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BLOCK CHAIN BASED AGRICULTURE SUPPLY CHAIN

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ABSTRACT

An Agriculture Supply Chain Trace a product from the producer to the customer. It is a blockchain based transparent system where the participants in the system could implement a co-operative farming method. Here, the farmers can put the potential crops and the expected amount on his farm on the distributed ledger. Other participants can view the details and check the source and product details. This creates a transparent and tamper-proof digital market platform for farm products. The challenge for the agriculture sector is to tracking the whole supply chain. A Buyer can purchase such items from the system. A Seller can mark an item as Shipped, and similarly a Buyer can mark an item as Received.

The process depends on a middleman for coordinating the goods are delivered safely and buyers have an agent for this process. The involvement of multiple agents adds high cost and that's why the whole process time consuming. By using the blockchain, the entire process can be simplified to a single system. Blockchain based agriculture supply chain can provide all parties like farmer, distributer, retailer and consumer with a single source of truth.

INDEXTERMS *Blockchain, ledger, tamper-proof, Ethereum*

I.INTRODUCTION

Monitoring and Tracking the agricultural products and efficient logistics management agricultural supply chain is critical to ensure product safety [3]. The growing concerns about food safety and contamination risks have renewed the focus for enhanced traceability across the supply chain. In addition agricultural products being traded across several countries require precise tracking and conformance to country specific regulations. [2]

The challenge for the agriculture sector is to tracking the whole supply chain. The process depends on a third-party for goods are delivered safely and buyers have an agent for this process. The involvement of multiple agents adds high cost and makes the entire process time consuming. By using the blockchain, the process can be managed to a single platform.

Buyers and sellers along agriculture-supply chains cannot operate with confidence, knowing that they will be paid and can access the finance

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necessary for business constancy and progress. This results with title transferring months before payment is made. This introduces risk that most often falls on the producer at the start of the supply chain.

Traceability of products in agricultural supply chain requires collection, interaction and control of critical information by precisely identifying the origin, various information exchanges in the supply chain. The dynamic nature of information in the agricultural supply chain where goods are produced, processed and sent via several intermediaries makes it difficult to track and trace. Product contamination and its implications to public health strongly emphasize traceability as necessary policy tool towards monitoring goods quality and safety.[2]

Blockchain technology can provide a meaningful and practical solution ensuring traceability of agricultural produce and eliminates the need for a trusted centralized authority. Blockchain technology has gained popularity among supply chain and logistics community due transparency and tracking of transactions, enhances trust among participating stakeholders. Due to its tamperproof, trusted, secure and traceable nature, blockchain can be deployed effectively in the agriculture and food supply chain management. The overall structure and functioning of food supply chain is vast and complex involving multiple stakeholders ranging from farmers, manufacturers, processors, and consumer. Food and agricultural supply chain is getting a lot of attention from the research community due to problematic long supply chain, from raw materials to the end consumer makes it extremely hard and time-consuming in tracking back the origin of a product. Hence, there is a need to create a secure framework for tracking details about the origin, farming methods adopted, and safety of the food product throughout the supply chain cycle without a third party or centralized control. Few other major issues to be solved in the supply chain cycle includes provenance, protocol regulations across multiple distributors, processors and retailers.[2]

In Supply Chain Management (SCM), the flow of materials and services required in manufacturing a given product is managed, which includes various intermediate storage and production cycles until the delivery to the final point of. Typically, multiple companies interact and trade on a global scale within a given supply chain. Due to this complexity, associated costs of managing the inventory, processes and failure detection are particularly costly.

Traditional SCM is driven by planning and communication. The future demand is estimated based on the past and current demand, information is pushed to the involved stakeholders that hope to get the relevant information on time to respond to changes, delays or errors. Companies decide what product is released to the market at what time, and customers indirectly drive the demand.

Traditional SCM compared to blockchain-based Supply Chain Management. Traditional SCM is distributed, i.e. there is no central entity. A blockchain powered SCM maintains a distributed ledger where participant can update and read (pull) the current SCM state. [3]

The supply chain network is centralized. In this system Decision making in a supply chain network can be performed in a centralized. It requires high centralization and high problem solving ability. The process depends on a third-party for coordinating the goods are delivered safely and buyers have an agent for this process. The involvement of multiple agents adds high cost and makes the entire process time consuming.

The blockchain is decentralized, shared database of transactions which enables participants to keep track of transactions without central third party. Blockchain is a shared distributed ledger contains blocks that include details of all transactions data, which is going to execute. Each block is hashed and linked to the next block, making it a secure chain of immutable and tamper-proof records. The contribution of this paper is summarized as follows:

- It results in creating a transparent, fault-tolerance, immutable and auditable records which can be used for goods traceability.
- The supply chain can be ensured with point to point update over the chain
- Provide security and achieve trust among the participants.
- Smart contracts can provide a better agreement between the participants
- Recorded transaction onto the blockchain will be permanent.
- Decentralized system will be remove the third party
- Creating a “chain” of information.

With 40% of the global workforce, agriculture sector presents 6.5% of the entire world’s economic production and its total

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worldwide production is $5,084,800 million. If we have ever visited the farm, we would have seen that farmers have complicated ecosystem with seasonal financing structures, careful timing and a lot of moving parts. After the food leaves the farm for the market, it becomes a part of the vast supply chain involving a lot of intermediaries, everyone would like to know where the grains has been produced before it is used. What if we could check the quality of grains before we eat it? It can become possible with blockchain in executing contracts and tracking information transparently. [4]

II. BLOCKCHAIN BASICS

Blockchain is a unique information storage technology that allows all members to record transactions in a digitized, decentralized data log maintained on a network of computers, rather than a physical ledger or a single database. It allows for transaction of values among the participants.

- Users create a permanent, unchangeable record of a transaction(a block of information) via what is known as distributed ledger technology
- The record is encrypted and stored on a network of computers that includes all the participants in the transaction.
- An identical copy of the transaction history, or ledger, is shared among participants, which eliminates the need for a third-party verification of the transactions accuracy.
- Each new transaction is permanently recorded to the ledger through verification by the network,

.

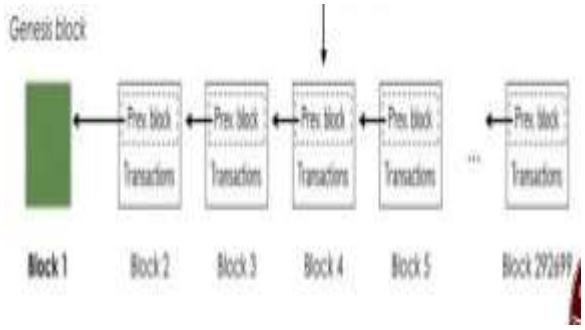

Fig. 2.1 Blockchain

Blockchain also helps on abundant supplies and reduce cases illegal producing and fraudulent activities.

III.METHODOLOGY

A. REQUIEREMETS FOR SYSTEM DESIGN

- Data on the blockchain should be brief.
- System should ensure the accessibility of sharing data among participants in specific supply chain and the inaccessibility of other people.
- System should provide way to ensure the quality and legitimacy of the data uploaded to the blockchain.
- System should be able to resist fraudulent activity.
- Data in the system must be authenticated.
- Cost should be controlled.

B. BLOCKCHAIN TECHNOLOGY

Blockchain is a data structure formed by blocks linked together. Each block consists of a block header and a block body, which is a collection of industry data such as bitcoin transaction records, smart contract codes, and agricultural tracing records, etc. The block header includes the metadata of the block. The most important part includes the timestamp of the block, the hash value of the block, the ID of the block, the ID of the parent block. The existence of the parent block ID makes all the blocks form a chain structure, as shown in Fig.3.1. The insertion of new blocks is allowed only in the tail, while the existing blocks are not allowed to be modified, which is a key rule of blockchain.[3]

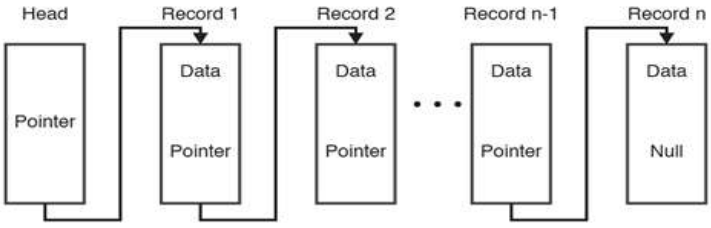

Fig 3.1: Structure of a typical blockchain

Working

EthereumDApp that demonstrates a Supply Chain flow between a Seller and Buyer. The user story is similar to any commonly used supply chain process. A Seller can add items to the inventory system stored in the blockchain. A Buyer can purchase such items from the system. A Seller can mark an item as Shipped, and similarly a Buyer can mark an item as Received.

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Ethereum is a "blockchain-based distributed computing platform" that allows user to create distributed program called **smart contracts**.

These contracts are written in a language called **Solidity** that has a C-like syntax .To actually use these smart contracts, you need to deploy them to the Ethereum network by paying some Ether, the native cryptocurrency of Ethereum blockchain.

Ethereum Ecosystem

- Decentralized platform that runs smart contracts.
- Provides developers with a foundational layer: a blockchain with a built-in Turing-complete programming language.
- Works on peer-to-peer network protocols where each blockchain database is maintained and managed by multiple nodes. [6]

Smart Contracts: Smart contracts allow to exchange money, shares, or anything of value in a transparent way while avoiding the services of a third party. Smart contracts help reading and writing data to the blockchain and executing logic. This is where we will actually code the application which is decentralized. Programming language is solidity, in which smart contracts are written.

C. SUPPLY CHAIN ARCHITECTURE

The architecture diagram describes the process in the Blockchain based agriculture supply chain. It contains the process of transfer of goods from the farmer to the consumer. As the Blockchain makes the process transparent every process is visible to every participant in chain. This makes the process immutable. Supply chain management includes the modeling and planning as well as the execution of various processes.

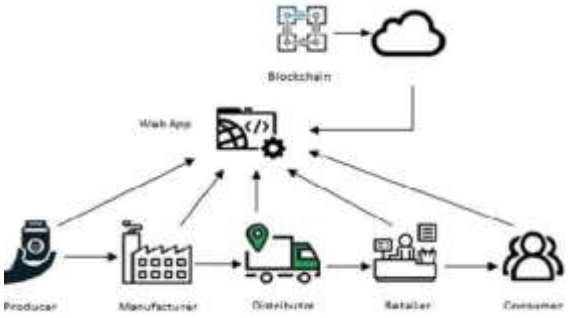

Fig 3.2: Supply chain Architecture [2]

IV.PROCESS FLOW

In the following we summarize the process involved in the supply chain:

- **Producing the goods (Farmer)**

The farmer will harvest and process the crops. After the processing of the crops the Farmer enters the details about the crops in the application built for the supply chain. The activities like harvest, process will be recorded on to the web app.

- **Distributing the goods (Distributor)**

The goods will receive by the distributor after farmer performed his activities. The distributor will distribute the goods to the retailer and transaction will be labelled as shipped on to the web app.

- **Selling the goods (Retailer)**

Retailer receives the goods from the distributor and the transactions will be marked.

- **Buying the goods (Customer)**

The customer will able to view the details about goods. The customer satisfaction can be achieved about the products they are buying. Customer will able to know the product origin and established trust among supply chain participants.

V. ADVANTAGES

- The supply chain can be ensured real time monitoring over the chain
- Provide security and achieve trust among the participants
- Provide transparency
- Smart contracts can create an agreement among the participants.
- Recorded transaction onto the blockchain will be permanent; hence no one can modify the data.
- Decentralized system will be remove the third party
- Makes the entire process fast.
- Customers know where their goods and fibres come from.

VI. IMPLEMENTATION

A. Prerequisites

- Truffle v5.0.3 (core: 5.0.3)
- Solidity - ^0.4.25 (solc-js)
- Node v10.14.1

- **Node Package Manager (NPM):** The first dependency we need is Node Package Manager, or NPM, which comes with Node.js. You can see if you have

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node already installed by going to your terminal and typing:

```
$ node -v
```

- **Truffle Framework:** The next dependency is the Truffle Framework, which allows us to build decentralized applications on the Ethereumblockchain. It provides a suite of tools that allow us to write smart contacts with the Solidity programming language. It also enables us to test our smart contracts and deploy them to the blockchain. It also gives us a place to develop our client-side application.We can install Truffle with NPM in command line like this:

```
$ npm install -g truffle
```

- **Ganache:** The next dependency Ganache, a local in-memory blockchain. It will give us 10 external accounts with addresses on our local Ethereumblockchain. Each account has 100fake ether.
- **Metamask:** MetaMask is a browser extension. It will be allows web applications to interact with the Ethereumblockchain. For users, it works as an Ethereum wallet, allowing them to store and send any standard Ethereum tokens.

  For developers, it allows to develop and run Applications right in our browser without running a full Ethereum node (which is what developers had to do before Metamask was available). MetaMask talks to the Ethereumblockchain for our web application.

B. Writing the smart contract

We'll start our dapp by writing the smart contract that acts as the back-end.

1. Create a new file named name.sol in the contract/ directory.
2. Add the following content to the file:
   pragma solidity^0.5.0;
   contract name{}

When deploy a contract on a network (main or test network), will get an address to be able to call it. To call a smart contract by keeping track of where (i.e. the address) is deployed, Truffle makes it easy.

C. Compilation: Solidity is a compiled language, In a terminal, make sure it root directory that contains the dapp.

Run: npm run compile

D. Migration

Migration is a deployment of contracts, it change the state of application's contracts. Before migrate the contract to the blockchain, it need to have a running blockchain. Here by using Ganache, a personal blockchain for ethereum development we can use it to deploy contracts, run tests and develop applications.

E. Runing the tests: In the terminal,

Npm run test

VII.RESULT ANALYSIS

Creating a user interface to interact with the smart contract

A. Instantiating web3

Examine the file /src/js/app.js. There is a global object to manage application, load in the data in init() and then call the function initweb3(). The web3 JavaScript library interacts with the Ethereumblockchain. It can get user accounts, send transactions, and interact with smart contracts.

B. Instantiating the contract:

It is possible to interact with Ethereum trough web3, it need to instantiate smart contract so web3 knows where it is. Now that we can interact with Ethereum via web3, we need to instantiate our smart contract so web3 knows where to find it and how it works. Truffle library called @truffle/contract help this by keeping track of information about the contract with migrations.

C. Interaction with the smart contract:

Now, through the terminal, run the application: npm run dev

When we make transaction, every ime we get back a transaction id which is proof that this transaction occurred and we can refer it. It also labels the activities of the users eg. Shipped, received etc.

VIII.CONCLUSION

The Blockchain based agriculture system will build a decentralized agro-market. The whole system transactions will be monitor. The supply chain can provide transparency, security and achieve trust among the participants. By using the blockchain, the entire process can be simplified to a single system.

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