A Mini-Project Report on

PHARMA SUPPLY CHAIN USING BLOCKCHAIN & IOT

Submitted in fulfillment of Mini-Project (ITM605)

of Semester VI

in

Information Technology

By

Jainam Chopra (18104064)
Satish Gupta (18104024)
Yash Bhosale (18104049)

Prof. Apeksha Mohite
Prof. Nahid Shaikh

Department of Information Technology NBA Accredited
A.P. Shah Institute of Technology
G.B.Road, Kasarvadavli, Thane(W), Mumbai-400615
UNIVERSITY OF MUMBAI
Academic Year 2020-2021

CERTIFICATE

This is to certify that

Mr. Jainam Chopra Student ID 18104064

Mr. Yash Bhosale Student ID 18104049

Mr. Satish Gupta Student ID 18104024

has completed all the specified work for submission in Mini-Project (ITM605) of Semester VI, as laid down by University of Mumbai in satisfactory manner within the premises of Institute during the academic year 2020-21. _____.

(Prof. Nahid Shaikh) Co-Guide

(Prof. Apeksha Mohite)
Guide

Prof. Kiran Deshpande
Head Department of Information Technology

Dr. Uttam D. Kolekar
Principal

External Examiner(s)

1.

2.

Place: A.P. Shah Institute of Technology, Thane
Date: 22/05/2021

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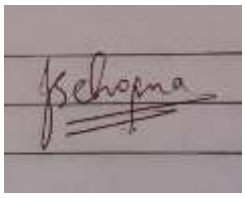
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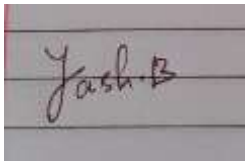
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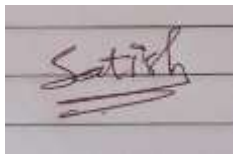
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Abstract

In today's globalized economy, supply chains in every industry are expansive and complex. Products are designed by teams in one or more locations, manufactured at other locations, stored elsewhere, and sold everywhere. Goods and components pass through various countries, warehouses, weather conditions, handling methods, and storage situations before final products reach end consumers. Developing a system combining IoT and blockchain provides a mature way to digitally track and trace pharma supply by fully integrating supply chain applications with core ERP applications. The system that we are trying to implement is based on Ethereum Blockchain that will store all the transactions made during the process product shipment. Using the concept of smart contracts of blockchain technology we can triggers various events like if the temperature has been ideal throughout the journey then double amount will be payed, and in case of destroyed goods penalty will be imposed on the stakeholder. This system will solve the problems faced by various regulators, end retailers and even end customers, by making a transparent system which eliminates all the trust issues by using Tamper proof Hardware along with Tamper proof Software.

1. Introduction

1 million people die every year because of counterfeit drugs.25% vaccines reach the destination in a degraded condition. 20% temperature sensitive products are destroyed during shipping. These numbers indicate that pharmaceutical supply chain safety is often measured only after the damage is done. Currently the traditional supply chain market uses manual intervention's in generating ASN, Purchase orders packaging and labeling barcodes, current infrastructure is just limited to tracking the location of an asset, in the current environment there is a lot of trust issues between all the parties because of the opaque nature of the business, and even catching hold of the real stakeholder responsible during damage of goods is not at all possible, which is one of the loopholes exploited by major big companies.

At minimum a blockchain based ledger is needed that stores the transactions done in the process of land ownership transfer. This problem is solved by Satoshi Nakamoto in his paper about bitcoins when he created. Implementation of applications using blockchain guarantees the quality of digital data that is being used [4].

a) Storing the information in a blockchain,
b) For correctness protocol rules can be used,
c) And for identifying the owner public key cryptography can be used.

One of the supports of the new paradigm is the blockchain technology, where the fight against corruption and cost reduction are conformed as guarantees of this technology, but it is precisely in its conjunction with the different governments where both fields have to be properly adapted [2]. Ethereum is a free open-source platform which helps developers to build and deploy decentralized Applications such as smart contracts and other complicated legal and financial applications. Ethereum is kind of a programmable Bitcoin where developers can use the underlying blockchain to create markets, shared ledgers, digital organizations, and other endless solutions application to a problem that need immutable data and agreements, all without the need for a moderator or realtor. Released in 2015, Ethereum is the brainchild of the prodigious Vitalik Buterin, who saw the potential uses of Bitcoin’s underlying blockchain technology as the next steps in speeding the expansion of the blockchain community. Ethereum is now currently the cryptocurrency with the second highest coin market cap and is expected by some to surpass Bitcoin as both a valued investment and as the world’s most popular cryptocurrency. Hence, Ethereum is best suited for creating a ledger that stores transactions during the land ownership transfer process. The aim is to create a ledger along with some smart contracts that will triggers the various events that are going to happen on the system during the process of transfer of pharma goods from one party to another.

The roles in the system are:

1. Manufacturers
2. Exporters
3. Wholesalers
4. Retailers
5. Regional buyers

2. Literature Review:

- 1:
    - Title: Product Tracking and Tracing with IOT and Blockchain, Infosys 2020 5th International conference
    - Authors:

      Dr. Arnab Banarjee, Murali Venkatesh

    - Findings: Current supply chain monitoring is limited just to certain logistic activities, real time condition monitoring of medicines, vaccines still a problem. The proper use of IOT and Blockchain is made to sense tamperproof data using TEE(Trusted execution environment), and tamper proof software using cloud and blockchain which give impregnable security in terms of data integrity which use SHA 256 algorithm the most secure algorithm in terms of cryptography and hashing the input data it cannot be breached. So, this combination of tamperproof hardware and tamperproof software helps building tamperproof and transparent system.

- 2
    - Title : Sustainable evaluation and verification in supply chains: aligning and leveraging accountability to stakeholders, J. Oper. Manag. 38 (2015) 1–13.
    - Author: J. Gualandris, R.D. Klassen, S. Vachon, M. Kalchschmidt Findings : Monitoring assets from the manufacturing level-monitoring components exactly from the time they are produced till the time they are delivered to end customer. Many a times the parts/components are stored in such conditions which either damage the component or destroy it resulting in degrading the performance of the final product. Hence finding the root liable authority for any damage caused is a major problem.
    - Blockchain issues token recipes for every component involved in making a product, which starts monitoring the condition right from the production line where the parts/components are produced and kept to be stored. As the components changes hands or gets added with new components or product the ownership also gets changed and a new block

is created using smart contracts, keeping the initial ownership records intact.

- 3 ○ Title: Traceability issues in food supply chain management: a review, Biosyst.

  Eng. 120 (2014) 65–80. ○ Author:

F.Dabbene, P. Gay, C. Tortia

○ Findings: Manual intervention increases the chances of data tamper while the products moves from one party to another. This paper focuses on the issues such as product recalls, triggering defaulter payments, claiming insurances, and looking into the clearing of custom houses in case of international export/import, as a small business or a consumer is not aware about the import and export laws, this system proposes developing a software using Erethrum Web Framework which directly uses the IF… THEN logic for triggering Smart Contracts.

3. Existing System Architecture/Working

Traditional supply chain management systems are isolated from other participants and unable to provide comprehensible provenance information which cause some shortcomings, including insufficient trust between parties, isolated data storage, and unsatisfactory standardization in communication and data formats.

The state-of-the-art for tracing and tracking products throughout a supply chain is to store records of suppliers and customers in a centralized manner within the supply chain management system of each participant. This information is isolated or shared among suppliers and customers to achieve comprehensive insights on supply chain provenance. For storing, sharing and managing relevant information, a plethora of information systems are used in practice. Warehouse and transport management systems focus on internal warehouse operations, while Enterprise Resource Planning (ERP) systems include supplier management, reordering and billing. Dedicated supply chain management applications target at forecasting future demands and satisfying them by available suppliers. As no global view on the supply chain is given, provenance information is retrieved from the next tier, requiring trust in the supplier or a third party.

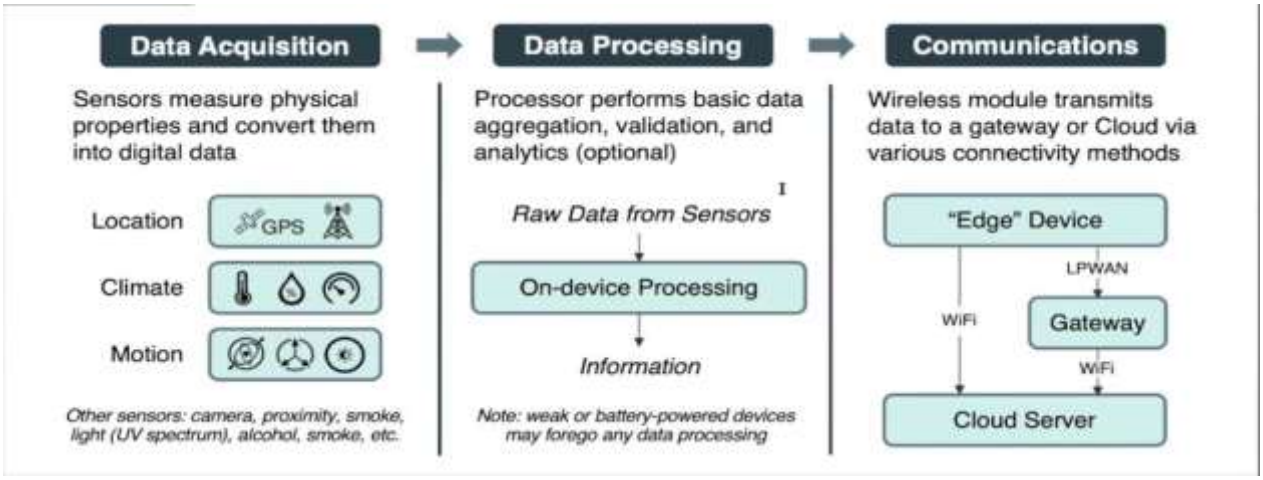
However, it is essential to enable the multi-tier traceability to decrease risks caused by quality fluctuations in source products .In order to ensure the coupling between physical goods and digital representations, identification mechanisms are fundamental. The ISO 28219:2017 standard defines guidelines for creating globally valid identifiers that are enforced by utilizing bar codes or twodimensional symbols, such as QR codes and alternative RFID tags, to project physical goods onto digital systems. Identifiers either refer to individual goods or product batches. Varying the batch size is able to influence the granularity to which the products are traceable. To ensure a certain quality grade**,** Bechini et al, have proposed a scheme to define batches of goods that are linked to a multitude of quality features. While traditional supply chain information systems are capable of uniquely identifying products, their traceability is limited. This is mainly due to isolated data that only reflects the organizations' sourcing and sales while tracing ingredients over multiple tiers would require shared data that is tamper-proof while maintaining high accessibility.

❖ The above diagram shows the current or traditional logistics supply where in there is no central system wherein all members are notified about the condition/location of a shipment.

4. Problem Definition

There is a pressing need for product tracking and tracing owing to globalized supply chains, diverse suppliers, risk of counterfeit products, and customer demand for in-depth visibility.

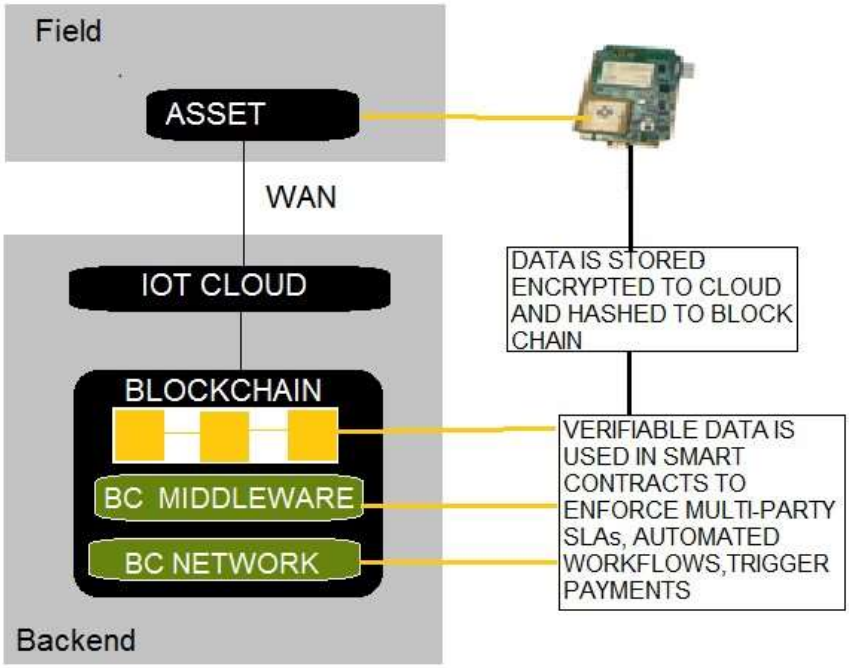
We recommend a system that allows for the traceability of manufactured goods, including their components. Products are represented using non-fungible digital tokens that are created on a blockchain for each batch of manufactured products. To create a link between a product and the components that are needed to produce it, we propose “token recipes” that define the amount of tokenized goods required for minting a new token. As input tokens are automatically and transparently consumed when creating a product token, the physical process of producing a new item out of existing components is projected onto the ledger. This ultimately leads to the complete traceability of goods, including the origin of inputs. Evaluating the performance of the system, we show that a prototypical implementation for the Ethereum Virtual Machine (EVM) scales linearly with the amount of The input and goods tracked.



❖ This is a data life cycle of typical IOT setup. Until now IOT was largely combined with Cloud Computing for any use case. But this again raises security concerns because the data collected by the sensors if it stored on the cloud there is a threat if there is DDos attack or there is a data breach, so to overcome this problem BLOCKCHAIN comes to the rescue.

5.

SYSTEM ARCHITECTURE/WORKFLOW



IoT sensors/devices capture data automatically, without human intervention. It helps determine and verify the source of component materials and their regulatory compliance. Sensors embedded in transported goods can monitor items and alert supply chain members to issues such as temperature deviations or product damage. At every stage of the supply chain data is captured with sufficient granularity to conduct root-cause analyses, determine liability in case of an incident, and gain any number or type of insight. When IoT data feeds into a blockchain, the data can be shared within a peer-to-peer network, distributed ledger. Each member of a supply chain—including producers, suppliers, processors, distributors, and retailers—is a node in the blockchain network and can access all data within the blockchain at any time. Smart contracts— self-executing scripts residing within the blockchain—integrate members and allow for proper, distributed, heavily automated workflows for information sharing. This provides a fully transparent, single source of truth about the provenance of materials, production history, and condition of items in transit changes of custody and ownership, and last-mile delivery information— all in real time.

Objectives

1. To design a supply chain traceability system that models manufacturing processes as token recipes.
2. To present a prototypical implementation for the Ethereum Virtual Machine (EVM) using smart contracts.

6.

3. To make users or the members present in a blockchain aware about the whereabouts' and the conditions of vaccines, medicine's etc.
4. To provide a decentralized, immutable, and secure blockchain.

7. Project Scope

1. Our project can be used in pharma supply chain
2. Our project can be used in efficient management of vaccines.
3. Our project can be used in logistics management of medical pharmacy equipment’s including door to door delivery.
4. Our project can be used in manufacturing operations etc.

8. Technology Stack/ Hardware used

i. **Backend** - Ethereum, Web3.js, Solidity, Truffle, Metamask

ii**.Frontend** - React.js, CSS, JavaScript

iii.Database - IPFS (Decentralized Storage)

iv.Server-Side Frameworks - Express.js

v. IOT DEVICES

External Gps : Taidou TD 1030

Environmental sensors: Bosch BME 680

Light Sensors: PMT TSL 2752

Motion Sensor: TDK ICM-42605

9. CONCLUSION

We have proposed a blockchain-based supply chain management system that enables tracing and tracking goods, including their transformation in the production process using smart contracts. The system provides comprehensive provenance information by projecting product compositions onto the blockchain in the form of tokens. Hereby, shortcomings of current traceability systems regarding isolated data storage and the problem of lacking transformation information are tackled. Defining compositions for production and enforcing them by using smart contracts enable the documentation of consumed resources in the production process. Through this mechanism, products are traceable from production to retail and the process starts from resource exploitation. As a result, transparency is generated along the supply chain, providing comprehensible production information.

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10.References

1. F. Dabbene, P. Gay, C. “Tortia, **Traceability issues in food supply chain management: a review”,** Biosyst. Eng., 120 (2014), pp. 65-80
2. J. Gualandris, R.D. Klassen, S. Vachon, M. Kalchschmidt, “Sustainable evaluation and verification in supply chains: aligning and leveraging accountability to stakeholders”, J. Oper. Manag. 38 (2015) 1–13.
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