Supply Chain Management using Blockchain

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Abstract- **As an attempt to collaborate the digital world with the physical one, we maintain a track of the journey of the dairy products from producer to consumer. IoT sensors can be linked to any product entrusted to someone else for transport, with traceable ownership, possession, and measurement parameters such as location, temperature, humidity, motion; for instance, milk, curd, etc. The final consumer can access a complete record of details and trust that the information is accurate and precise. One of the upcoming technologies, blockchain, is a great way for handling the quality of supply-chain management, since it uses the distributed public general ledger. Blockchain technology proves to be helpful in the supply-chain sector in the following manner: reduce errors, avoid product delays, eliminate fraudulent activities, improve management, increase consumer/supplier trust, and so on. In case of lack of transparency, blockchain provides recorded information about a variety of transactions in goods and/or services, which are recorded and tracked in real time.**

(Keywords-- Supply Chain; Blockchain; Hyperledger Fabric; Hyperledger Composer; Hyperledger Playground; IPFS.)

I. INTRODUCTION

Even when you're running a small business, managing a supply chain isn't easy. By the time we look at the bigger picture, the supply chain starts to look more like a web and less like a chain, full of interconnectivity. Even though Enterprise Resource Planning (ERP) solutions or digital shipment tracking devices are deployed, the complexities and product losses abound. Blockchain is effectively an incorruptible ledger, thus it makes comparatively easier to track compliance efforts by recording each and every step. The inaccuracies in records, problems in billing, fraud and corruption, this implies that the entire chain needs to be audited by impartial third parties, and it should be done frequently. Although, imagine if the whole supply chain could be electronically managed from the first phase of raw materials up to last phase of customer delivery, without getting one single error in the process, without the need of maintaining any checkpoints and any time-consuming weigh. The speed at which a product could flow from A to D would be commendable.

Blockchain technology has been the heart of financial topic since the inception of Bitcoin. It is an open-source technology wherein all the transactions are visible to all authorized users and is traceable within the ledger. Blockchain technology is resilient. It does not have any single point of failure and the transactions processed are immutable and irrevocable.

Transactions in a blockchain are processed from one single peer to end user peer without or with fewer intermediaries.

One of the benefits of blockchain ledger is that it gets updated automatically thus less time and work force is required. Since both sides of the transactions would be executed simultaneously. Resource required mainly is computing power that costs less than traditionally used human resources. No reconciliation of tracks would be required using Blockchain technology.

Following are the 8 major aspects to be included while developing Hyperledger fabric:

1. Blockchain Architect: Architects and designs the blockchain solution.
2. Blockchain User: It is the business user who operates in a business network and is unaware of the Blockchain. They use an application to interact with the Blockchain.
3. Blockchain Regulator: They are the authority in a business network and might require wide access to the contents of the ledger.
4. Blockchain Developer: In addition to the applications, they also develop the smart contracts. These contracts interact with the Blockchain and are used by Blockchain users.

5.Blockchain Operator: The operators of a blockchain perform the basic functions of determining who can participate in the blockchain, distributes blocks to participants, etc.

6.Membership Services: The different types of certificates required to run an authorized Blockchain are managed.

7.Traditional Processing Platform: This platform is an existing computer system which may be used by the Blockchain to simulate processing.

8.Traditional Data Coordinator: It is an existing data system which provides data that might impact the characteristics of smart contracts.

II. RELATED WORK

"Agri-food chain traceability system using RFID and Blockchain"[1]: From this paper, we studied the positive as well as negative impact of RFID and blockchain technology on supply chain for agriculture food. The system proposed in the paper provides food safety and traceability in all the aspects of the supply chain.

"Research on garment supply chain management system based on RFID"[2]:This paper gives a brief description of use of RFID in the garment supply chain.It provides information regarding EPC global network and also helps to understand how transparency can be achieved throughout the supply chain.

"Overview of business innovations and research opportunities in blockchain and introduction to the special issue"[3]: This paper gives us an overview regarding the research as well as development in the blockchain.It also gives us a brief idea of how blockchain is used for implementing bitcoins.

"Blockchain ready manufacturing supply chain using distributed ledger"[4]:This paper gives an insight on how blockchain can be used for developing supply network globally.

"Blockchain as a Service for IoT"[5]:This paper gives an insight regarding how the blockchain can be fundamental in IoT.

"Blockchain for the Internet of Things: A systematic literature review"[6]:This paper proposes many case studies that suggest the use of blockchain in IoT.

"Big Data and supply chain management: a review and bibliometric analysis"[7] :This paper gives an insight on how big data and analytics can be used to enhance supply chain management.

In the hyperledger, you can record the transactions and it cannot be changed or deleted without the permission of each and every peer.[8]. Thus, this improves the Supply Chain- more secured and reliable service, data efficiency can also be increased.[9].

And also, supply chains can be more dynamic, huge data can also be converted into more reliable information.[10].

III. PROPOSED WORK

Our system is a licensed blockchain network set by the organizations with the purpose of setting up a association. The organizations that build the Hyperledger Fabric network are called as the "members".

It is the responsibility of each member to arrange the peers to participate in the blockchain network. The need of all the peers in the network is arranged by providing cryptographic material such as Certificate Authority and related information.

Given the task of providing a supply chain system that would connect many small businesses we want to minimize the need for expensive infrastructure, and since the target sector was dairy products we also wanted to provide a system that would be easy to learn and use for non-technical people. Consequently, we have decided to make the system available via a mobile app due to the ubiquity of mobile devices and peoples familiarity with them. We used react-native to build the app so that we could target both Android and iOS in a single app, and also have the option of turning it into a desktop web-app with minimal adjustments. For the server-side blockchain implementation we have chosen Hyperledger Composer. Its user friendly GUI, allowed us to dive in and get started straight away, and its modeling language mapped well to our problem domain. Softwares used are:

1.Hyperledger Fabric: It is used for implementing blockchain framework .The main reason for developing Hyperledger Fabric was to provide modular architecture.The platform of Fabric is licensed.The differentiating factor of fabric is that it provides support to pluggable consensus protocol.Smart contract also known as chain code in Fabric serves as an agreement among the peers.

2.Hyperledger Composer: Hyperledger is a collection of tools and scripts which makes the development of business network easier and faster. Using the hyperledger composer we can develop and deploy the solution in shorter time period. The tools were built using Javascript.

3.Docker: Docker helps us to create our application with the environment set up in the form of containers. As the applications are contained inside our mobile phones, they are invulnerable to attacks and hacking is difficult. In the similar manner, various platforms like Mongo, MySql, etc are already present as software packages (containers) and thus Docker has implicit security setting.

4.Loopback: Loopback is generally used in troubleshooting or connecting with the servers on same machine, because as the name says, it ECHOs the request and response and 127.0.0.1 routes back to the same machine. This range can be from 127.0.0.0 to 127.255.255.255.

5.IPFS: IPFS stands for Interplanetary File System. It creates a distributed web, where data is stored inside the nodes, and there is no duplication in the data among the nodes. Each file is given a unique cryptic hash. There is no single point of failure. Also each and every data can be owned by a person and not a group. For example, if you have a website on the IPFS and government shuts down the network, your website can never be shut down.

Methodology

There are suppliers of raw materials who send the material to the factory, and this material can be either of a good or a bad quality. Temperature, humidity play an important role in determining a quality of the raw material, especially milk.

Smart contract contains the minimum and maximum temperature criteria and penalties in different scenarios. Now, before receiving the shipment temperature and humidity are checked using sensors and this information is compared with the information in the Smart contract, and penalty is assigned(if any). After receiving the shipment, its price and penalty is calculated. In this way, shipper, importer and exporter will be charged or they will receive the payment according to that particular scenario.

This whole data is recorded in the block and as the raw material turns into product and gets delivered this whole information is stored in the chain of blocks. This blockchain information can neither be altered nor deleted.
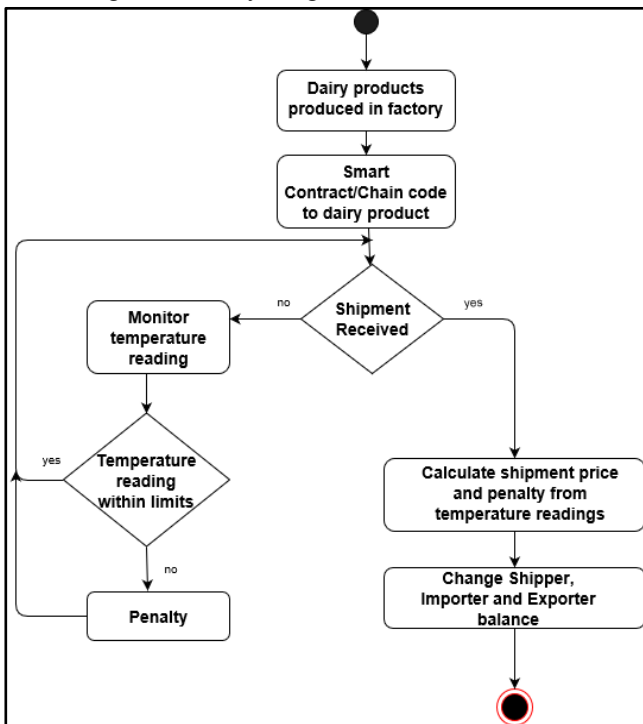
Refer the given Activity Diagram.

Figure 1 Activity Diagram

IV. RESULT ANALYSIS

• Here, grower's data is stored as JSON data(similarly there is also shipper's and importer's data stored) .Refer Figure 2.

```
1  {
2    "$class": "org.acme.shipping.perishable.Grower",
3    "email": "grower@email",
4    "address": {
5      "$class": "org.acme.shipping.perishable.Address",
6      "country": ""
7    },
8    "accountBalance": 114
9  }
```

Figure 2

• For each shipping item, there is a contract (as shown below) on the basis of which grower and shipper get their respective penalties or payments. Refer Figure 3.

```
1  {
2    "$class": "org.acme.shipping.perishable.Contract",
3    "contractId": "contract@email",
4    "grower":
       "resource:org.acme.shipping.perishable.Grower#grower@email",
5    "shipper":
       "resource:org.acme.shipping.perishable.Shipper#shipper@email",
6    "importer":
       "resource:org.acme.shipping.perishable.Importer#importer@email",
7    "arrivalDateTime": "2019-02-06T06:55:38.580Z",
8    "unitPrice": 0.2,
9    "minTemperature": 2,
10   "maxTemperature": 4,
11   "minPenaltyFactor": 0.01,
12   "maxPenaltyFactor": 0.02
13 }
```

Figure 3

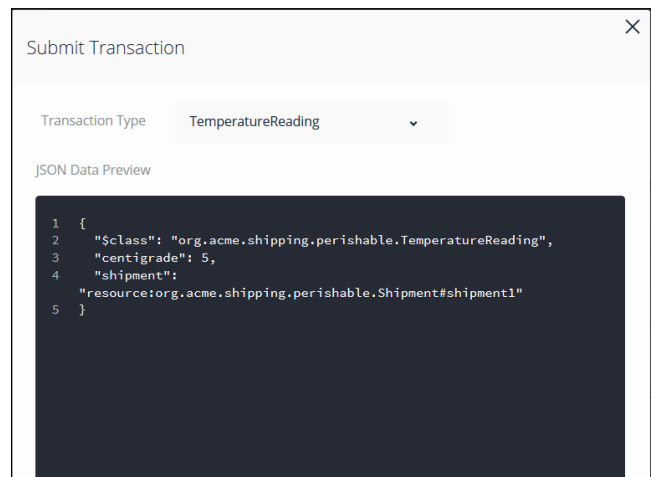•Read the temperature (First Transaction. Note, here transaction refers to a single sub process.). Refer Figure 4.

Figure 4

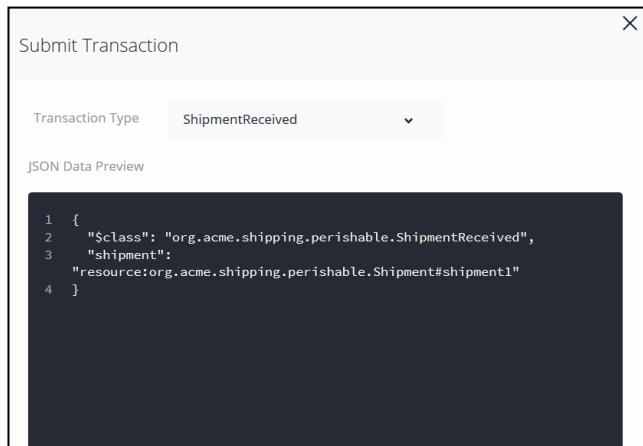•Shipment is received and payment is done based on the data which is verified using shipment id. Refer Figure 5.

Figure 5

V. CONCLUSION

Thus, blockchain helped us to overcome the problems in the supply chain like eliminating the expired food from consuming. Also, it would help equal distribution of the revenue generated among the participants in the food supply chain. Transparency and security throughout the supply chain is achievable through the project. Also, smart contracts can help eliminate costly delays and waste currently due to manual handling of paperwork.

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