A Project/Dissertation ETE Report

on

Authenticity in Food Supply Chain Using Blockchain

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

B. Tech in Computer Science and Engineering

GALGOTIAS UNIVERSITY
(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

Under The Supervision of
Dr. Munish Sabharwal
Dean SCSE

Submitted By

Lakshya Bansal

18021120002

Shefali Chaurasia

18021011508

SCHOOL OF COMPUTING SCIENCE AND ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
GALGOTIAS UNIVERSITY, GREATER NOIDA
INDIA
December, 2021

Abstract

The food supply chain is a complex but necessary food production arrangement needed by the global community to maintain sustainability and food security. This continually affects the vulnerable among society, including impoverished individuals and small restaurants/grocers. The supply chain has been extended geographically involving many more stakeholders, making the supply chain longer and complicated and thus involving many challenges like lack of communication among stakeholders, lack of traceability, honesty and transparency, supply of fraudulent food products and failure to monitor warehouses.

We proposed a system that would enable methodical monitoring and tracking solutions, ensure a transparent supply chain, prevent fake food supply, and secure and cashless payments using blockchain. Blockchain technology in the food industry applies in a mindful and holistic manner to check and certify the quality of a product. By building a decentralized public ledger system that could allow for multiple verifications of the authenticity of products, thus helping to restrain the spread of fake ones with features like transparency, decentralization, and immutability.

Blockchain stores data for each transaction happening on the network and the data stored on the blockchain is immutable. There is an owner for every product on the blockchain and only the owner of the records can modify the ownership of the products. Every data stored on the blockchain is public and hence easy to track products.

The result of the proposed project would be a web-based user-centric application that would prevent fake food item drives, a platform to track food items worldwide, proper food distribution, transparency regarding the authenticity and verification of manufacturers and farmers.

The proposed system tries to solve some of the major problems faced in a consumer-centric food supply chain with the help of blockchain. This system can act as a central microservice that can be implemented in all other existing services to ensure authenticity and find the vulnerabilities in existing systems.

.

List of Tables

List of Figures

Acronyms

B.Tech.	Bachelor of Technology
M.Tech.	Master of Technology
BCA	Bachelor of Computer Applications
MCA	Master of Computer Applications
B.Sc. (CS)	Bachelor of Science in Computer Science
M.Sc. (CS)	Master of Science in Computer Science
SCSE	School of Computing Science and Engineering

Table of Contents

CHAPTER-1
Introduction

The food supply chain is essential for both the food producer industries and consumers. Such systems are designed to ensure transparency of food handling and process, leading to the high quality of food production. Blockchain using food supply development services can provide greater visibility into complex steps in a food supply.

A product's tracking across the supply chain with blockchain transactions can aid in establishing trust among consumers and substantiating claims. Blockchain technology is an immutable and transparent data storage system, which is a constituent component that empowers the Blockchain using Food Supply Chain. Blockchain data may grow rapidly as compared to the existing approach, and such circumstances are an issue that needs to be addressed. Blockchain Using Raw material Supply Chain is a lengthy process, which includes supplier, manufacturing, distributor, retailer, and consumer. Each product is relayed through various verified stages and information is recorded relevant to the product. The recorded data is vital because it provided feedback to the manufacturers as well as consumers about the source and the handling mechanism of the products. The main challenges of the existing system are to sustain the integrity of information along the food supply chain. Blockchain technology enables digital data to be stored information of products every data block consists of a timestamp, transaction, manufacturer, distributor, retailer, and consumer. Once the data has been verified and added to the blockchain using food supply, the data will be permanently stored on the smart contract.

CHAPTER-1
Introduction

1.2 Formulation of problem

The major problems leading to development of decentralised supply chain system includes:

- Central servers controlling the storage of data in the existing system.
- Increasing importance of user data and concerns about privacy.
- Data theft and cyber attacks leading to data leaks.

1.2.1 Tools and technologies used

We have used and worked on following technologies:

- MetaMask - to interact with smart contracts

  MetaMask is a popular and established browser extension which functions as a cryptocurrency wallet that connects to the Ethereum blockchain. MetaMask allows users to interact with the Ethereum ecosystem, which hosts a vast universe of decentralized applications (Dapps), without having to download the entire blockchain on their device. As such, it's the one of the best Ethereum wallet solutions for easy access to decentralized exchanges (DEX), gaming platforms, gambling sites and many other applications.

  The wallet is compatible with the most widely adopted browsers such as Chrome, Firefox, Brave and Microsoft Edge. Apart from storing Ethereum's native currency, ETH, MetaMask also holds tokens that are built on the protocol's ERC-20 and ERC-721 standards.

  MetaMask was founded by Aaron Davis and the blockchain company ConsenSys.

CHAPTER-1
Introduction

- Web3.js - for interfacing with the Ethereum blockchain

  Web3.js enables you to fulfill the second responsibility: developing clients that interact with The Etherem Blockchain. It is a collection of libraries that allow you to perform actions like send Ether from one account to another, read and write data from smart contracts, create smart contracts, and so much more!
  If you have a web development background, you might have used jQuery to make Ajax calls to a web server. That's a good starting point for understanding the function of Web3.js. Instead of using a jQuery to read and write data from a web server, you can use Web3.js to read and write to The Ethereum Blockchain.

- Truffle – development environment, testing framework for blockchain

  Truffle is a world-class development environment, testing framework and asset pipeline for blockchains using the Ethereum Virtual Machine (EVM), aiming to make life as a developer easier. Truffle is widely considered the most popular tool for blockchain application development with over 1.5 million lifetime downloads. Truffle supports developers across the full lifecycle of their projects, whether they are looking to build on Ethereum, Hyperledger, Quorum, or one of an ever-growing list of other supported platforms. Paired with Ganache, a personal blockchain, and Drizzle, a front-end dApp development kit, the full Truffle suite of tools promises to be an end-to-end dApp development platform.

- Ganache – local blockchain for Ethereum development

  So, to begin with, Ganache is part of the Truffle Suite ecosystem. Specifically, the Truffle Suite consists of Ganache and an additional pair of tools; Truffle and

CHAPTER-1
Introduction

Drizzle. Truffle is a development environment, asset pipeline, and testing framework using the EMV (Ethereum Virtual Machine); meanwhile, Drizzle is a collection of frontend libraries.

On the other hand, Ganache is a high-end development tool used to run your own local blockchain for both Ethereum and Corda dApp development. Ganache is helpful in all parts of the development process. The local chain allows you to develop, deploy and test your projects and smart contracts in a deterministic and safe environment.

There are two different ”versions” of Ganache, one desktop application, and one command-line tool. The desktop application is called Ganache UI, and it supports development for both Ethereum and Corda; meanwhile, the command-line tool is called ganache-CLI, which solely supports Ethereum development. Furthermore, all the different versions of Ganache are available for Mac, Windows, and Linux.

1.3 Blockchain

A blockchain is a dispensed database that is shared the various nodes of a pc network. As a database, a blockchain shops data electronically in digital layout. Blockchains are exceptional known for their crucial role in cryptocurrency structures, along with Bitcoin, for keeping a at ease and decentralized document of transactions. The innovation with a blockchain is that it guarantees the fidelity and protection of a file of statistics and generates agree with without the want for a relied on third celebration.

One key difference among an average database and a blockchain is how the information is structured. A blockchain collects facts together in businesses, called blocks, that maintain sets of records. Blocks have positive garage capacities and, when stuffed, are closed and linked to the formerly filled block, forming a chain of statistics called the

blockchain. All new data that follows that freshly brought block is compiled into a newly fashioned block so that it will then additionally be delivered to the chain as soon as filled.

A database commonly systems its facts into tables, whereas a blockchain, like its call implies, systems its records into chunks (blocks) which can be strung together. This statistics structure inherently makes an irreversible time line of data whilst implemented in a decentralized nature. whilst a block is filled, it's miles set in stone and will become a part of this time line. every block inside the chain is given an genuine time stamp whilst it's miles added to the chain.

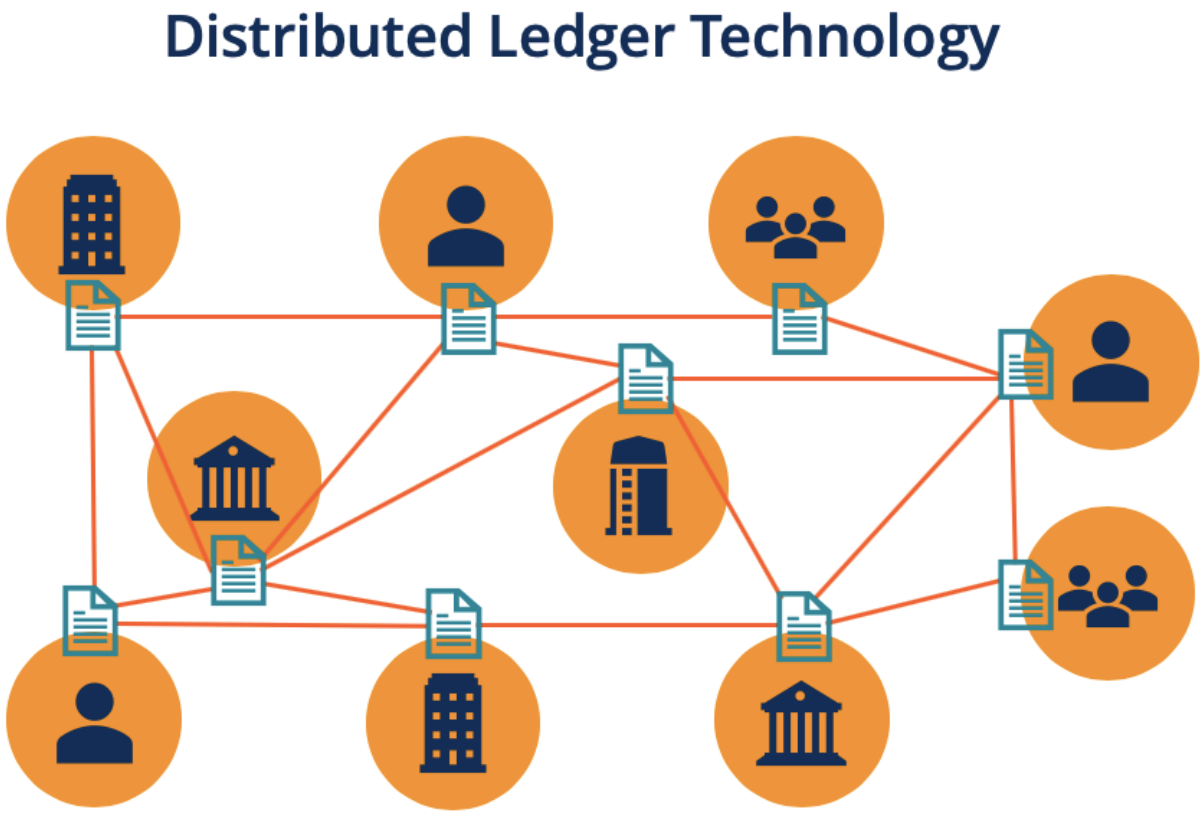
Why Blockchain is Important?

Commercial enterprise runs on information. The faster it’s obtained and the more accurate it's far, the better. Blockchain is good for delivering that information as it provides on the spot, shared and absolutely obvious records stored on an immutable ledger that can be accessed best by means of permissioned community contributors. A blockchain community can track orders, bills, accounts, manufacturing and plenty greater. And because contributors percentage a single view of the reality, you could see all details of a transaction stop to quit, providing you with more self assurance, as well as new efficiencies and opportunities.

Key elements of a blockchain

Distributed Ledger Technology

CHAPTER-1
Introduction



Distributed Ledger Technology (DLT) is a protocol that permits the at ease functioning of a decentralized virtual database. distributed networks put off the want for a government to hold a take a look at towards manipulation.

DLT allows for garage of all information in a at ease and accurate manner using cryptography. The identical may be accessed using "keys" and cryptographic signatures. as soon as the information is stored, it becomes an immutable database and is governed by using the guidelines of the network.

The idea of a allotted ledger is not totally new, and plenty of agencies do maintain data at one of a kind locations. but, every vicinity is normally on a connected vital gadget, which updates every considered one of them periodically. This makes the primary database susceptible to cyber-crime and prone to delays due to the fact that a principal frame has to update each distantly located word. The very nature of a decentralized

ledger makes them resistant to a cyber-crime, as all of the copies saved throughout the community need to be attacked at the identical time for the assault to achieve success. additionally, the simultaneous (peer-to-peer) sharing and updating of statistics make the entire manner tons quicker, more effective, and inexpensive.

DLT has wonderful potential to revolutionize the way governments, establishments, and businesses work. it is able to help governments with tax series, the issuance of passports, recording land registries and licenses, and the outlay of Social protection benefits in addition to balloting procedures. The generation is making waves in industries together with finance, tune and leisure, diamond and other precious assets, artwork, deliver chains of diverse commodities, and greater.

Similarly to startups, many massive corporations such as IBM and Microsoft are experimenting with the blockchain era. some of the maximum popular disbursed ledger protocols are Ethereum, Hyperledger material, R3 Corda, and Quorum.

Immutable Records

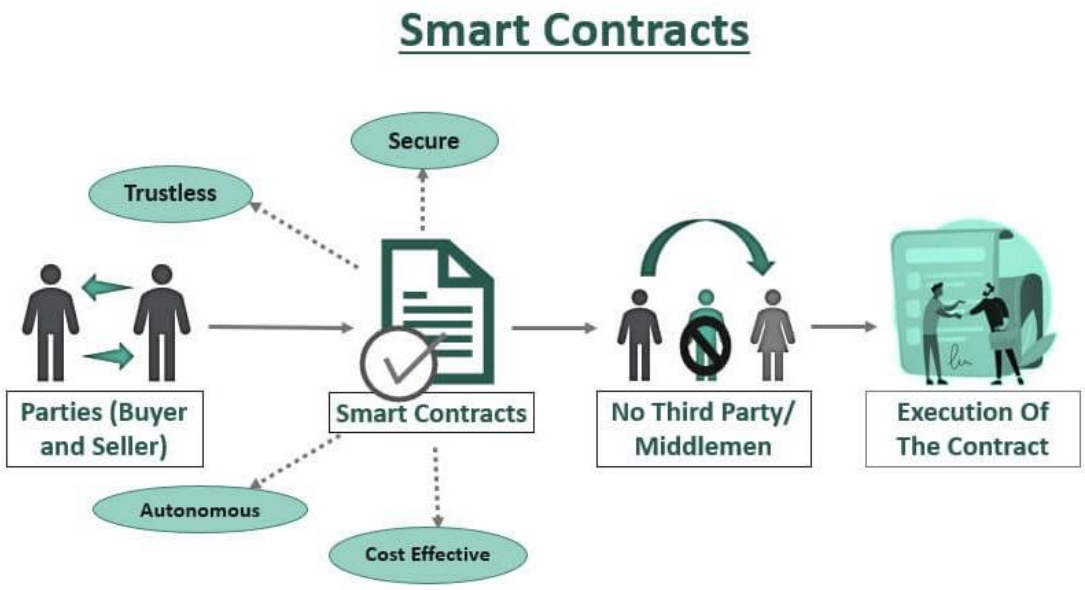
Immutability can be defined as the ability of a blockchain ledger to stay unchanged, for a blockchain to remain unaltered and indelible. extra succinctly, records within the blockchain cannot be altered.

Every block of information, which include statistics or transaction information,

continue the usage of a cryptographic precept or a hash price. That hash price consists of an alphanumeric string generated by way of each block separately. every block now not handiest carries a hash or virtual signature for itself however additionally for the previous one. This ensures that blocks are retroactively coupled together and unrelenting. This functionality of blockchain era ensures that no person can intervene within the system or modify the statistics saved to the block.

It's also crucial to know that blockchains are decentralized and distributed in nature, wherein a consensus is made many of the diverse nodes that save the replica of records. This consensus ensures that the originality of records must be maintained. certainly, immutability is a definitive characteristic of this era. This concept has the capacity to redefine the overall facts auditing technique and makes it greater green, cost-effective, and brings extra trust and integrity to the statistics.

Smart Contracts



CHAPTER-1
Introduction

A smart contract is a self-executing agreement with the phrases of the settlement between buyer and seller being directly written into traces of code. The code and the agreements contained therein exist throughout a allotted, decentralized blockchain community. The code controls the execution, and transactions are trackable and irreversible.

Smart contracts permit depended on transactions and agreements to be done among disparate, nameless parties with out the want for a central authority, criminal machine, or external enforcement mechanism.

While blockchain era has turn out to be thought of mainly as the foundation for bitcoin, it has advanced a ways past underpinning the virtual foreign money.

Benefits of Smart Contracts

- **Speed, efficiency and accuracy**

  Once a condition is met, the contract is executed immediately. Because smart contracts are digital and automated, there's no paperwork to process and no time spent reconciling errors that often result from manually filling in documents.

- **Trust and transparency**

  Because there's no third party involved, and because encrypted records of transactions are shared across participants, there's no need to question whether information has been altered for personal benefit.

- **Security**

  Blockchain transaction records are encrypted, which makes them very hard to hack. Moreover, because each record is connected to the previous and subsequent records on a distributed ledger, hackers would have to alter the entire

chain to change a single record.

- **Savings**

  Smart contracts remove the need for intermediaries to handle transactions and, by extension, their associated time delays and fees.

How Blockchain Works

As each transaction occurs, it is recorded as a "block" of data

Those transactions show the movement of an asset that can be tangible (a product) or intangible (intellectual). The data block can record the information of your choice: who, what, when, where, how much and even the condition — such as the temperature of a food shipment.

Each block is connected to the ones before and after it

These blocks form a chain of data as an asset moves from place to place or ownership changes hands. The blocks confirm the exact time and sequence of transactions, and the blocks link securely together to prevent any block from being altered or a block being inserted between two existing blocks.

Transactions are blocked together in an irreversible chain

A blockchain Each additional block strengthens the verification of the previous block

and hence the entire blockchain. This renders the blockchain tamper-evident, delivering the key strength of immutability. This removes the possibility of tampering by a malicious actor — and builds a ledger of transactions you and other network members can trust.

Benefits of Blockchain

Greater Trust

With blockchain, as a member of a members-only network, you can rest assured that you are receiving accurate and timely data, and that your confidential blockchain records will be shared only with network members to whom you have specifically granted access.

Greater Security

Consensus on data accuracy is required from all network members, and all validated transactions are immutable because they are recorded permanently. No one, not even a system administrator, can delete a transaction.

More efficiencies

With a distributed ledger that is shared among members of a network, time-wasting record reconciliations are eliminated. And to speed transactions, a set of rules — called a smart contract — can be stored on the blockchain and executed automatically.

Cost Reductions

CHAPTER-1
Introduction

Typically, consumers pay a bank to verify a transaction, a notary to sign a document, or a minister to perform a marriage. Blockchain eliminates the need for third-party verification—and, with it, their associated costs. For example, business owners incur a small fee whenever they accept payments using credit cards, because banks and payment-processing companies have to process those transactions. Bitcoin, on the other hand, does not have a central authority and has limited transaction fees.

Private Transactions

Many blockchain networks operate as public databases, meaning that anyone with an Internet connection can view a list of the network's transaction history. Although users can access details about transactions, they cannot access identifying information about the users making those transactions. It is a common misperception that blockchain networks like bitcoin are anonymous, when in fact they are only confidential.

When a user makes a public transaction, their unique code—called a public key, as mentioned earlier—is recorded on the blockchain. Their personal information is not. If a person has made a Bitcoin purchase on an exchange that requires identification, then the person's identity is still linked to their blockchain address—but a transaction, even when tied to a person's name, does not reveal any personal information.

Types Of Blockchain

Private Blockchain Network

Private blockchains perform on closed networks, and have a tendency to work properly for personal companies and agencies. groups can use private blockchains to customize their accessibility and authorization options, parameters to the community, and other

critical protection alternatives. simplest one authority manages a non-public blockchain network.

Public Blockchain Network

Bitcoin and different cryptocurrencies originated from public blockchains, which also played a role in popularizing dispensed ledger era (DLT). Public blockchains additionally help to remove positive demanding situations and problems, together with security flaws and centralization. With DLT, information is sent throughout a peer-to-peer community, in place of being stored in a unmarried place. A consensus set of rules is used for verifying records authenticity; evidence of stake (PoS) and proof of work (PoW) are two often used consensus strategies.

Permissioned Blockchain Network

Additionally, every now and then known as hybrid blockchains, permissioned blockchain networks are personal blockchains that permit special get right of entry to for authorized individuals. groups usually set up those kinds of blockchains to get the quality of both worlds, and it permits better shape when assigning who can take part in the community and in what transactions.

Consortium Blockchain

Similar to permissioned blockchains, consortium blockchains have both public and private components, except multiple organizations will manage a single consortium blockchain network. Although these types of blockchains can initially be more complex to set up, once they are running, they can offer better security. Additionally, consortium blockchains are optimal for collaboration with multiple organizations.

CHAPTER-1
Introduction

Drawbacks of Blockchain

Technology Cost

Although blockchain can save users money on transaction fees, the technology is far from free. For example, the PoW system mentioned earlier, which the bitcoin network uses to validate transactions, consumes vast amounts of computational power. In the real world, the power from the millions of computers on the bitcoin network is close to what Denmark consumes annually.

Despite the costs of mining bitcoin, users continue to drive up their electricity bills to validate transactions on the blockchain. That's because when miners add a block to the bitcoin blockchain, they are rewarded with enough bitcoin to make their time and energy worthwhile. When it comes to blockchains that do not use cryptocurrency, however, miners will need to be paid or otherwise incentivized to validate transactions.

Speed and Data Inefficiency

Bitcoin is a perfect case study for the possible inefficiencies of blockchain. Bitcoin's PoW system takes about 10 minutes to add a new block to the blockchain. At that rate, it's estimated that the blockchain network can only manage about seven transactions per second (TPS). Although other cryptocurrencies such as Ethereum perform better than bitcoin, they are still limited by blockchain. Legacy brand Visa, for context, can process 24,000 TPS.

Solutions to this issue have been in development for years. There are currently blockchains that are boasting more than 30,000 TPS.

The other issue is that each block can only hold so much data. The block size debate has been, and continues to be, one of the most pressing issues for the scalability of blockchains going forward.

Illegal Activity

While confidentiality on the blockchain network protects users from hacks and preserves privacy, it also allows for illegal trading and activity on the blockchain network. The most cited example of blockchain being used for illicit transactions is probably the Silk Road, an online dark web illegal-drug and money laundering marketplace operating from February 2011 until October 2013, when it was shut down by the FBI.[7]

The dark web allows users to buy and sell illegal goods without being tracked by using the Tor Browser and make illegal purchases in Bitcoin or other cryptocurrencies. Current U.S. regulations require financial service providers to obtain information about their customers when they open an account, verify the identity of each customer, and confirm that customers do not appear on any list of known or suspected terrorist organizations. This system can be seen as both a pro and a con. It gives anyone access to financial accounts but also allows criminals to more easily transact. Many have argued that the good uses of crypto, like banking the unbanked world, outweigh the bad uses of cryptocurrency, especially when most illegal activity is still accomplished through untraceable cash.

While Bitcoin had been used early on for such purposes, its transparent nature and maturity as a financial asset has actually seen illegal activity migrate to other cryptocurrencies such as Monero and Dash. Today, illegal activity accounts for only a very small fraction of all Bitcoin transactions.[8]

CHAPTER-1
Introduction

Regulation

Many in the crypto space have expressed concerns about government regulation over cryptocurrencies. While it is getting increasingly difficult and near impossible to end something like Bitcoin as its decentralized network grows, governments could theoretically make it illegal to own cryptocurrencies or participate in their networks.

CHAPTER-2
Literature Survey

A food supply chain is defined by “Many interdependent companies that work closely together to manage the chain of goods, services, and materials along the value-added chain of raw materials and food products".[4]

When the food production chain takes place in more vulnerable value chains, which requires more attention over handling processes, such as producing and storing the food. In addition, food tracking and detecting make sure about food safety and quality a challenge in the food supply chain[3]. Food products failure includes food, food poisoning, substandard food, counterfeit products, or improper labelling with unpopular ingredients during food production. Every raw material step and every supplier which is used in a food supply chain matters to the final food products. Therefore, the food supply chain requires closer partner collaboration and higher efficiencies to maintain the value food chain and detect products failure[2,3].

The modern food supply chain is centralized can threaten the supply chain transparency, which causes information inequality and trust issues[2]. Companies will have to be chosen to open up selected information of the verified raw material which are included in food, that is beneficial to its own brand image. Therefore, customers feel safer by the food products and demands more, after tracking and verifying the products before purchasing[1].

Major food brands often choose to open up partially selected information to the public and aim to benefit companies themselves, which may result in consumers not having enough information about the products and company details of their suppliers, suggesting that insufficient information may contribute to food security[1]. Therefore, Using a blockchain has been found to be more transparent, improve information authenticity, and speed up food memory.

The complexity of the supply chain can be reduced and operations can be performed automatically using smart contracts[1]. Higher-order and customization, the difference

CHAPTER-2
Literature Survey

between the application level and the basic system, the direction of the sensory recording in relation to the scalability, the definition of authorization, make the blockchain technology appropriate. one of the key features of the blockchain is the allocation of space in different countries, which allows for authorized users to make transactions and access direct history without intermediate power interventions.[2,3] Always the registered official user has the same ability to check the activity, and have a copy of the history.

A brief review of relevant concepts, including Blockchain, decentralization, Smart Contract, and traceability, to provide some background information:-

Blockchain:- Nakamoto introduced the concept of the blockchain in a peer-to-peer ledger in 2008. Blockchain is used to save each digital traceability data. It has recently gained so much considerable attention for addressing food supply chain tracking. It has been successfully applied in the financial area and now a day it triggers huge interest in multiple areas, including the food supply chain, property, voting, etc.

Decentralization:-It is different from traditional transactions that need to be approved by any central authorities. Decentralization eliminates the address's details and equal power by allowing direct transactions between users. It will always ensure that every authorized user has equal power within a network and transaction. Users can help each other to validate transactions and have equal power to access transaction history anytime and anywhere. Different stakeholders save the copies of records and store the data, which can be retrieved and shown on-demand anytime[6,7].

Smart Contract:-A smart contract is another important aspect of the blockchain, which is a digitalized agreement and operates automatically works once certain agreements have been met. The use of smart contracts can significantly speed up transactions and improve the trust of customers. A planned contract will keep paperwork, speed up processing time, and reduce staffing efforts compared to

traditional sales. All of these features of blockchain can eliminate the risk of transactions in the absence of a trusted environment, increase food supply chain visibility and tracking, improve efficiencies, and protect every stakeholder's benefits.

Traceability:- Traceability provides the recording and tracking of products movement, which allows companies and consumers to have a clear view of the supply chain, raw material used in the product, make better decisions, and avoid quality risks. It is considered as an added value of food products. In addition, It is the most attractive tool in marketing to attract customers and gain customer loyalty. The record is also a point of verification for companies to be sure about the raw material quality is good and verified. Blockchain has been identified as a solution for achieving effective tracking in food supply using some of the research in food tracking.

CHAPTER-3
UML Diagrams

System Architecture

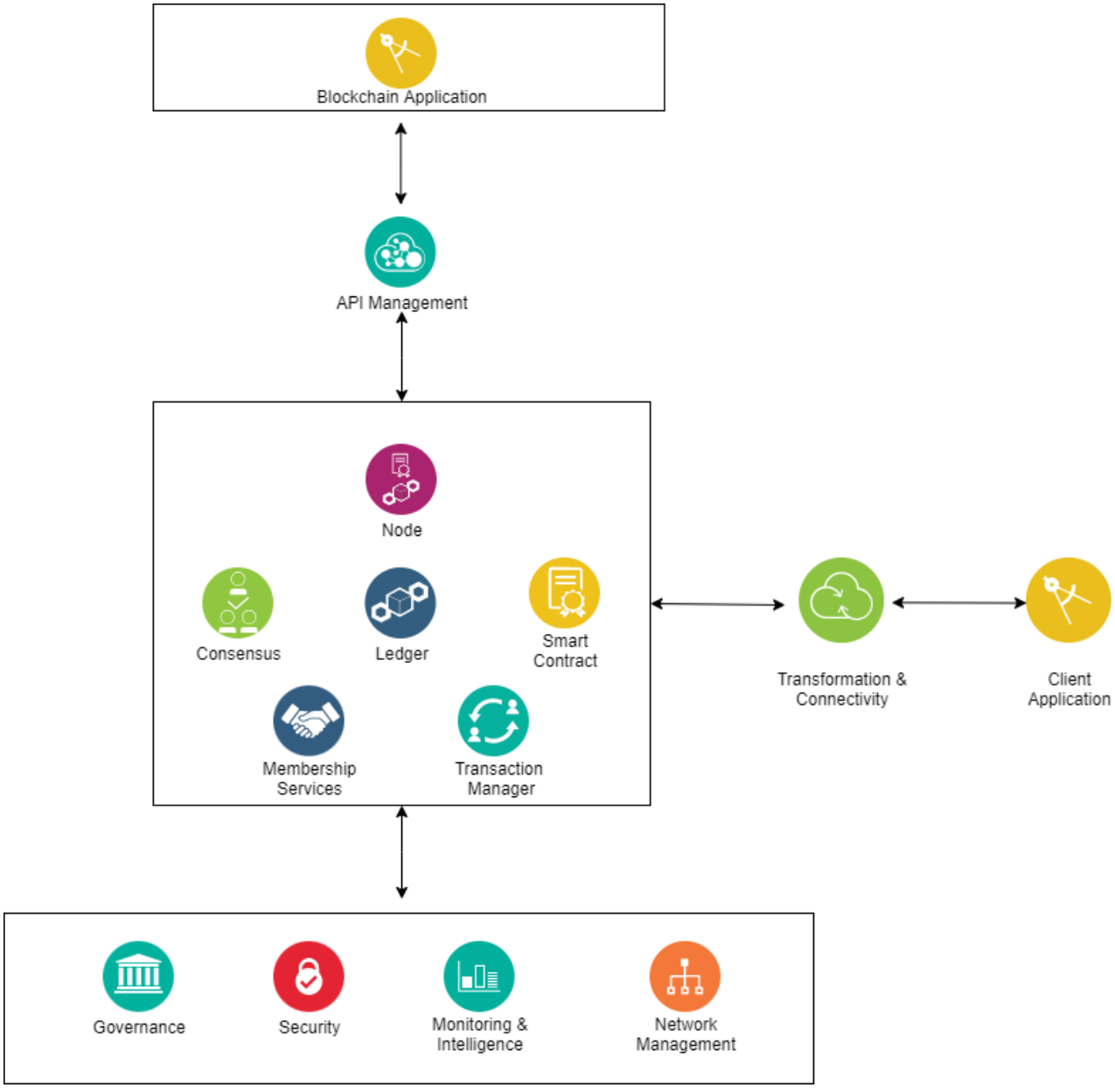


Figure 1 System Architecture

CHAPTER-3
UML Diagrams
Class Diagram

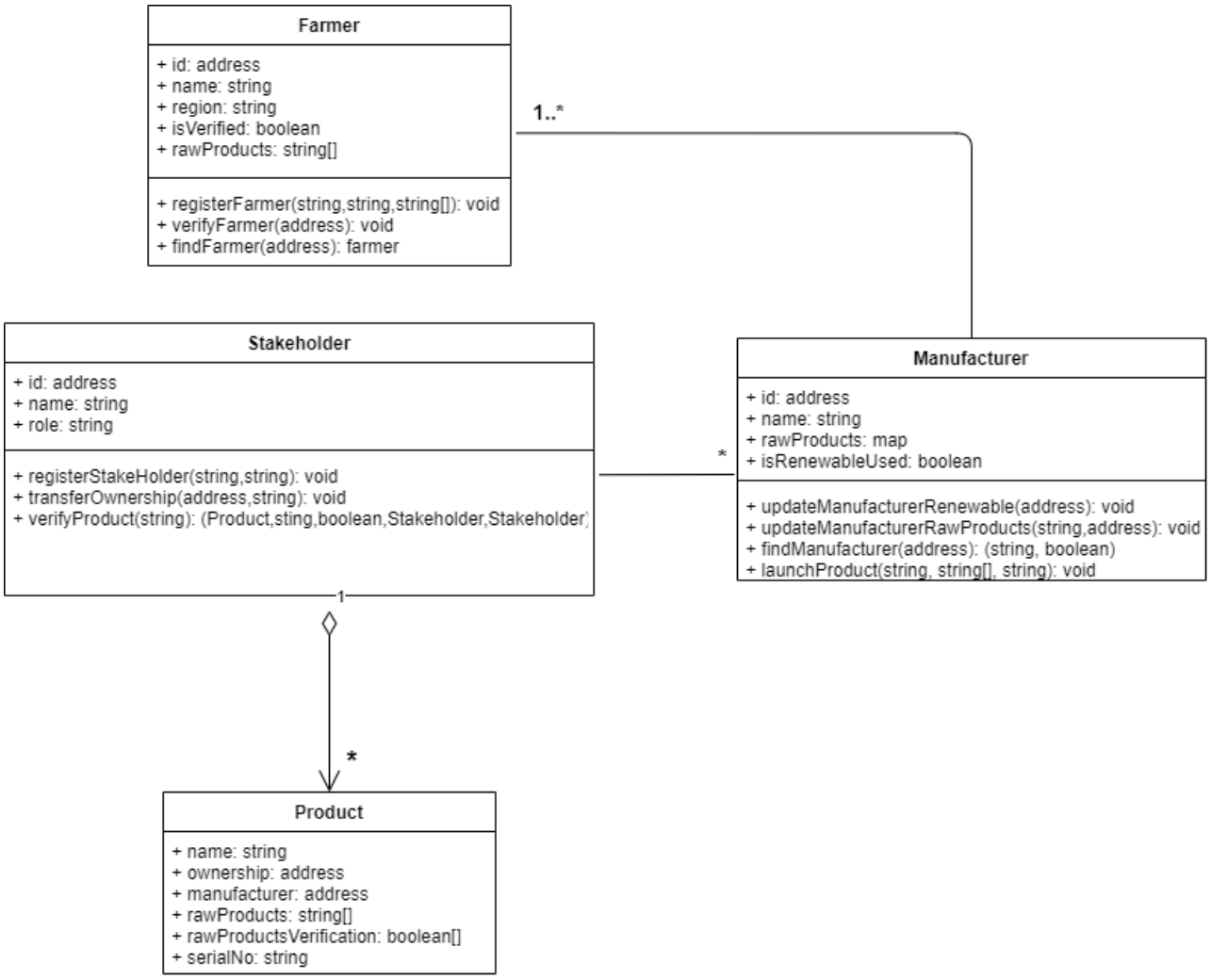


Figure 2: Class Diagram

CHAPTER-3
UML Diagrams

Sequence Diagram

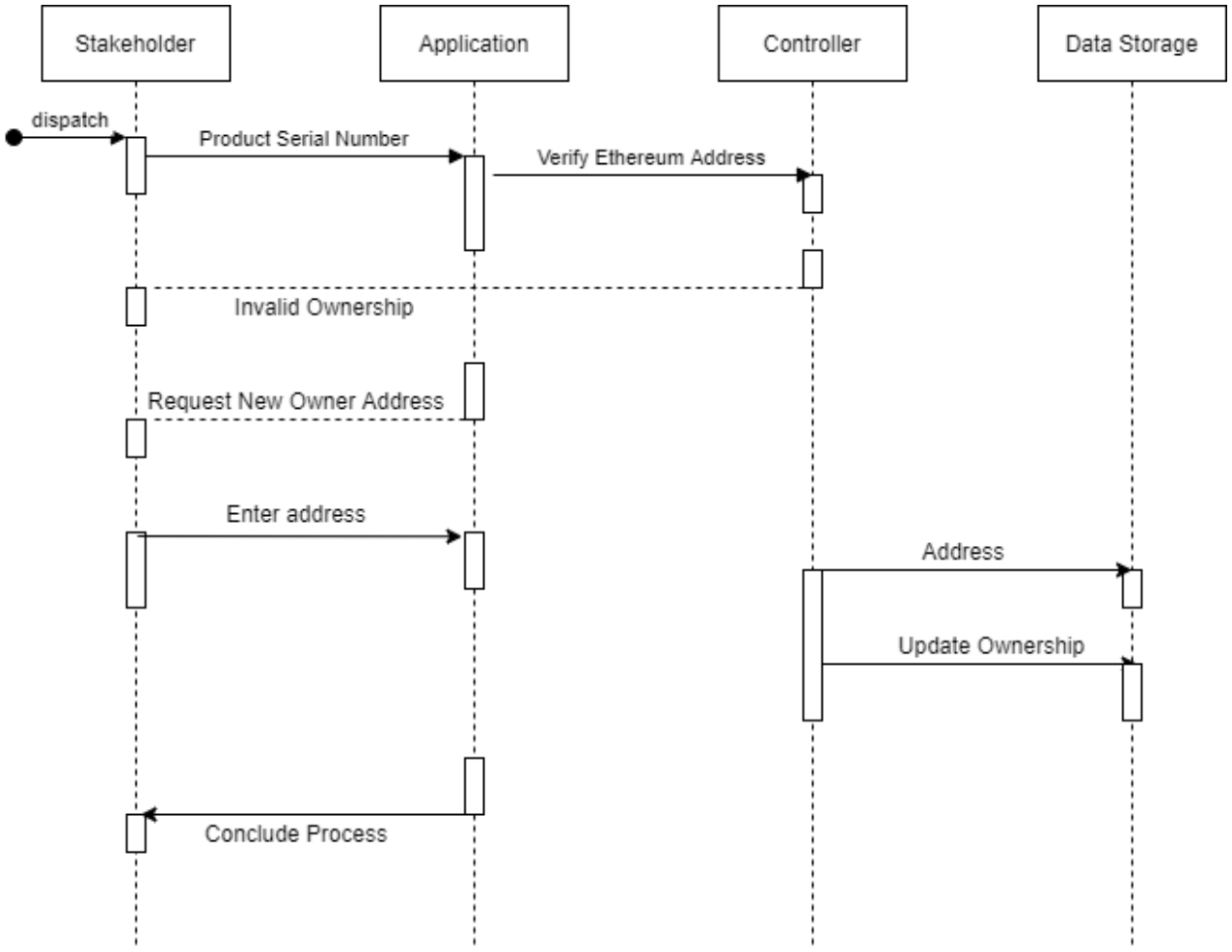


Figure 3 Sequence Diagram (Case: Transfer Ownership)

CHAPTER-3
UML Diagrams

Data Flow Diagram

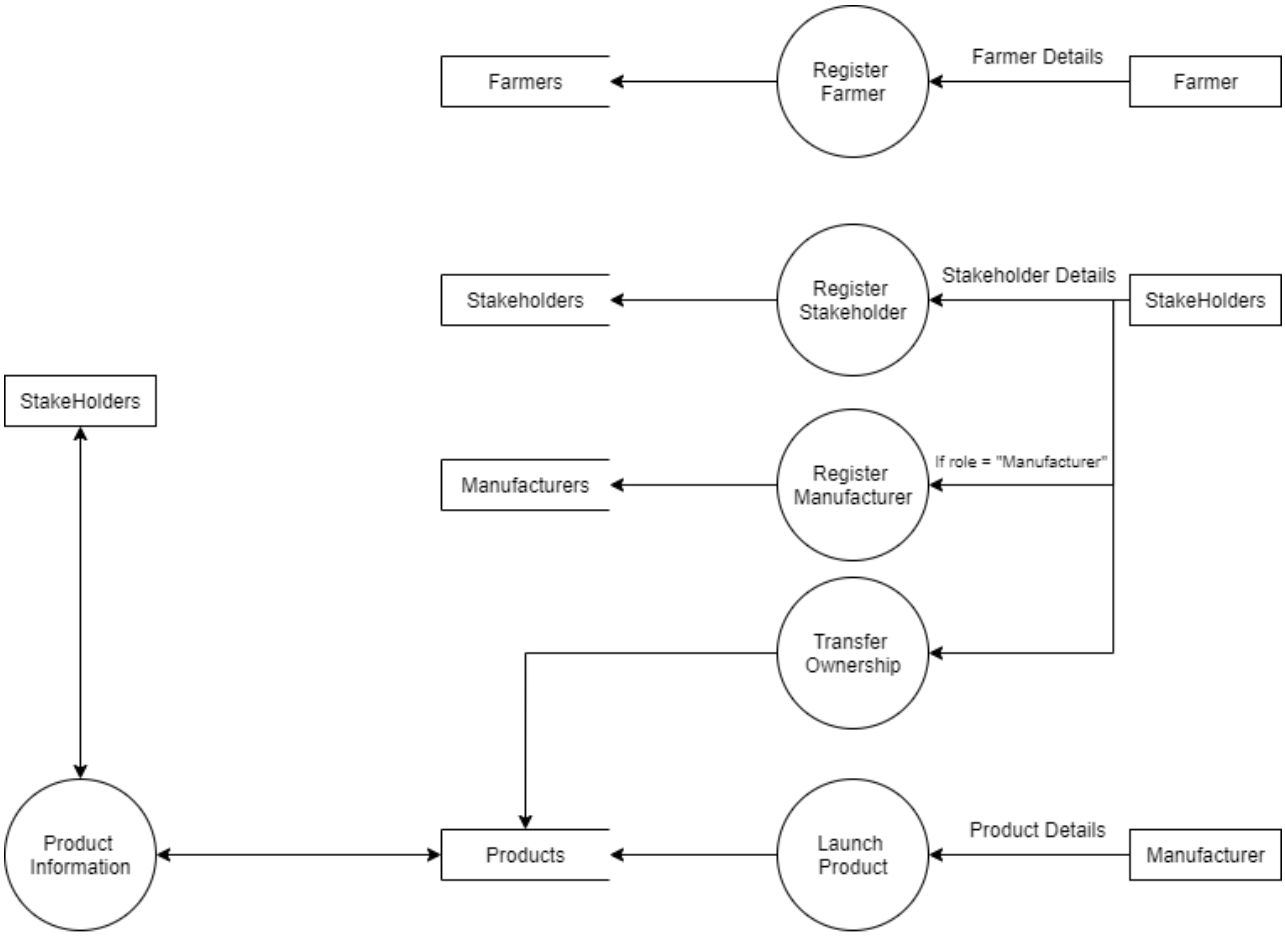


Figure 4 Data Flow Diagram

CHAPTER-3
UML Diagrams

Use Case Diagrams

Use Case Diagram1: Farmer

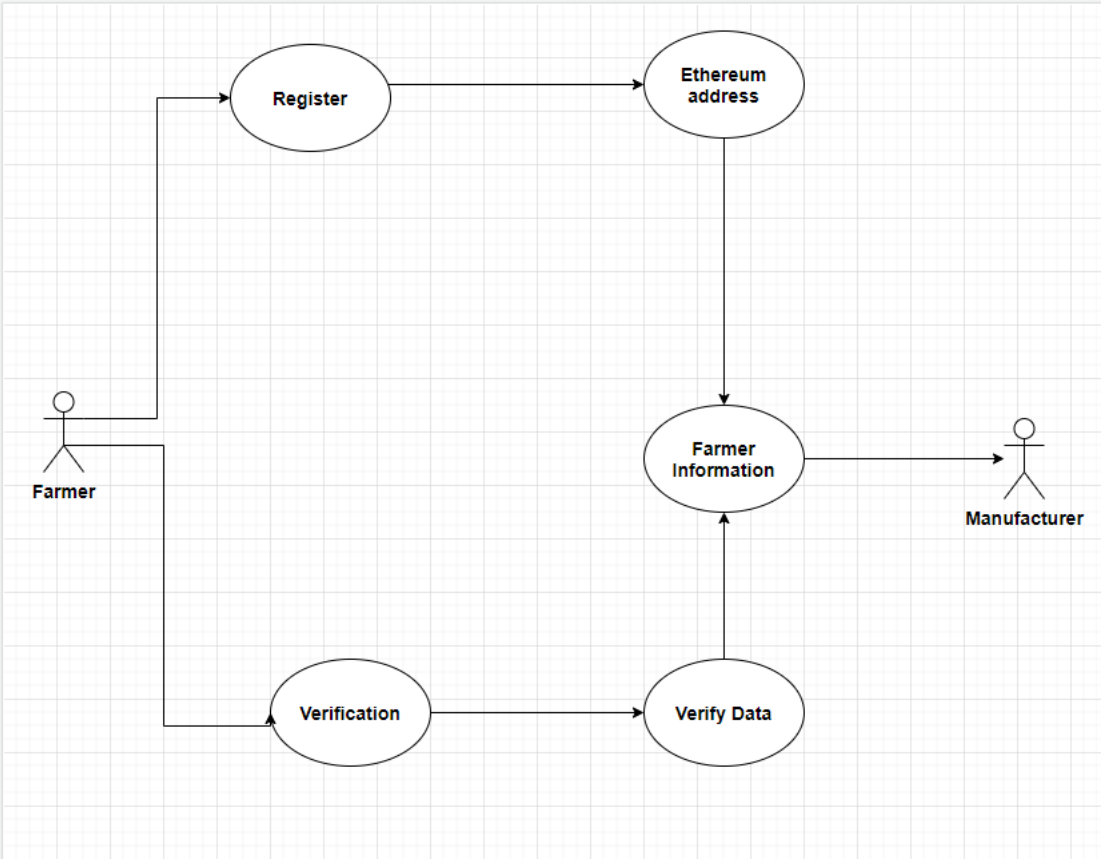


Figure 5 Farmer Use Case Diagram

CHAPTER-3
UML Diagrams

Use Case Diagram2: Manufacturer

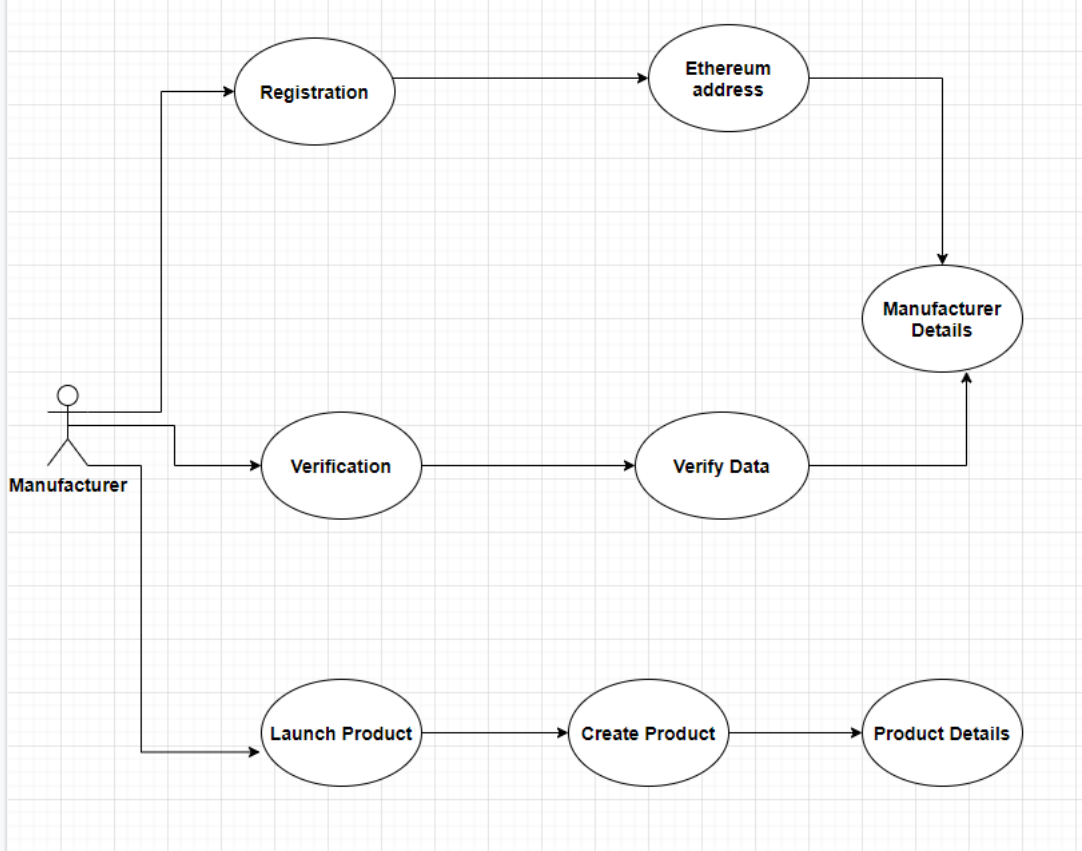


Figure 6 Manufacturer Use Case Diagram

CHAPTER-3
UML Diagrams

Use Case Diagram3: Consumer

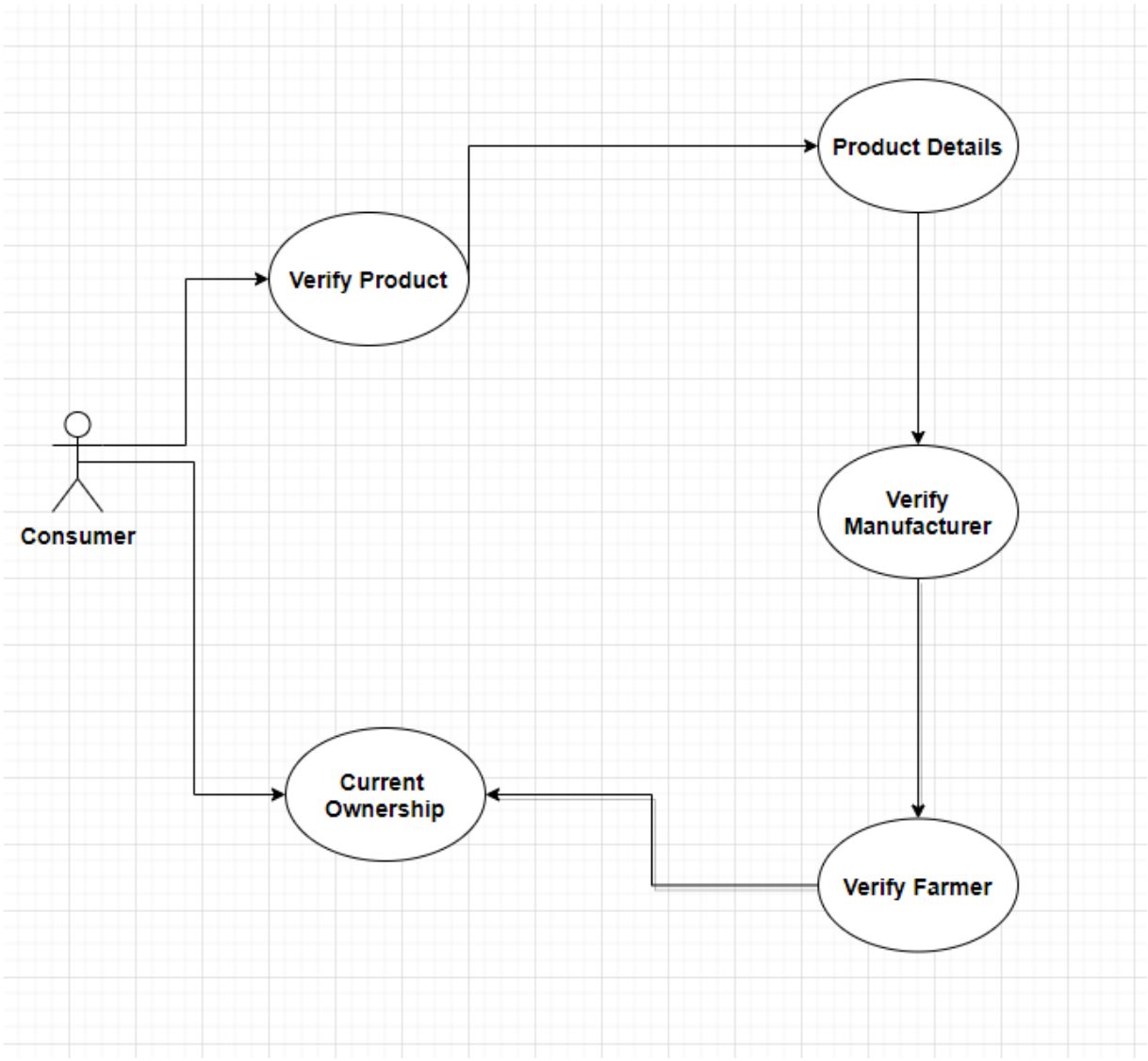


Figure 7 Consumer Use Case Diagram

CHAPTER-4
Modules Description

Solidity

Solidity is an object-oriented, high-level programming language used to create smart contracts that automate transactions on the blockchain. After being proposed in 2014, the language was developed by contributors to the Ethereum project. The language is primarily used to create smart contracts on the Ethereum blockchain and create smart contracts on other blockchains.

Solidity is similar to one of the most common programming languages, JavaScript. It can be considered as a dialect of JavaScript. This means that if you understand JavaScript, it can be easy to pick up Solidity. Solidity also shares similar characteristics to the programming languages C++ and Python.

As a high-level language, Solidity does away with the need to type code in ones and zeros. It makes it much easier for humans to write programs in ways they find easier to understand, using a combination of letters and numbers.

Solidity is statically typed, with support for inheritance, libraries, and complex user-defined types. As Solidity is statically typed, the user much specify each variable. Data types allow the compiler to check for the correct use of variables. Solidity data types are usually categorized as either value types or reference types.

The main difference between value types and reference types can be found in how they are assigned to a variable and stored in the EVM (Ethereum Virtual Machine). While changing the value in one variable of a value type does not affect the value in another variable, anybody referring to changed values in reference type variables may get updated values.

CHAPTER-4
Modules Description

Javascript

JavaScript is a dynamic programming language that's used for web development, in web applications, for game development, and lots more. It allows you to implement dynamic features on web pages that cannot be done with only HTML and CSS.

Many browsers use JavaScript as a scripting language for doing dynamic things on the web. Any time you see a click-to-show dropdown menu, extra content added to a page, and dynamically changing element colors on a page, to name a few features, you're seeing the effects of JavaScript.

Being a scripting language, JavaScript cannot run on its own. In fact, the browser is responsible for running JavaScript code. When a user requests an HTML page with JavaScript in it, the script is sent to the browser and it is up to the browser to execute it. The main advantage of JavaScript is that all modern web browsers support JavaScript. So, you do not have to worry about whether your site visitor uses Internet Explorer, Google Chrome, Firefox or any other browser. JavaScript will be supported. Also, JavaScript runs on any operating system including Windows, Linux or Mac

React JS

React.js is an open-source JavaScript library that is used for building user interfaces specifically for single-page applications. It’s used for handling the view layer for web and mobile apps. React also allows us to create reusable UI components. React was first created by Jordan Walke, a software engineer working for Facebook. React first deployed on Facebook’s newsfeed in 2011 and on Instagram.com in 2012.

React allows developers to create large web applications that can change data, without reloading the page. The main purpose of React is to be fast, scalable, and simple. It

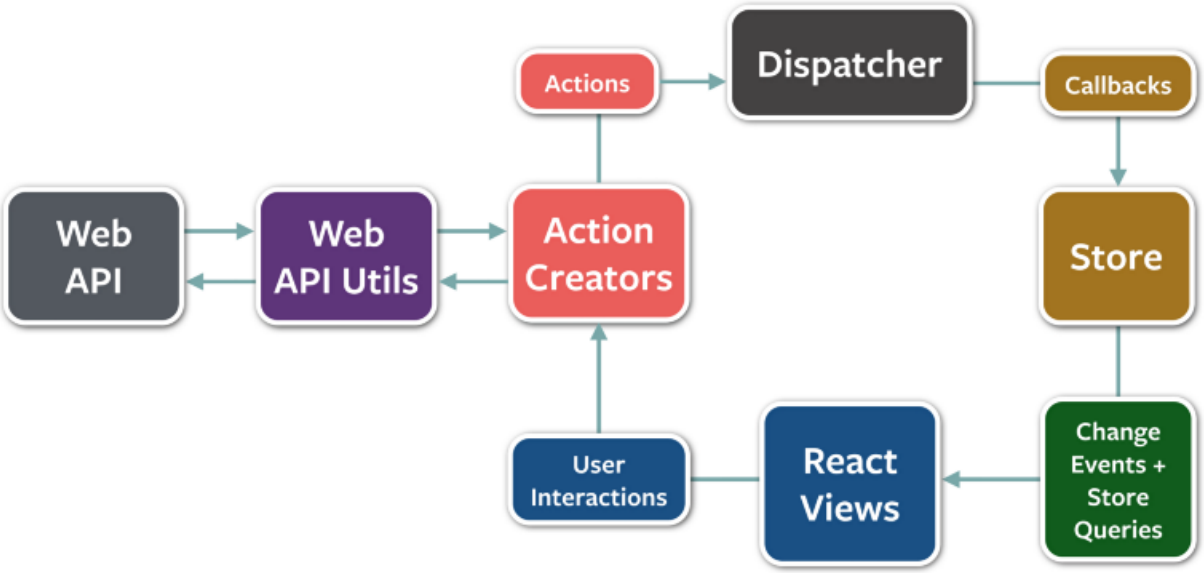
CHAPTER-4
Modules Description

works only on user interfaces in the application. This corresponds to the view in the MVC template. It can be used with a combination of other JavaScript libraries or frameworks, such as Angular JS in MVC.

React.js properties includes the following

- React.js is declarative
- React.js is simple
- React.js is component based
- React.js supports server side
- React.js is extensive
- React.js is fast
- React.js is easy to learn

Flux Architecture



CHAPTER-4
Modules Description

After learning a few highlights regarding the instability and complexity of the MVC architecture, the Facebook development team made some important changes in the system and released Flux as an alternative to MVC architecture. The Flux architecture is based on the following components:

- Store/ Stores: Serves as a container for the app state & logic
- Action: Enables data passing to the dispatcher
- View: Same as the view in MVC architecture, but in the context of React components
- Dispatcher – Coordinates actions & updates to stores

Application Modules

We propose a layered architecture to achieve transparency and immutability of the stored records on the blockchain network. The advantages of the proposed architecture include modularity, maintainability, flexibility, scalability.

- API: REST Application Programming Interface exposing the features of the proposed blockchain application to other applications with a high level of abstraction.
- Controller: This component is responsible for querying and manipulating the data stored on blockchain into high-level information for the client application.
- Blockchain: The main component of the application having all the business logic implemented through smart contracts on the blockchain.

The various stakeholders involved in the food supply chain are:

1. Farmer: Responsible for making the land for harvesting the crops, sowing the seeds and taking care of it.

CHAPTER-4
Modules Description

2. Manufacturer: Produces finished goods from raw materials.
3. Distributor: Responsible for moving the finished goods from manufacturer to retailer.
4. Retailer: Responsible for selling the products directly to consumers.
5. Consumer: Responsible for purchasing the goods.

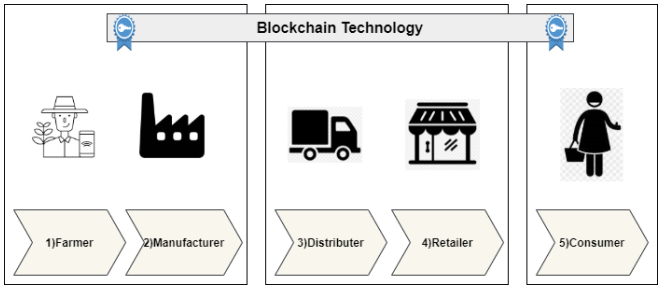


Figure 8 System Stakeholders

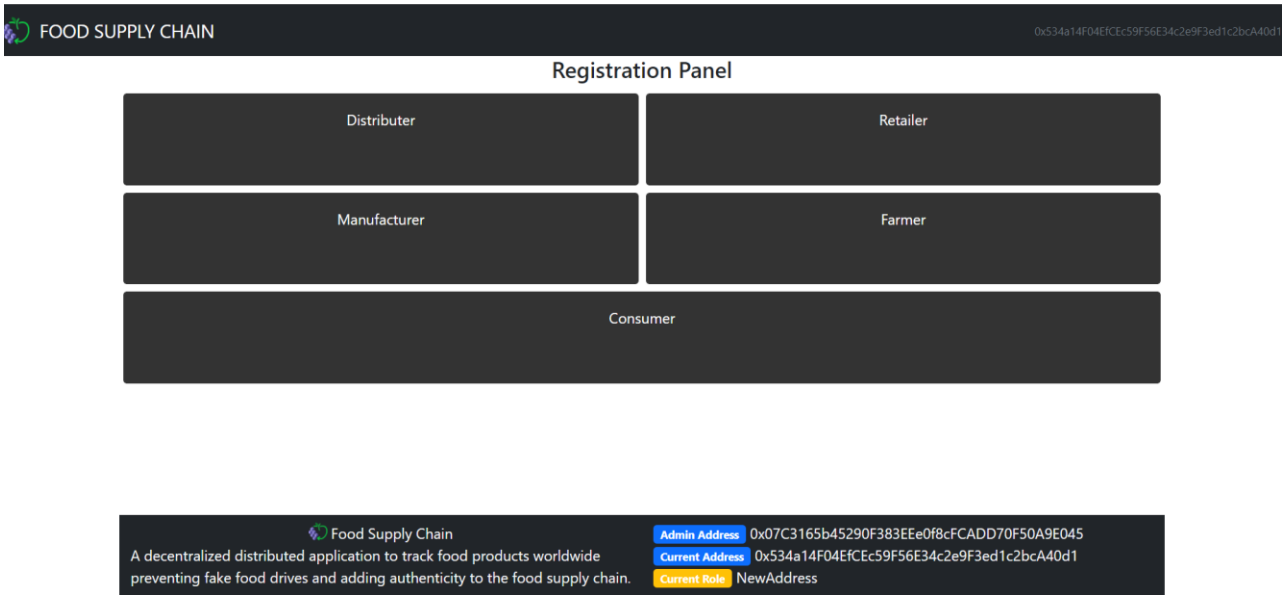


Figure 9 Application Registration Screen

CHAPTER-4
Modules Description

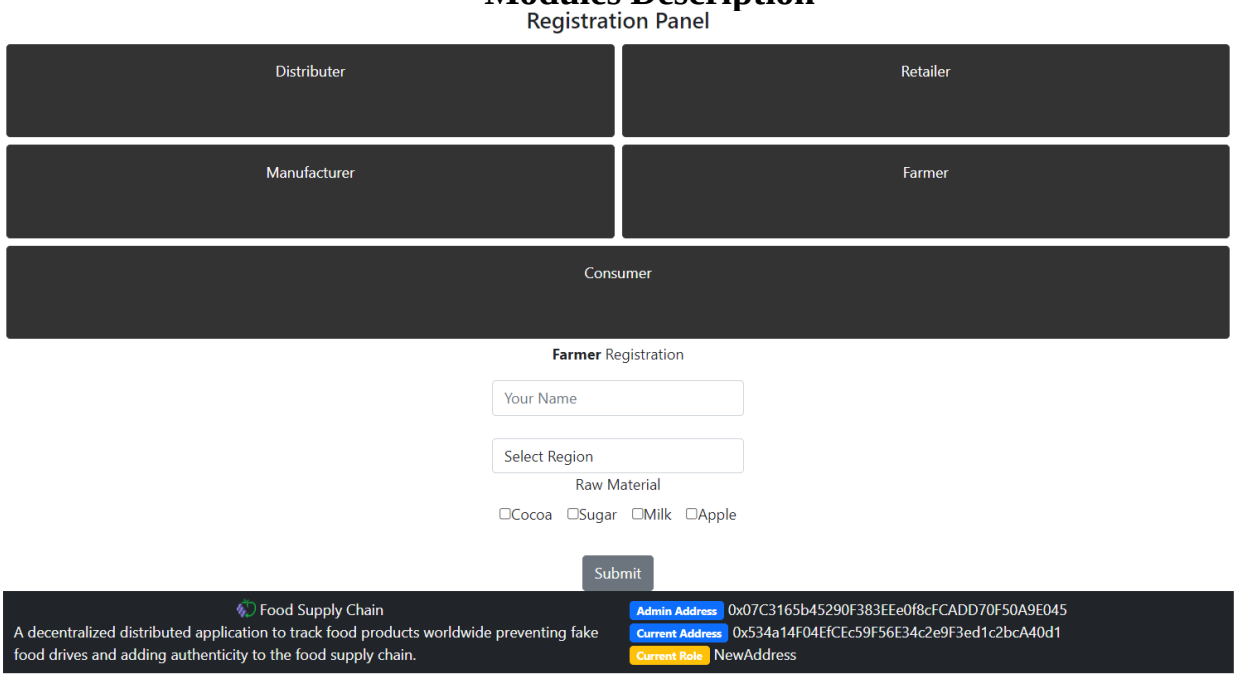


Figure 10 Farmer Registration Screen

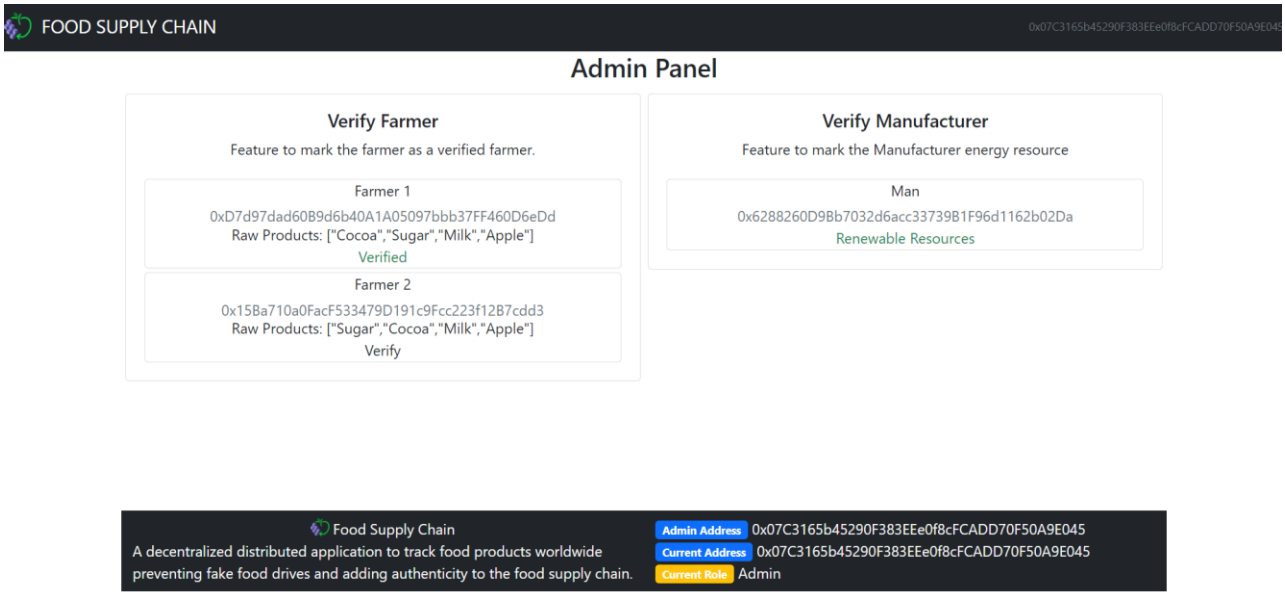


Figure 11Admin Panel to verify Farmer and Manufacturer

CHAPTER-4
Modules Description

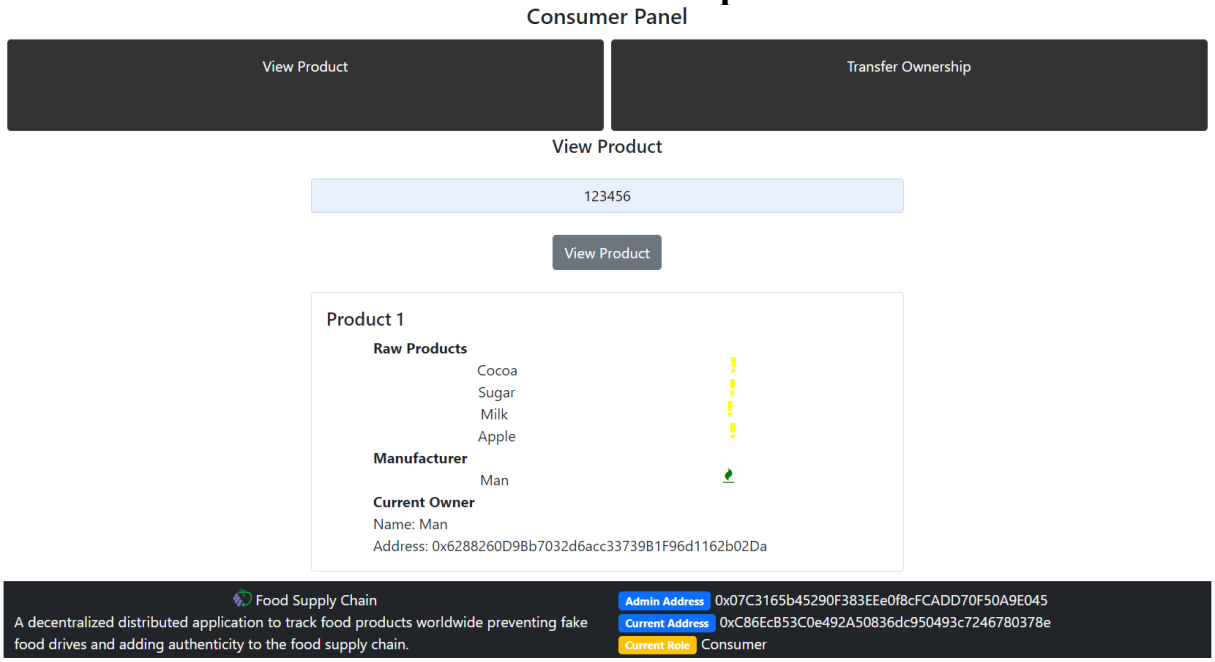


Figure 12 Consumer and Product Verification Panel

CHAPTER-5
Result and Conclusion

In this section, we begin by introducing the existing supply chain system and proposing a blockchain-based food supply chain system.

- Food Supply Chain Overview

  The food supply chain system describes the process of how food items are processed and supplied to end-users. The journey includes production, distribution and consumption. Then material we consume reaches us using a food supply chain where items move in domino-like motion from manufacturers to customers. As the supply chain is domino-like where affecting one part of the supply chain can affect the whole supply chain. In fact, governments and organizations have taken note of food security issues and have taken steps to address them[9]**.** However, there is a long way to go.

- Flaws in Centralized System

  Lack of traceability, growing regulations, rising supply chain costs, consumer trust, product quality, environmental impact, etc are the reliability issues that are faced in the current food supply chain. Consumers demand more transparency and information but current systems are not capable of providing such information. In most cases, the information is checked by third parties, and the records are kept on paper or in the centralized database[10].

- Food Supply System using Blockchain

  Blockchain helps to improve traceability in the food supply chain by providing a decentralized public ledger that helps to connect farmers, manufacturers, distributors and consumers who are far apart and working under different geographical conditions. Transactions in the blockchain cannot be altered as every change is reflected in the entire network[11,12]. Through the use of the

CHAPTER-5
Result and Conclusion

Blockchain-based platform, features like smart contracts, decentralized databases, and proof of performance ensure security and transparency in the food supply chain[13,14].

Therefore, our blockchain-based food tracking system is based on the Ethereum blockchain, which is an open-source and smart contract application. The reason we use this blockchain is that it provides a structured and flexible design, which is scalable and authentic. Alternatively, it can be structured as a federated blockchain that is reliable and trustworthy between different groups and is suitable for supply management applications[10].

In this paper, a blockchain-based solution has been proposed which facilitates a secure and authorized flow of food items throughout the supply chain and security to the stored data that is encrypted, decentralized and cross-checked which permit the data to remain strongly backed. The system also allows tracking the product ownership transaction history from manufacturing to consumers.

CHAPTER-6
References

1. https://ieeexplore.ieee.org/document/8823910
2. Mining logistics data to assure the quality in a sustainable food supply chain: A case in the red wine industry. Int. J. Prod. Econ. 2014, 152, 200–209.
3. Traceability in a food supply chain: Safety and quality perspective. Food Control 2014, 39, 172–184
4. https://www.mdpi.com/1660-4601/17/5/1784
5. A Content-Analysis Based Literature Review in Blockchain Adoption within Food Supply Chain Jiang Duan 1, Chen Zhang 2,*, Yu Gong 2, Steve Brown 2 and Zhi Li 3 1 Blockchain Research Center of China, Southwestern University of Finance and Economics, Chengdu 611130,y.gong@soton.ac.uk (Y.G.); steve.brown@soton.ac.uk (S.B.) 3 School of Electromechanical Engineering, Guangdong University of Technology, Guangzhou 510006, China; piersli@foxmail.com * Correspondence: cz3g16@soton.ac.uk Received: 27 January 2020; Accepted: 3 March 2020; Published: 9 March 2020
6. Ensure Traceability in European Food Supply Chain by using a Blockchain system. 2019 IEEE/ACM 2nd International Workshop on Emerging Trends in Software Engineering for Blockchain (WETSEB).
7. Rejeb, A.; Keogh, H.G.; Treiblmaier, H. Leveraging the Internet of Things and blockchain technology in supply chain management. Future Internet 2019, 11, 1–22.
8. S. Malik, S. S. Kanhere, and R. Jurdak, “Productchain: Scalable blockchain framework to support provenance in supply chains,” in 2018 IEEE 17th International Symposium on Network Computing and Applications (NCA). IEEE, 2018, pp. 1–10

CHAPTER-6
References

9. A Blockchain-based decentralized system to ensure the transparency of organic food supply chain B. M. A. L. Basnayake; C. Rajapakse 2019 International Research Conference on Smart Computing and Systems Engineering (SCSE).
10. "Docker," https://www.docker.com, Accessed: 2019-04-15.
11. "Hyperledger Fabric," https://hyperledger-fabric.readthedocs.io/en/ release-1.1, Accessed: 2019-04-15.
12. https://ieeexplore.ieee.org/document/8846964
13. Data Management in Supply Chain Using Blockchain: Challenges and a Case Study July 2019 DOI:10.1109/ICCCN.2019.8846964 Conference: 2019 28th International Conference on Computer Communication and Networks (ICCCN).
14. Ge, L., Brewster, C., Spek, J., Smeenk, A., and Top, J., Findings from the pilot study Blockchain for Agriculture and Food. 2017.
15. The solution is based on Ethereum. It helped them to accurately record events along with the supply, processing, packaging, and distribution chain. Identify, evaluate and interpret research and developments relevant to the application of blockchain technology in the food supply chain. FSC. The systematic process of method collection and analysis is useful for extracting pertinent insights based on the findings of previous research and identifying possible knowledge gaps.
16. https://timreview.ca/article/1446.
17. Bose, I.; Lam, C.W. Facing the Challenges of RFID Data Management. Int. J. Inf. Syst. Supply Chain Manag. 2008, 1, 19. [CrossRef].
18. Basnayake, B. M. A. L.; Rajapakse, C. (2019). [IEEE 2019 International Research Conference on Smart Computing and Systems Engineering (SCSE) - Colombo, Sri Lanka (2019.3.28-2019.3.28)] 2019 International Research Conference on Smart Computing and Systems Engineering (SCSE) - A

CHAPTER-6
References

Blockchain-based decentralized system to ensure the transparency of organic food supply chain. , (), 103–107. doi:10.23919/SCSE.2019.8842690.

19. Nakamoto, S., “Bitcoin: A Peer-to-Peer Electronic Cash System.
20. https://ieeexplore.ieee.org/abstract/document/8290114?casa_token=Lb0a51YkhD0AAAAA:It_hqLVPBmm_1f-_Bb9HKmnPE1NqcLeHcIwBE-_Dp6jmvzZZUOFT9M7r7xusaXW0SVZLRkctug.
21. https://ieeexplore.ieee.org/abstract/document/7538424?casa_token=ED5t_8rMul0AAAAA:7wnVIaz-EBR0hGt0bIsE-nZ3-yCKMyH6G3gi9TKYzvjcMQXH3hc_XIAGm8-ghha5u8wgprw4tw