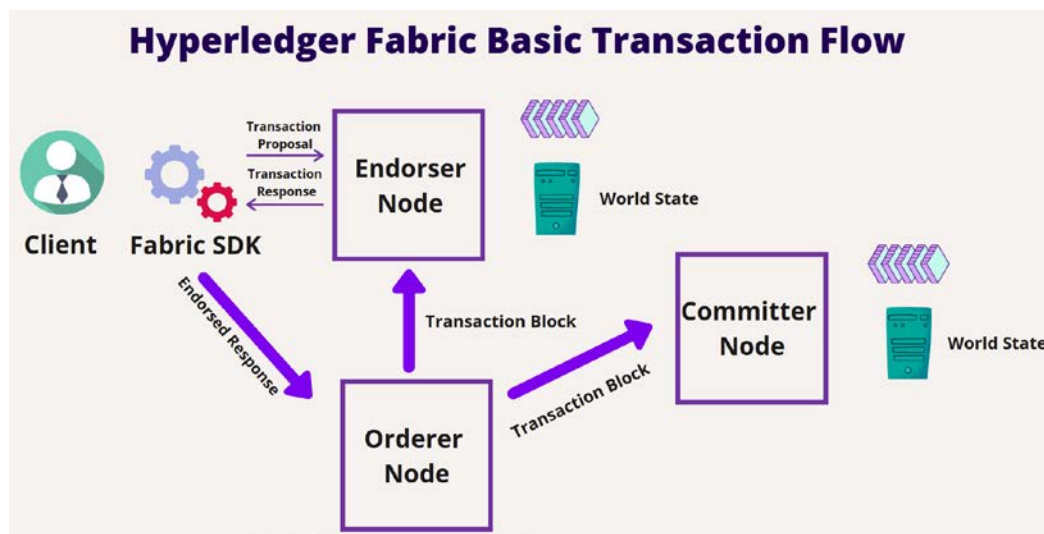

Figure 2: Hyperledger Fabric Basic Transaction Flow

3. Revolution in agriculture Industry

The most important concern in supply chain management is the alterations and the quality which degrades in between the time of transportation. There is no proper monitoring system in case of the agriculturefield. Sometimes stakeholders misunderstood the quantity of food they have which causes a great problem as a result the amount which is to be used by people gets rotten. Also, there is an unavailability of a proper tracking system by which one can know if the product is original or not. Especially in the case of seeds and costly fruits, it became very important for every person to know about the quality of the product. Due to the lack of a tracking system, onecan not know where does the product comes from i.e. starting point to endpoint. Blockchain tracking systems come into existence
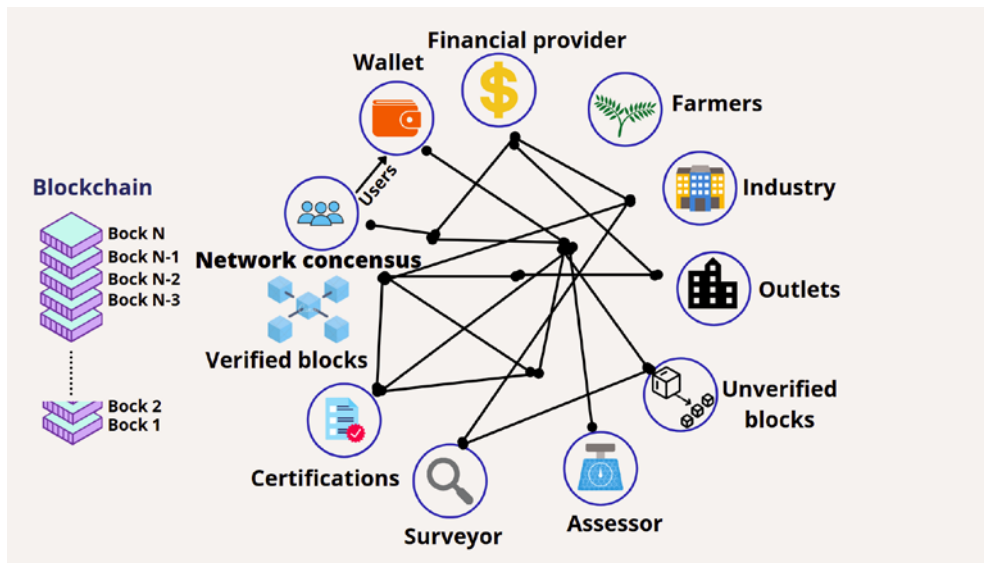
Figure 3: Blockchain Network

when there are two or more two organizations and they can not trust each other. One can achieve all these things with one shot i.e. using blockchain. With the application of blockchain, we can apply a real-time end-to-end tracking system. We can use the blockchain as a supply chain. All the data will be stored in the blockchain blocks as the data will be most secured and unhackable. There will be a transparent supply chain as all the data will be visible to the users and there will be assurity of the product whether it is original or not. Now after the application of blockchain one can know from where does the product comes from i.e from starting point to the endpoint as it is the transparent supply chain. All the stakeholders will be connected to each other in a blockchain network and can communicate with each other. Now there will be not a single point of failure if one node becomes a fail, as all others nodes are active in blockchain blocks and data can not be manipulated by someone. Blockchain will be proved to be a revolution in the agriculture industry by which every single flaw will vanish.
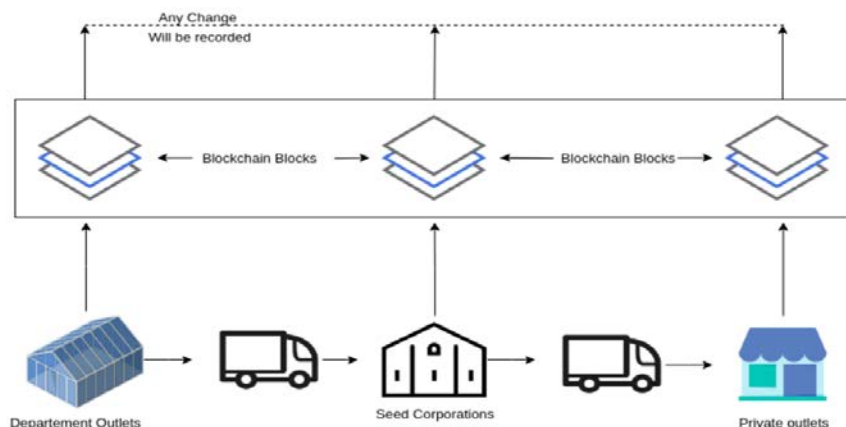
4. Ideation

Figure 4: Basic Ideation

A blockchain-based tracking system for the products to track them in real-time from starting point to endpoint from manufacturer to the consumer i.e tracking of certified seeds as shown in above fig. . There will be assurity that the productis original or not. Product will be tracked through unique product ID and order ID etc.During the supply of products i.ecertified seeds from department outlets to the seed corporations and from seed corporations to the private outlets, all the data at each and every point fromend to end journey will be stored in the blockchain blocks, and if there is any change that will be recorded.

5. High-Level architecture solution

This is the high-level architecture solution for the supply chain management or tracking system in the agriculture industry i.e tracking of certified seeds. First of all certified seeds will onboard from agricultural farm or manufacturer to the departmental outlets and blockchain smart contracts will be activated, where certificates as like certificate of origin, lot number, shipmentdate, order number and certificate number, etc will be checked through smart contracts to ensure whether the same package has been delivered or not. And all the data will be recorded in the blockchain blocks. Now the certified seeds will onboard from department outlets to the corporations and blockchain smart contracts will get activated, where certificates like certification of origin, lot number and production data, etc. will be checked with the help of smart contracts to ensure that the same package is delivered or not. And all the data will be stored in blockchain blocks. After that the package will onboard to the distributor where they again check the details such as shipment, order number, certificate number, the temperature of the product, and barcode, and data will be entered in blockchain blocks.
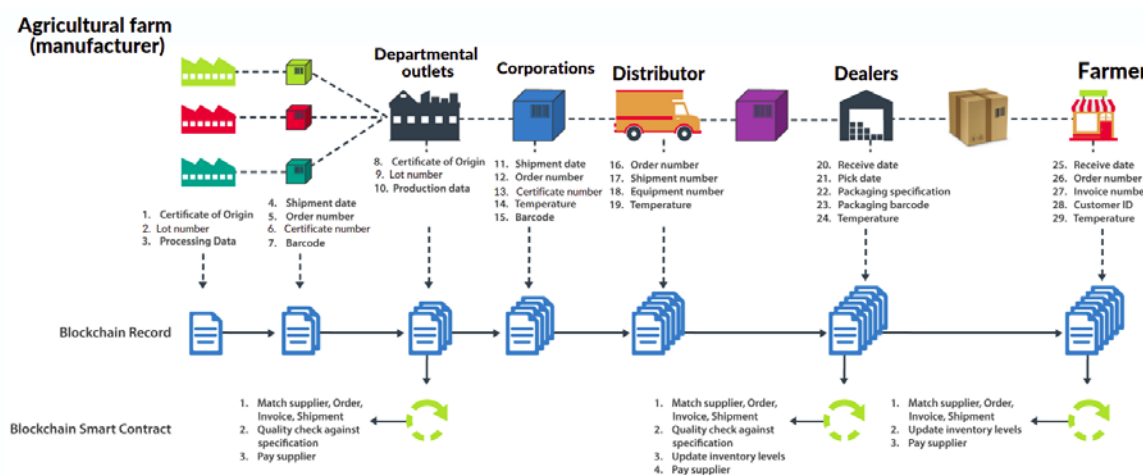

Figure 5: High Level Architecture

After that again the package will be onboarded to the dealer which ensures that the same package is delivered by checking the details like the order number, shipment number, and temperature for the safety of the product and enter the details in the blockchain blocks and again package has to depart for the next stage i.e. farmer which ensures the quality of the product i.e certified seeds and then finallyenter the details like receive date, pick a date, package specification and package barcode to the blockchain blocks. During the whole process of the supply chain from the manufacturer to the consumer, everything is transparent.

6. Technical Workflow

The below figure is about our technical workflow. In this section, we will explain how the technical things will work out from starting point to the endpoint. In this section, we will also explain the technologies we have used.
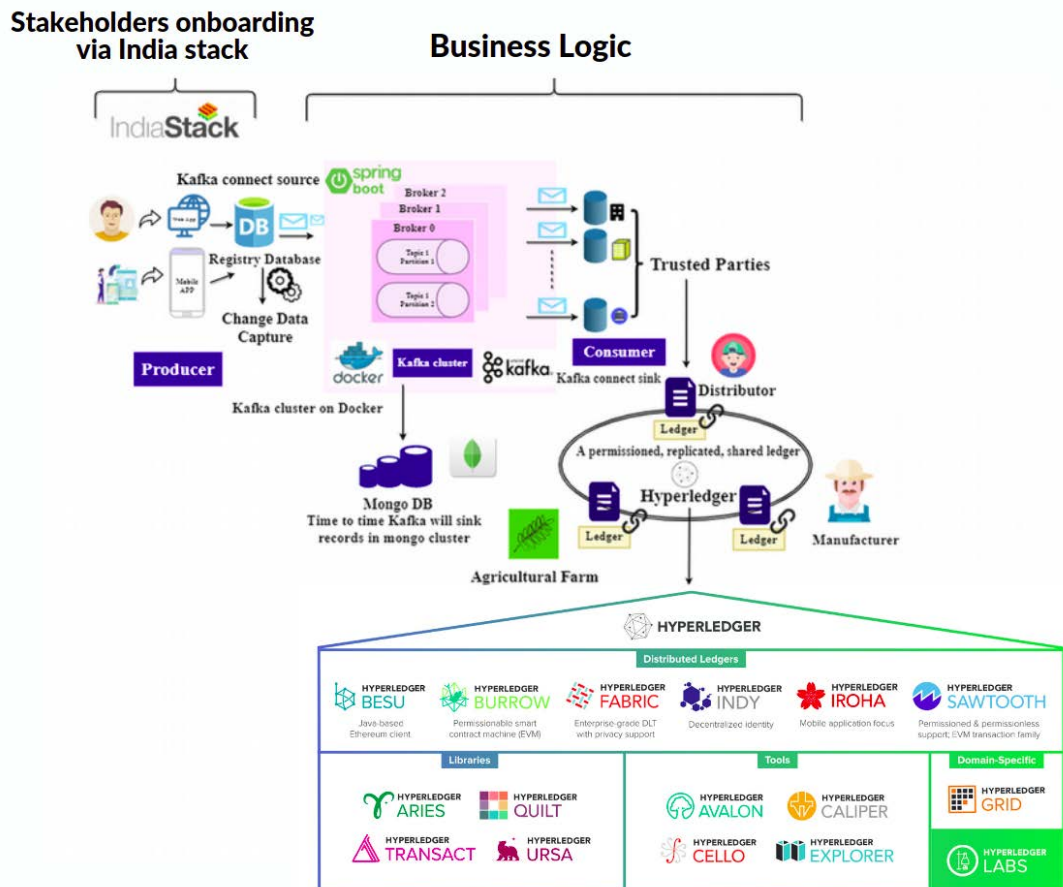
Figure 6: Technical diagram

The front-end is the main part of any web application which is seen by the user. It is the part that creates a direct impact on the user. For this, we are using HTML, CSS, bootstrap, thymeleaf, andjavascript. Thymeleaf also can be used as a server-side language. For the backend part we are using Kafka, hyperledger fabric, spring-boot. And we are using MongoDB as a database for our system. Kafka is a data streaming tool that is used in the real-time data pipeline. Springboot is a java framework from which we can create standalone enterprise-level applications in minimum time as it has spring auto configurations and a built-in Tomcat server. Hyperledger Fabric is a blockchain framework from which we can create permission or private application. It is the only blockchain framework that has 2.0 support. We are using MongoDB as our database because it is a NoSQL document type database. MongoDB uses JSON-like documents with optimal schemas. We are using docker as our infrastructure layer. It is a set of the platform which uses OS-level virtualization. It helps in packing up all the required software and packages into one package called a container. Kafka, MongoDB, and spring-boot are running on docker as docker is our infrastructure layer. First of all, the user will access the web app and then one has to sign up, now after login user will generate the queries and Kafka connect source which has many brokers and topics, running on docker will take that queries to the database MongoDB and Kafka connect sink will take the queries from a database and come back to the user. From the manufacturer to the consumer such as manufacturer, distributor, dealer, and consumer all are trusted parties which are connected in a blockchain network and these parties can communicate to each other through blockchain network. Hyperledger has many frameworks, we are using one from them which is hyperledger fabric.

7.   Idea Feasibility

7.1.   Cost-Efficient

This will be a cost-efficient method as one doesn't need any external hardware for the application of blockchain. Also, a team of good engineers can handle all the things. Also, it is an open-source project so one doesn't need to buy any software for the application of blockchain.

7.2.   Assurance

After the application of Blockchain it will be assured that the person will get the same product as it was sent by the seller or if there will be any change in the product it will be reflected and we got to know at which point it had happened.

7.3.   Security

Data security is the most important thing that a user wants nowadays. Blockchain is well known in this field. It provides 100% security. After the application of Blockchain, the system is unhackable. In the case of data breach detection will be captured by our technical workflow before something messed up.

7.4.   Transparent Supply Chain

In this Blockchain-enabled tracking system there will be a transparent supply chain. Everything will be stored in blocking from starting point to endpoint. Due to this transparency now everyone will be able to know where does the package comes from and where it has been manufactured and all the information about the package.

7.5.   Fraud prevention

After the successful application of blockchain rate of fraud will become negligible due to which the economy will get a boost and customers will be more aware of their package. As a result, the customer satisfaction rate will be increased.

8. Stakeholders of Supply Chain

- Manufacturer
- Distributer
- Dealer
- Consumer

First of all, the manufacturer will manufacture the product and market with the unique id and all the information such as unique id, price, date of manufacture, etc. will be recorded in the blockchain blocks. Now the distributor will check whether theproduct is original or not with the help of some unique identifiers like bar code, date of manufacture, etc. All these things will be captured in the blockchain from the end of thedistributor. Now dealer will reconfirm the details that were entered by the distributes so that he can confirm that the product he has received is original and the dealer will again enter all the information about the product that will be stored in the blockchain block. Now finally consumer will check the originality of the product and will enter all the details of the product he received.
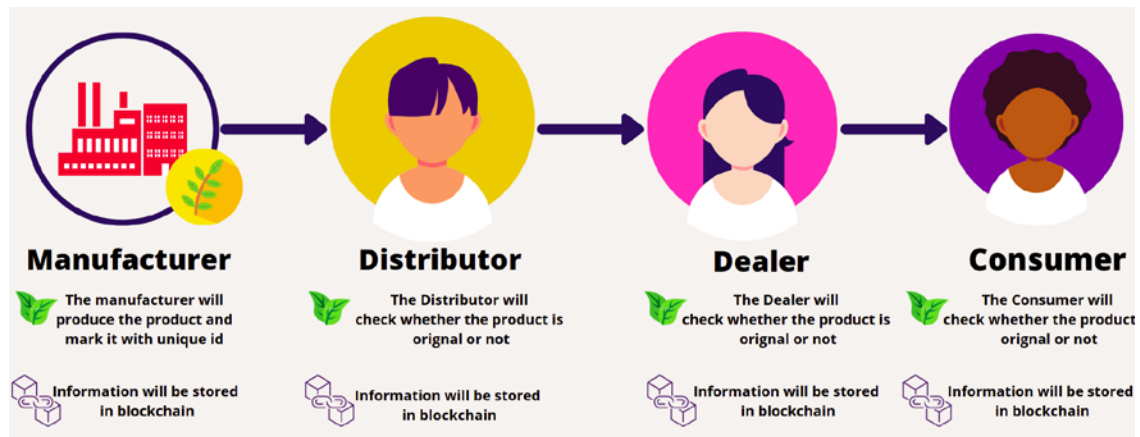
Figure 7: Stakeholders of Supply Chain

9. Conclusion

We need a change in the agriculture industry and blockchain will be proved to be a revolution in this industry. The application of Blockchain as a supply chain is a new era in the world and will become fruitful in the agriculture industry. Though this technology has some limitations that it can only be implemented having resources like powerful computers. This technology based web application needs much more time as compared to other technologies. More than one-fourth of our total food got wasted because of a lack of proper and transparent supply chain management. After the application of blockchain, we will able to reduce this amount of food wastage to a greater extent which will help in feeding humanity with this huge amount of food. Also,a major problem related to current supply chain management is that the people won't get the same quality item they have ordered. With the application of blockchain, it becomes fully transparent and now consumers will be able the reconfirm the quality of the product, and users will able to know about the quality of the item. Also, we can integrate this application of blockchain with AI and IoT in the future. After the integration of AI and IoT in blockchain, it will become the most powerful and secured application. Further blockchain technology can be extended in other fields such as Blockchain-assisted secure fine-grained searchable encryption for a cloud-basedhealthcare cyber-physical system[13].

10. Acknowledgments

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