A Project Report on

Applying Blockchain to transparent, secure and traceable Supply Chain Management

Submitted in partial fulfillment of the requirements for the award
of the degree of

Bachelor of Engineering

in

Information Technology

by

Yugandhar Ghatge(19104046)
Mayuri Patil(19104012)
Abhijeetkumar Mishra(19104019)

Under the Guidance of

Prof. Neha Deshmukh

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

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Approval Sheet

This Project Report entitled ***"Applying Blockchain to transparent, secure and traceable Supply Chain Management"*** Submitted by ***"Yugandhar Ghatge"(19104046), "Mayuri Patil"(19104012), "Abhijeetkumar Mishra"(19104019)*** is approved for the partial fulfillment of the requirement for the award of the degree of ***Bachelor of Engineering*** in ***Information Technology*** from ***University of Mumbai***.

Prof. Neha Deshmukh
Guide

Dr. Kiran Deshpande
Head, Department of Information Technology

Place:A.P.Shah Institute of Technology, Thane
Date:

CERTIFICATE

This is to certify that the project entitled ***"Applying Blockchain to transparent, secure and traceable Supply Chain Management"*** submitted by ***"Yugandhar Ghatge" (19104046), "Mayuri Patil" (19104012), "Abhijeetkumar Mishra" (19104019)*** for the partial fulfillment of the requirement for award of a degree ***Bachelor of Engineering*** in ***Information Technology***,to the University of Mumbai,is a bonafide work carried out during academic year 2022-2023.

Prof. Neha Deshmukh
Guide

Dr. 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:

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Yugandhar Ghatge
(19104046)

Mayuri Patil
(19104012)

Abhijeetkumar Mishra
(19104019)

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Yugandhar Ghatge(19104046)

Mayuri Patil(19104012)

Abhijeetkumar Mishra(19104019)

Date:

Abstract

Companies nowadays must be adaptable, sensitive, and nimble to survive. The successful people are those who encourage ongoing innovation throughout their supply chains and businesses and who distinguish themselves in a cutthroat market by staying nimble and relevant. Enhancing the effectiveness and openness of your company's supply chain is essential as the pace of change quickens. Fortunately, Blockchain technology can facilitate the process' simplification. The transfer of commodities from producer to consumer is referred to as supply chain management (SCM). Every product in an SCM is the result of the combined efforts of numerous organizations and stakeholders. Blockchain technology possesses the capacity to improve user experiences by enabling tradeability, transparency, and traceability while also reducing costs. A reliable and impenetrable audit record of the movement of data, inventory, and money within a supply chain is provided via a shared Blockchain ledger. Businesses can track each transaction using Blockchain technology, which also makes it feasible to share papers, individual data and cryptocurrencies. The project aims to create a decentralized platform for supply chain management using Blockchain technology and smart contracts. The platform enables all supply chain stakeholders to participate and have a clear and immutable record of all transactions, from raw material sourcing to final product delivery. The smart contract's features include verifying the authenticity of goods, ensuring regulatory compliance, and automating payment processes. The transparency and security of the Blockchain network prevent fraudulent activities such as counterfeiting or data tampering. Blockchain technology and smart contracts also assist businesses in improving compliance, lowering legal costs and penalties for late tax payments, and reducing counterfeiting and fraud. The Blockchain can be used to construct a transparent supply chain because entries cannot be removed from it. Additionally, because every step in the chain is securely recorded, logistics problems may be quickly traced back to their origin.

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SCM: Supply Chain Management
DLT: Distributed Ledger Technology
RPA: Robotic Process Automation
API: Application Programming Interface

Chapter 1

Introduction

Supply chain management (SCM) is a crucial business activity in charge of transporting goods and services between different stakeholders[6]. The traditional SCM is based on a centralized approach, with all other sub-offices receiving instructions from the main office, which is handled at the central headquarters. Security, transactional transparency, traceability, stakeholder involvement, product counterfeiting, additional delays, fraud, and instability are some of the primary problems with current SCM systems. In today's economy, supply chain management is a crucial component in practically every business industry. As a result, there is a growing need for an automated and sustainable system that can address all the shortcomings of the earlier approaches.

Introducing Blockchain, which is merely a network of blocks. The terms "block" and "chain" typically refer to digital data that is stored in an open database. Blocks maintain information that sets them apart from other blocks, including information about transactions and information about taking part in a transaction. The network between a business and a supplier is established in order to distribute a certain product to the end-chain consumer. Additionally, it refreshes data on the good and service. The Blockchain system is utilised to ensure transparency and end-to-end tracking throughout the supply chain (cryptography and bitcoin transaction). A company that digitises its physical data using Blockchain technology and makes a decentralised, unchangeable record for access and transparency. For organisations, the Blockchain model is a game-changing technology that can be especially helpful for international transfers, transactions, and agreements. It may also open up new business prospects in a variety of industries, including retail, consumer packaged goods, healthcare, life sciences, and communications which are made possible by Blockchain technology and the capacity to express business logic using smart contracts: Transparency into the provenance of consumer goods from the point of origin to point of consumption, improvement in customer experience, and cost effectiveness.

Chapter 2

Literature Review

In this section, gists of ideas are covered from the various technologies used by authors. A few of them are summarized below.

- In paper[1], the proposed system focuses on the tracking of assets between every two parties in a supply chain and validation of the assets at every stage. Main entities of the system are the manufacturer, supply chain entities, customer and arbitrator. All the entities in the system have an associated Ethereum address and is used to interact with the permission based smart contracts. As the item passes down the supply chain, a series of transactions takes place while verifying the asset. A key hash is used to confirm the receiving of an item by the supply chain entities. Hence, a key is given with the asset to the next entity or finally to the customer and then its hash is created and compared to the hash already decentralised. This verification is done to ensure that the item that is received is the original one dispatched at the manufacturer's end and not an altered or fake one. Every entity in a supply chain will have it's own Ethereum address and a set of rules asserted to that address that they need to follow. Every product or product batch has a decentralised key asserted to it and also has a QR code or NFC tag on it that has the key hashed using keccak-256 encryption which is in-built in Solidity. When the product reaches an entity he/she scans the product to obtain the hashed key. This key is then matched with the key decentralised by the original owner of the product. This system eliminates the discrepancies in the current system and ensure customer satisfaction and create a tamper proof system. Although the system is efficient and provides transparency it might be difficult to set up and understand the network.

- In paper[2], a Blockchain based model is made to eliminate all the discrepancies present in the current system. The various entities participating in the system are the producer, processor, distributor, wholesaler, and retailer. Along with them, an authority organization is included in our system which is a physical entity and the customer is the end user of our system. Every entity has its characteristics and specific roles in the system. Initially, every entity participating in the system have to register themselves. They will be then provided the credentials and their digital signature to enter into the system. This will allow them to mine a block into the Blockchain system. The mining of a block in the system will include the timestamp, the digital signature of the entity

who mined the block as well as the data of the product conveying the state of the product at their end. This data could be of any form. It could simply be a text file, an image file for an individual product, or a video file for a batch of products. This is a generalized system that can be used for a wide range of products. The authority organization could be a government body that will verify every entity participating in the system. They will perform random visits at the work fields of the entities to examine whether all the rules and regulations are being followed and every task is being performed under specific guidelines.The process will begin at the producer end where they produce the raw material for our finished product. The raw material could be taken into multiple processes such as refining and filtering them, making it more suitable to be processed later to manufacture the final product. After all the processes are carried out with the product, it will be associated with its unique ID. In the final stage, the product would be available in the retail store for the customers to purchase them along with the unique ID tag present on the product. This tag on the product will allow the customer to scan them and scrutinize all the blocks that were associated with that particular product and trace all the activities that were undertaken with the product from the raw state at the producer end to the final finished product at the retailer end. As the model works on a QR basis, there might be some possible errors and mismatching which destroys the entire trustworthiness within the system.

- In paper[3], the task was providing a supply chain system that would connect many small businesses to minimize the need for expensive infrastructure, and since the target sector was dairy products they also wanted to provide a system that would be easy to learn and use for non-technical people to make the system available via a mobile app due to the ubiquity of mobile devices and peoples familiarity with them. React-native was used 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 webapp with minimal adjustments. For the server-side Blockchain implementation Hyperledger Composer is used. Its user friendly GUI, allows to dive in and get started straight away, and its modeling language mapped well to the problem domain. 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. Smart contract contains the minimum and maximum temperature criteria and penalties in different scenarios. 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. Hyperledger provides limited access to the features as compared to the public Blockchain and due to which it requires higher knowledge and set up cost.

- In paper[4], SCM, the phrase "product confidentiality" is very significant. It means that only those who have been validated have access to the information. This paper emphasizes reducing the involvement of third parties in the supply chain system and improving data security. Traditional supply chain management systems have a number of significant flaws. Lack of traceability, difficulty maintaining product safety and quality, failure to monitor and control inventory in warehouses and shops, rising supply chain expenses, and so on, are some of them. The focus of this paper is on minimizing third-party participation in the supply chain system and enhancing data

security. This improves accessibility, efficiency, and timeliness throughout the whole process. The primary advantage is that individuals will feel safer throughout the payment process. However, in this study, a peer-to-peer encrypted system was utilized in conjunction with a smart contract. Additionally, there are a few other features. Because this document makes use of an immutable ledger, the hacker will be unable to get access to it. Even if they get access to the system, they will be unable to modify any data. If the goods are defective, the transaction will be halted, and the customer will be reimbursed, with the seller receiving the merchandise. By using cryptographic methods, transaction security will be a feasible alternative for recasting these issues. Finally, this paper will demonstrate how to maintain the method with the maximum level of safety, transparency, and efficiency. This paper is a small-scale and extremely particular piece. However, if there is a large volume of data, the latency may be affected. Blockchain transactions will be extremely beneficial in terms of storage and computational costs.

- In paper[5], The automation of operations within the supply chain management (SCM) is maintained with increased evolution; each part of supply chain management is being affected by the digital transformation and the challenge to become more agile, efficient, and dynamic. To consistently achieve performance, supply chain management (SCM) must focus on higher- value activities that lead to significant results. The automation of low-value activities is important for the continuity and sustainability of supply chain management (SCM) and at the same time for providing better results. Software robots work 24 hours/7 days and can be implemented quickly because they can work on the existing architecture of programs that are already used in SCM. Robotic Process Automation (RPA) can be trained and prepared by users to undertake repeatable structured tasks 7 that interact at the same time with multiple computer systems. The article considers the definition of RPA and its benefits in SCM, the use of RPA within SCM, as well as an example of the applicability of RPA in supply chain management. Lack of interoperability is the major drawback identified in the system.

- In paper[6], Blockchain (BC) emerges as a technology that can manage the data and build trust efficiently and transparently. It can also aid in transaction authorization and verification in the supply chain or payments without a third party. To address the present SCM issues, BC technology is a feasible solution. This paper undertakes a comprehensive analysis of the literature on BC characteristics, implementations, and business consequences in various SCM. This Blockchain-centered study, in particular, discloses the research state and delineates future research directions by studying and analyzing 97 up-to-date publications highlighting BC's supply chain uses. Transparency and traceability, information sharing, product anti-counterfeiting, and building trust are the major aspects propelling BC's implementation in SCM. Further, they analyzed various applications of SCM in which BC can be used as a probable technology to secure all transactions. Here, they have highlighted open issues and research challenges for adopting BC technology in SCM that open the doors for beginners eager to start work in this amazing area.

- In paper[7], the thesis mainly applies the management ideas of supply chain. First, it analyzes the production and distribution(PD) system in the supply chain environment through the method of system analysis, and through the further study of the model,

it is found that the system analysis method does not reflect the reality well, and the operation time is total. It appears as a fixed value, and system simulation can make up for this shortcoming. Therefore, this paper proposes a combined analysis method of system analysis and system simulation. The data obtained through system simulation is applied to the analysis model, and then, the system analysis method is used to study the PD system. The following conclusions are obtained: The comprehensive idea of supply chain management can reflect the relationship between overall efficiency and local efficiency and reflect the interdependence and interaction between overall efficiency and local efficiency. However, mining is an extremely difficult task that requires a lot of electricity and money to lay out computing power to complete. This may lead to lower investment in mining hardware.

Chapter 3

Project Design

The main goal is to make a system that tracks an asset throughout the supply chain and if there is any tampering or replacement, then find out exactly at which stage it took place. Our solution will work irrespective of the size and extent of the supply chain.

3.1 Existing System

Existing traceability systems adopt either a centralized or distributed architecture. Centralized architectures are managed by an authoritative third party body with the risk of (i) single node attack, (ii) data tampering, and (iii) information disclosure. The practice of tampering with the products has been on a constant rise since the last decade. Supposedly a product is being transferred from one stage of supply chain say manufacturer to the next person in supply chain say distributor, someone sees this as an opportunity and replaces the original product with a duplicate one in order to sell the original product someplace else for maximum profit. The statistics have shown that people using counterfeiting products have increased by 23 percent over the last three years. With customers not being satisfied with products they blame the company for it hence it damages the reputation of the company. Also, if products like medicines get tampered, it will result in a disaster. The Blockchain system is built on a foundation of decentralisation, traceability, tamper-proofing, and cryptographic security.

3.2 Proposed System

Proposed system will be able to work with as many manufacturers or supply chain administrators as required and will work in an ample, trustworthy and safe way.

The main functionalities of the system are :

a. Supply chain Management - The foremost objective is to develop a supply chain management system using Ethereum Blockchain. The system would be a web based application where users are registered with their respective roles. Once the access is granted, the interfaces gets displayed through a Blockchain enabled transaction. There they would be able to track the assests as well authorise their identity for proceeding further in the chain. Every single transaction that happens in the supply chain is archived on the Blockchain and reflected in real-time, making each stakeholder an active participant in all the transactions.

Real-time tracking makes it easier for one to be familiar with every activity going around at any point in time.

b. Secure Environment - With the use of Blockchain, the entire system process gets encrypted within the network making it highly secure and traceable. Users find it much more convenient in sorting transactions and supplying of assets. In a Blockchain supply chain, one or more transactions are recorded on different blocks. These recordings are then distributed over a network of computer systems in the Blockchain, which makes the information highly available and transparent.

c. Automated design - The entire SCM system is not only well encrypted but also automated which makes the application even more desirable. Users find it very easy to navigate between the functions, make transactions and other. To ensure proper collaboration between staff in different departments, automation of the system is ensured with technologies such as Robotic Process Automation. It is critical to lay down processes of communication when shipments have been successfully delivered, when they are stuck midway or delayed, and when they need to be canceled.

A decentralized approach multiplies the security of the automated system with authentications and verifications. The proposed methodology mainly consists of Ethereum Blockchain which is integrated with the application along with smart contracts. The main entities involved in the supply chain are :

- Manufacturer : The individual who initiates the chain by manufacturing of a product.
- Vendor : The entity who purchases products in sets so as to sell it to their customers.
- Delivery Hub : The storage area responsible for transporting of goods from vendor to the customer.
- Customer : The end user of the product.

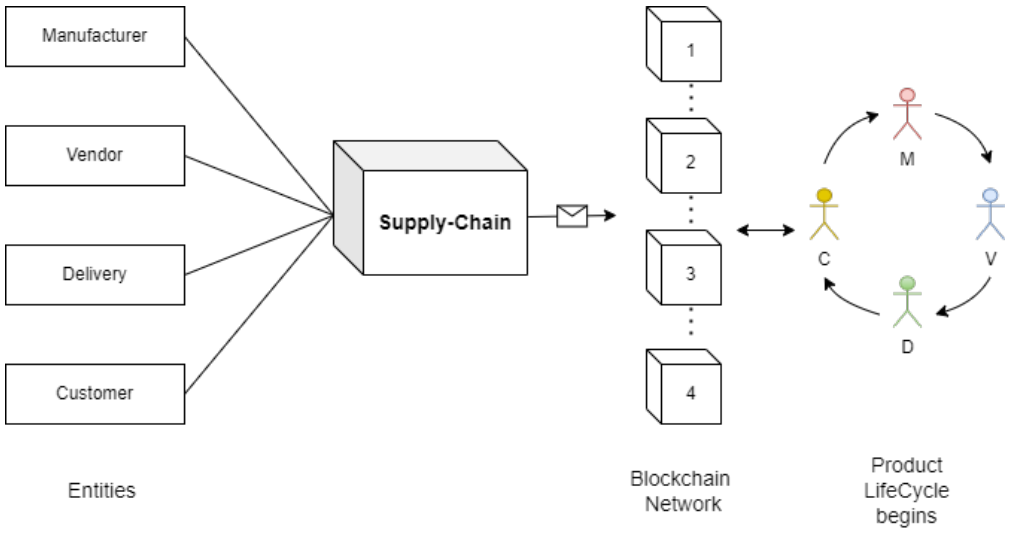

Figure 3.1: Workflow

3.3 System Design

The design is formerly based on Ethereum Blockchain which acts as the backbone and data storage centre for the system. Accordingly, smart contracts are designed which provide the general workflow for the Blockchain. Supply chain entities need to be added with their addresses to authenticate the transactions between them. Smart contracts are compiled and tested with a local Blockchain network such as Ganache. The entire truffle suite environment provides all the compilations and migrations tasks of contracts. The address details and transactions are done with a wallet namely Metamask. All this part is integrated with a react framework in the interface.

3.3.1 Block Verification

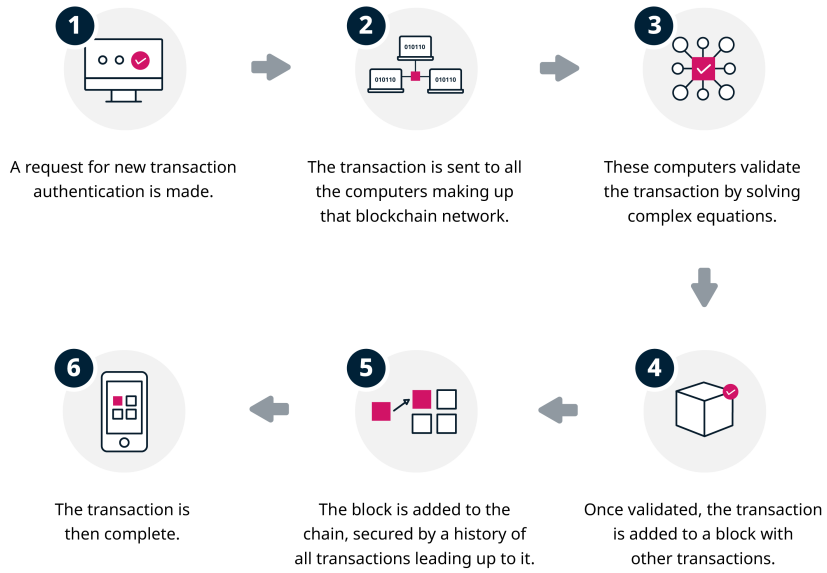

Figure 3.2: Lifecycle of a block

The figure above demonstrates the exact mining process and how new blocks get added into the Blockchain.

3.3.2 System Functionalities

The entire worklow is designed to almost 9 steps and includes transactions among all these four entities. However, the administrator is responsible for adding these entities to the chain and registering them.

Step 1 : Manufacturer creates a product.
Step 2 : Purchase of manufactured product by Vendor.
Step 3 : Shipping of purchased product to Vendor.
Step 4 : Received the purchased product shipped by Manufacturer.
Step 5 : Purchase of a product at Vendor by Customer.
Step 6 : Shipping of product by Vendor purchased by customer.

Step 7 : Receiving of product by delivery hub purchased by customer.
Step 8 : Shipping of product by delivery hub purchased by customer.
step 9 : Received by customer.

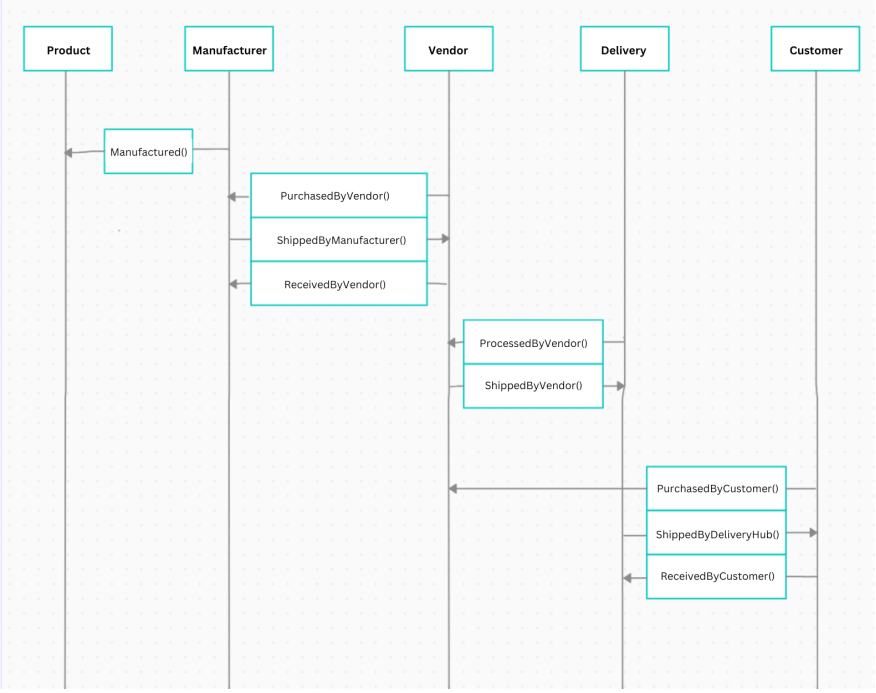

Figure 3.3: Sequence Diagram

The sequence diagram shows the exact representation of the 9-step functions that get called. These functions are declared in the smart contracts and act as events or checkpoints for the application flow.

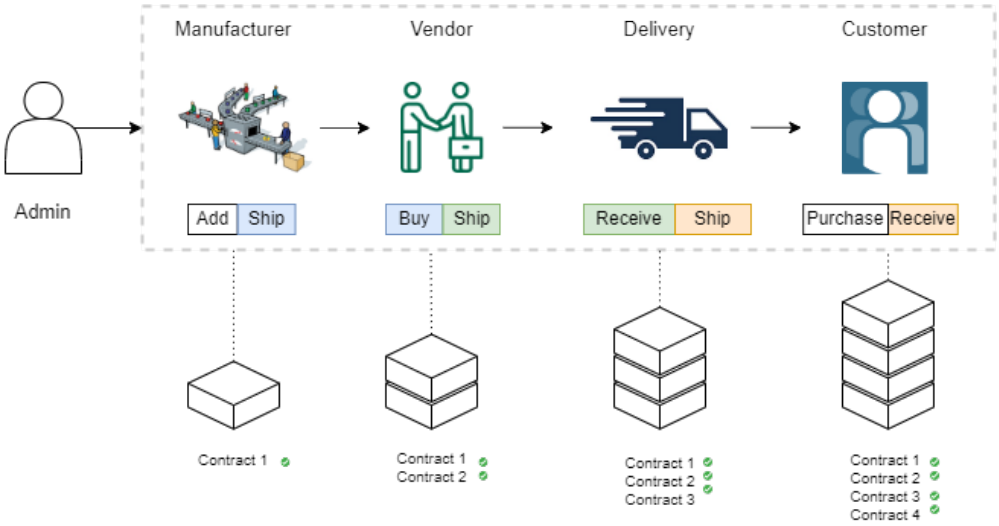

Figure 3.4: Product Flow

3.3.3 Technologies

The main technologies used in the system includes :

- Ethereum - Ethereum network acts as the core pillar of the system where all the block details are stored in the chain.
- Solidity- The main language used for making contracts and interacting with the Blockchain network.
- Web3JS- Web3JS is an advanced version of Javascript which plays an essential role in carrying out transactions and contract calls.
- MaterialUI- The entire framework is being integrated with React's Material UI framework.
- Truffle Suite- Truffle suite package comes up with tools for implementing and migrating contracts as well as setting up a local Blockchain network.
- Metamask- One common wallet used for making transactions is Metamask where all account addresses are registered with their associated public and private keys.
- Maps API- For better traceability and experience, the system is integrated with a google maps api key which tracks the exact location for the product.

Chapter 4

Project Implementation

The entire implementation is based on a two step process :
a. Contract creation and deployment
b. Application Integration and Testing

4.1 Contracts

The initial step after creation of contracts is to compile them and check for errors/issues. Smart contracts define the structure and workflow of the system. They are primarily used for defining the logic behind the chain and what functions need to be performed as well stored in the block.

Figure 4.1: Compilation

After successful compilation, the next step is to migrate them to the Blockchain network. Migration details include the contracts that need to be deployed and other details.

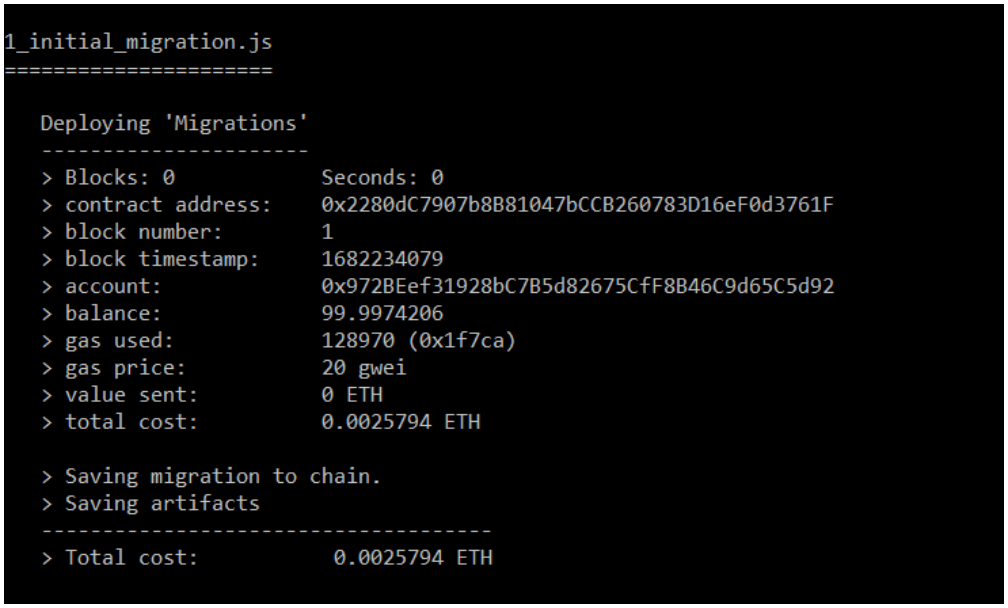

Figure 4.2: Migrations

For the transaction processing, a gas fee is charged and deducted from one of the local Ethereum accounts. Finally the contracts are deployed. Deployment is done through local Ganache Ethereum account and all details are stored in a block.

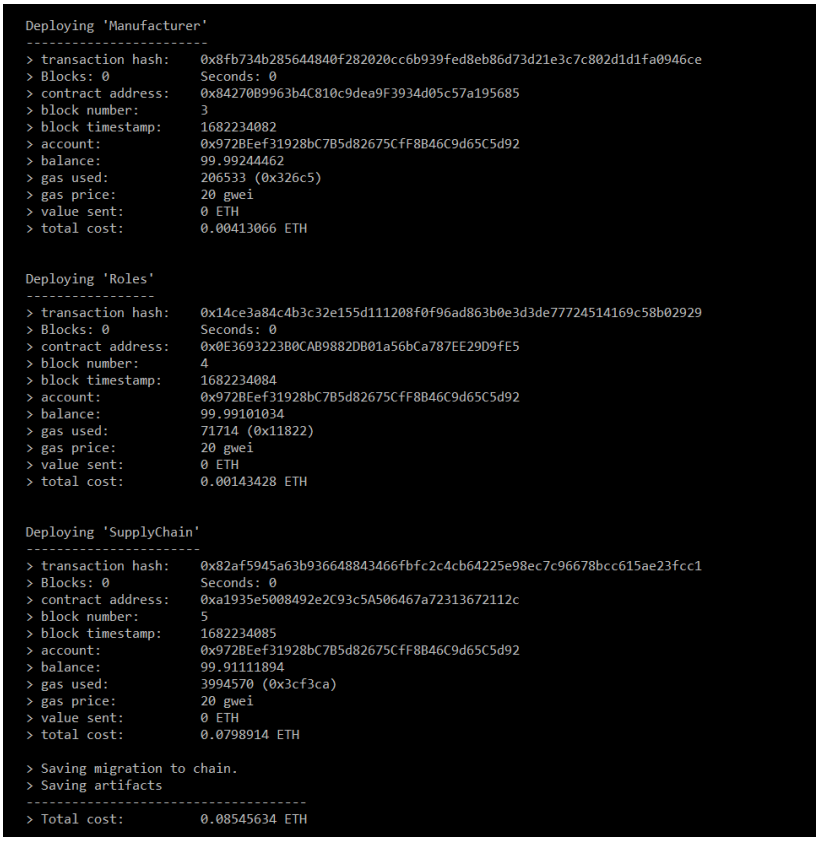

Figure 4.3: Deploy contracts

4.2 SCM Application Interface

The home or the landing page of the application where the user or the admin is exposed to all the features of the system.

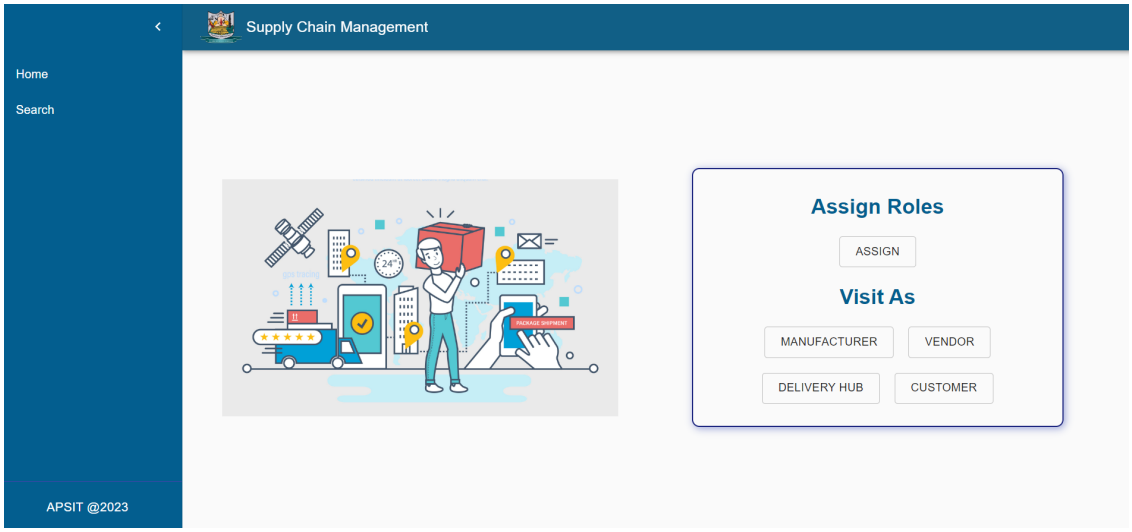

Figure 4.4: Landing page

The first step to start the chain would be assigning addresses to the all the respective entities that will be participating in the supply chain.

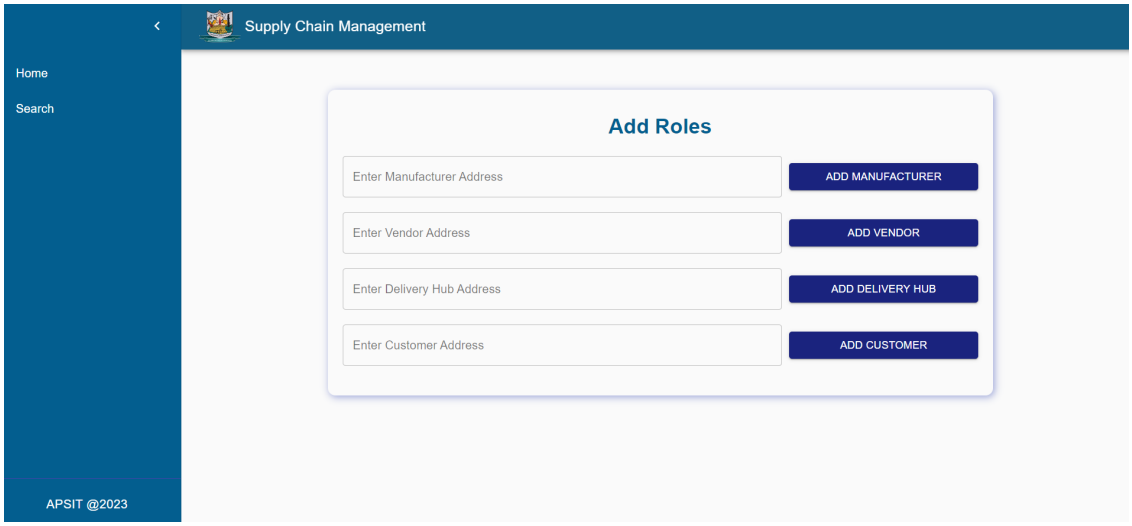

Figure 4.5: Assign account addresses

The process gets started with the creation of a product/asset by the manufacturer. Also, the manufacturer is further provided with shipping function on request generated by the vendor.

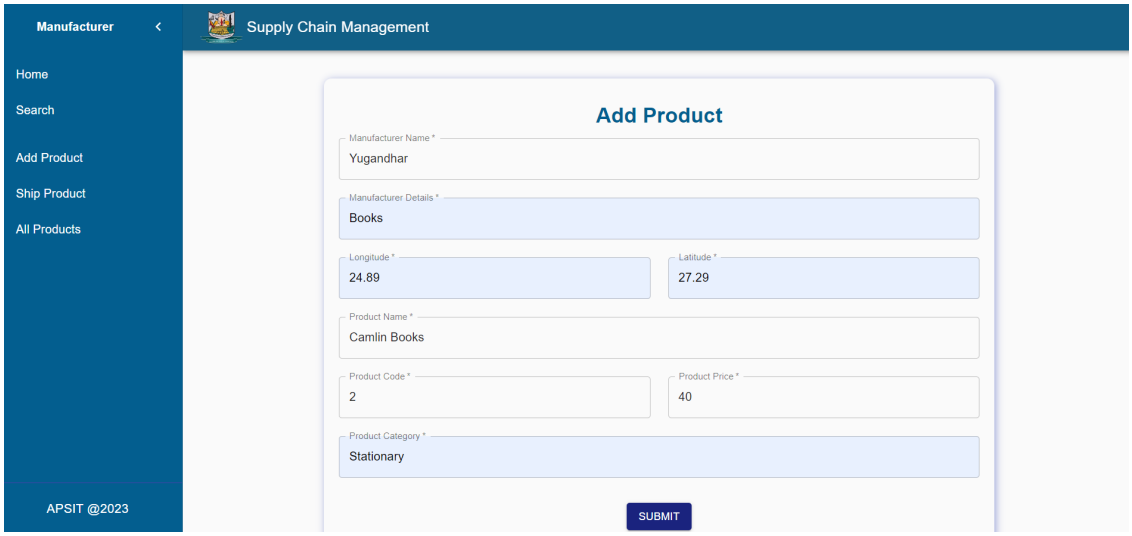

Figure 4.6: Creation of product by Manufacturer

The vendor acts as the one who purchases the product from the manufacturer and generates the request for the same.

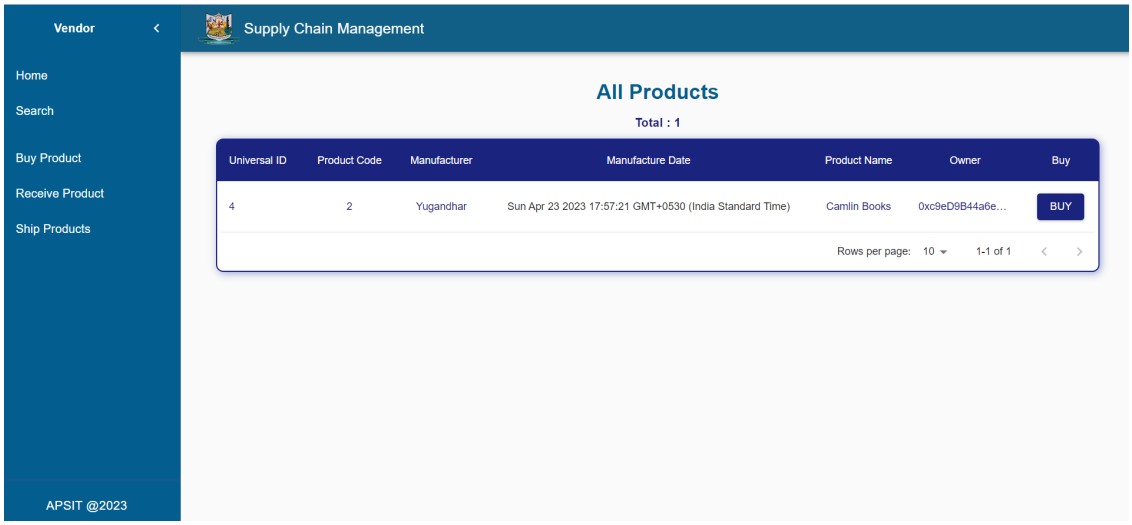

Figure 4.7: Purchasing of product by Vendor

The delivery team is responsible for the transfer of products from the vendor to the customer.

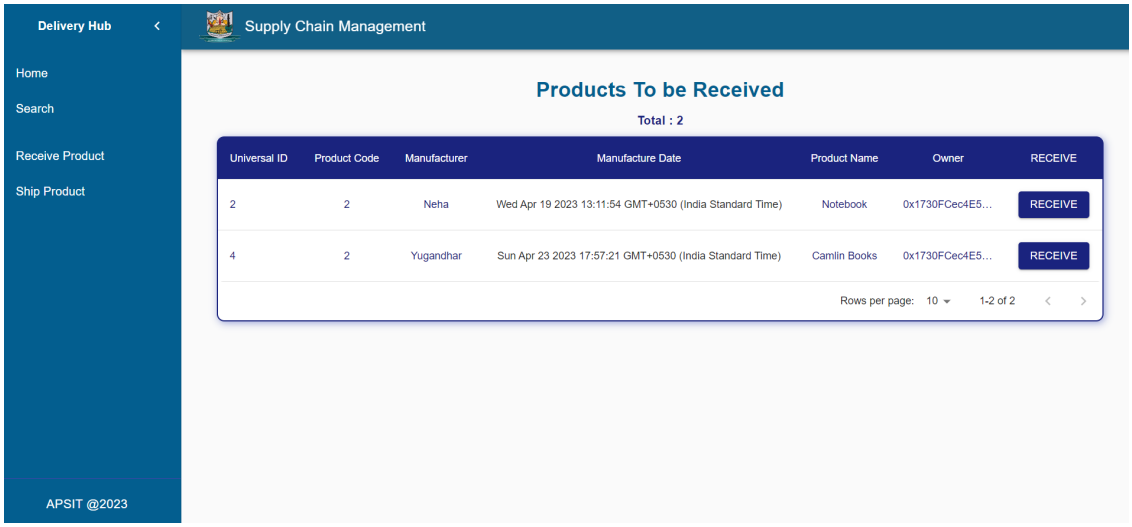

Figure 4.8: Shipment of products from Delivery Hub

The customer is the end user of the system who ultimately purchases and uses the product.

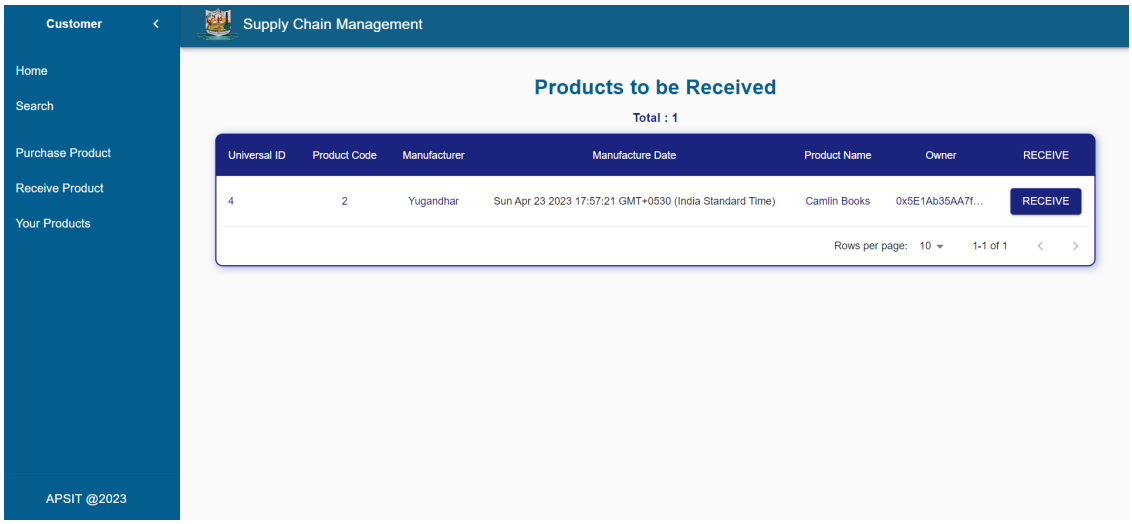

Figure 4.9: Accepting of product by customer

Fig 4.10 is an example of a transaction call that occurs for the vendor while receiving the product.

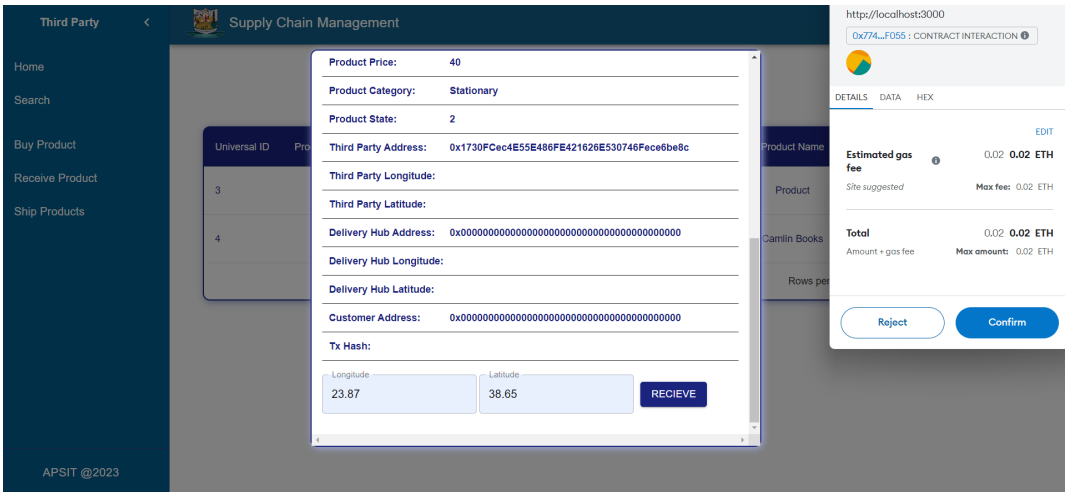

Figure 4.10: Transaction call

Metamask acts as the wallet for transactions for the contract calls. Metamask wallet provides two keys i.e, the public and the private key. The public keys are the main account addresses whereas the private keys are meant to be private which identifies the account.

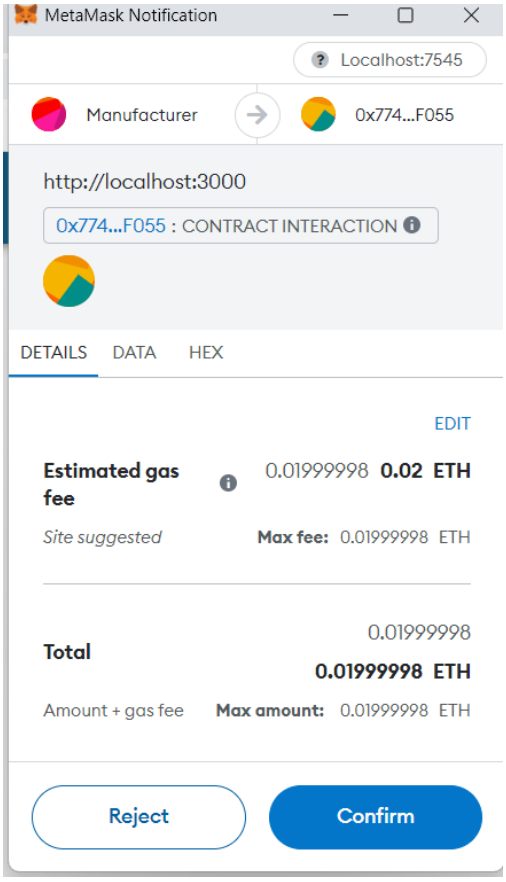

Figure 4.11: Confirming a transaction bill

Finally, the explorer function allows to track the product along with an integrated google maps api service.

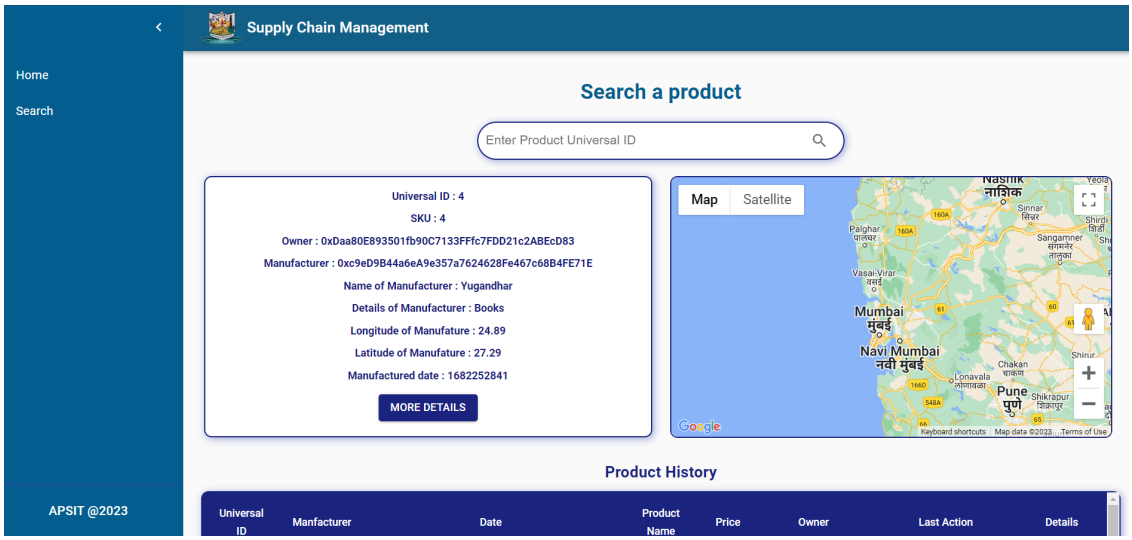

Figure 4.12: Search a product

Overall all the product history is stored step by step along with the entity details, transaction hash, entity addresses, etc.

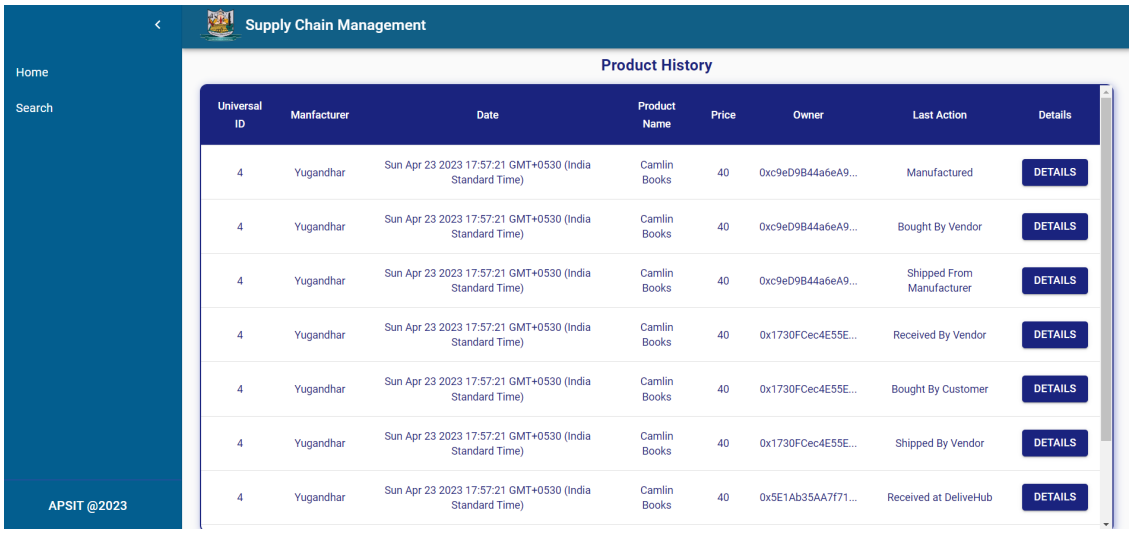

Figure 4.13: Product History

For each operation, a transaction needs to be performed referred to as a checkpoint in the contract. These checkpoints act as trigger points and authorize the exchange of information between the entities.

Chapter 5

Testing

In this process, we validate and verify that the application does what it's supposed to do. Software Testing is a method to check whether the actual software product matches expected requirements and to ensure that software product is Defect free. It involves execution of software/system components using manual or automated tools to evaluate one or more properties of interest. The purpose of software testing is to identify errors, gaps or missing requirements in contrast to actual requirements.

5.1 Functional Testing

Functional testing is a type of software testing technique that focuses on verifying the specific functions or features of an application, such as a Blockchain-based supply chain management system. The goal of functional testing is to ensure that the application functions as expected and meets the requirements of the stakeholders.

This testing technique involves testing the functionalities of the Blockchain-based supply chain management application to ensure that it meets the requirements of the stakeholders. Functional testing can be done manually or through automated tools and includes testing the user interface, transactions, smart contract functionalities, and other features of the application. Functional testing of a Blockchain-based supply chain management system can include testing various functions and features, such as:

- Creating and tracking transactions, including product orders, shipments, and deliveries.

- Validating transactions using smart contracts to ensure that they meet specific criteria or requirements.

- Ensuring that the system is secure and free from vulnerabilities.

- Testing the user interface to ensure that it is user-friendly and easy to navigate.

- Testing data integrity and consistency across the entire supply chain.

Ultimately, the testing techniques employed will depend on the specific requirements and characteristics of the Blockchain-based supply chain management application. It is recommended to employ a combination of different testing techniques to ensure that the application is thoroughly tested and meets the requirements of all stakeholders involved.

Chapter 6

Result

The implementation of a supply chain management system with Blockchain can result in various benefits, including increased transparency, traceability, efficiency, and security. By using Blockchain technology, companies can create a tamper-proof and immutable record of all transactions and events along the supply chain, from raw materials to finished products. This can help to improve accountability, reduce the risk of fraud or counterfeiting, and enhance the overall quality of products.The following table demonstrates the goal of our project and the respective accomplishments for it.

Goal	**Accomplishment**
Develop a Blockchain based system	Ethereum Network
Ensure secure and transparent data	Cryptography and validation
Cost-efficiency	Reduction of Intermediaries
Develop a sustainable and scalable solution	Modular architecture
Perform Testing and Debugging	Functional testing

Table 6.1: Result Sets

In addition, Blockchain-based supply chain management systems can also enable real-time tracking of goods, which can help to reduce delays and optimize inventory management. Smart contracts are used to ensure compliance, streamline supply chain processes, and enable stakeholders to identify and address any issues quickly. By having access to a decentralized and distributed database of information, stakeholders in the supply chain can more easily communicate and collaborate, resulting in smoother and more efficient operations.

Overall, the use of Blockchain technology in supply chain management has the potential to transform the way that companies manage their supply chains, leading to improved efficiency, security, and customer satisfaction. However, the implementation of such a system requires careful planning, investment, and collaboration among all stakeholders involved in the supply chain.

Chapter 7

Conclusions and Future Scope

In conclusion, implementing a supply chain management system with Blockchain technology can bring significant benefits to businesses and participants in the supply chain. The use of Blockchain provides a secure, transparent, and immutable system for tracking the movement of goods, ensuring the accuracy of data, and enabling automated execution of business rules through smart contracts. Furthermore, the integration of IoT devices can capture data and update the Blockchain in real-time, improving the efficiency of the supply chain process. Overall, the use of Blockchain in supply chain management can reduce fraud, increase transparency, and enhance efficiency, leading to cost savings and improved customer satisfaction.

The Blockchain integrated supply management system is versatile and adaptable in many more verticals as they enhance the transparency, efficiency, and security of the system. Expansion to other industries increases the application of Blockchain and smart contracts technology beyond supply chain management, enabling various industries to benefit from its features such as:

- Expand the application to other industries: Explore how the Blockchain-based supply chain management application can be adapted to other industries beyond the current scope. For instance, it could be applied in the food industry to track the origin of ingredients and ensure food safety.

- Implement data analytics and visualization: Integrate data analytics and visualization tools into the application to provide insights into supply chain performance and identify potential areas for improvement. This could involve the use of machine learning algorithms and predictive analytics to analyze data in real-time.

- Develop a mobile application: Create a mobile application for the supply chain management system, which would allow stakeholders to track shipments, receive notifications, and perform transactions on-the-go. This can increase accessibility and convenience for users.

  Along with these, the integration of RPA with supply chain management using Blockchain technology has enormous potential to transform the supply chain industry. It can streamline operations, increase transparency, improve efficiency and productivity, reduce costs, and enhance security.

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Appendices

Appendix-A: Node and Npm setup

1. Download and install nodejs from the official NodeJS website.
2. Verify the installation : node -v and npm -v
3. Initialize the project : npm init

Appendix-B: Truffle Environment

4. Install truffle through cmdline : npm install -g truffle
5. Create a truffle project : truffle init
6. Compile smart contracts : truffle compile
7. Configure : 'truffle-config.js'
8. Deploy the contracts : truffle migrate –network=develop –reset

Appendix-C: Running the application

9. Install node modules: npm i
10. Start the server: npm start

Publication

Paper entitled **"Applying Blockchain to transparent, secure and traceable Supply Chain Management"** is accepted and will be presented in May 2023 at **"International Conference on Contemporary Challenges in Science and its Engineering Applications (IC3SEA 2023)"** by **"Yugandhar Ghatge, Mayuri Patil, Abhijeetkumar Mishra, Prof. Neha Deshmukh and Dr. Kiran Deshpande".**