The University of Hong Kong

COMP4801 Final Year Project

Interim Report

# Blockchain in Supply Chain

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# Abstract

Following the global impact of the Covid-19 pandemic, there has been an increasing demand for transparency within supply chains. This heightened emphasis aims to ensure product safety and facilitate comprehensive inventory flow tracking. However, the current approach for transparency enhancement relies on the voluntary disclosure of critical information by companies. To address this issue, this project proposes a blockchain-based solution that enables all stakeholders to participate in a decentralized network, granting them access to verified information. The project has completed the user interface for the application, while the development of the back-end server and smart contracts is underway. Subsequently, the integration of the front-end and back-end components will be executed, followed by rigorous testing procedures.

# Acknowledgements

I would like to thank my supervisor, Dr. Qian Chenxiong, for providing so many valuable guidance and support throughout this project. His expertise, feedback, and dedication have been instrumental in shaping the direction of my research.

# Abbreviations

**BCT** Blockchain Technology

**IPFS** InterPlanetary File System

**CID** Content Identifier

**DApp** Decentralized application

**NGO** Non-governmental organization

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# Chapter 1

# Introduction

This chapter provides an introduction to the background of the project, followed by an exploration of the motivation and objective.

## 1.1 Background

In the wake of the Covid-19 pandemic, there has been a heightened public emphasis on the transparency of supply chains, driven by a growing demand for enhanced assurances regarding the safety of products and services(1). A study conducted on consumer habits in 2016 revealed that 94% of customers expressed a desire for transparency within the food supply chain, specifically seeking comprehensive information on the production process(2). By providing such transparency, businesses can establish and foster trust and confidence among consumers, enabling them to make informed decisions regarding whether or not to purchase a product. Additionally, prioritizing transparency contributes to a positive brand reputation, allowing companies

to stand out and attract more customers(3).

On the other hand, several industry-leading companies have endeavored to enhance their supply chain transparency to improve sustainability. A notable instance occurred in 2005 when Nike faced accusations of providing inadequate working conditions in its global factories. In response to public scrutiny and to protect its brand reputation, Nike opted to disclose detailed supplier information, including names and addresses(4). These examples highlight the increasing significance of transparency, which yields numerous advantages for both the public and the companies involved.

## 1.2 Motivation

The conventional method of enhancing supply chain transparency involves companies voluntarily disclosing detailed information. However, these disclosures are dependent on a single source of trust and may encounter challenges such as data loss, data manipulation, and reduced trustworthiness. To address these issues, the emergence of blockchain technology (BCT) offers a potential solution through decentralized application (DApp) for managing the supply chain. Leveraging the characteristics of blockchain and smart contracts, all uploaded information becomes immutable and can be accessed and verified by stakeholders. This enables companies to establish a decentralized system that enhances transparency, increases trust among stakeholders, and mitigates risks associated with centralized data sources (5).

## 1.3 Objective

This project aims to develop a decentralized blockchain solution for recording and managing product information throughout the supply chain. The system will be open to all stakeholders, including suppliers, logistics companies, and customers, enabling their participation and access to the shared data. The process commences with suppliers inputting product details through smart contracts. To ensure the integrity of the data, an ownership mechanism will be implemented, granting modification rights exclusively to the parties responsible for the inventory flow until the products reach the end consumers.

## 1.4 Outline

The remaining sections of this report are organized into four chapters. Chapter 2 provides an overview of the workflow of the blockchain solution and elaborates on the key technologies that will be employed throughout the development process. After that, Chapter 3 focuses on the current progress of the project, highlighting the front-end interface of the application and followed by a scheduled project timeline in Chapter 4. Then, Chapter 5 delves into a comprehensive discussion on the limitations of the project, analyzing its constraints and potential areas for improvement. Finally, Chapter 6 provides a conclusion for this project.

# Chapter 2

# Methodology

This chapter provides an overview of the workflow of the application and implementation of this project.

## 2.1 System workflow

Users are required to employ their digital wallets to engage with the network. Depending on whether they hold ownership of the products, users can either amend the records associated with the products or simply view the existing data.

### 2.1.1 Product initialization

Suppliers initialize a product using smart contract on the network. The product object is created with essential details such as supplier name, address, auto-generated date, product ID, and other relevant information. This could include product specifications, batch numbers, expiration dates, and other

product-specific data (see Figure 1 step 1).

### 2.1.2 Shipping and Transfer of Ownership

When product is shipped to a logistics company or other intermediaries, the ownership of the product is transferred to the receiver such that the receiver can append a record to the product object. This could be a document which includes the date of shipment, destination, mode of transport, tracking number, and other relevant information. This process will be repeated until the product is received by the retailers (see Figure 1 step 2).

### 2.1.3 Retailer Receipt and Record

When the retailer receives the product, they add a record. This could include the date of receipt, quality check results, and any other relevant information. After that, the retailer generates a QR code that encoded with the product ID. This QR code is then attached to the product and displayed in the store (see Figure 1 step 3).

### 2.1.4 Customer Access

When a customer scans the QR code, their device will decode the product ID and invoke a lookup smart contract on the blockchain. Upon successful execution, record history of the product will be retrieved and return to the customer's device (see Figure 1 step 4).

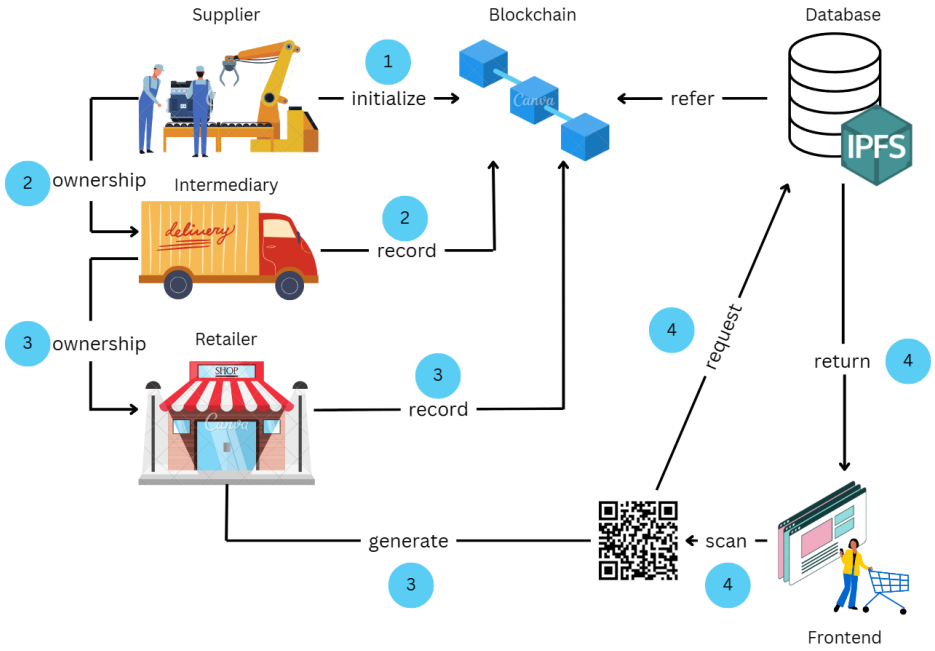


Figure 1: System workflow

## 2.2 Implementation

This section provides an explanation of each technology used in the project and justifies the choice of these technologies.

### 2.2.1 Blockchain: Solana, Rust

Solana is chosen for this project based on several compelling factors. Firstly, Solana stands out as one of the most high-performance public blockchain networks presently available. Its remarkable capacity to process up to 65,000 transactions per second. This capability is crucial for a logistics system when managing a substantial volume of transactions within a supply chain context.

Besides, transactions on the Solana network are relatively cheap, which is around $0.00025. This means that the costs associated with tracking and updating the status of shipments can be kept low, which could be beneficial for a logistics system. Rust is a systems programming language that can be used to write smart contract on Solana (6).

### 2.2.2 Back-end framework: Node.js

The back-end server will be implemented utilizing Node.js, a robust runtime environment renowned for its extensive collection of built-in functions and comprehensive ecosystem of external libraries, which greatly facilitate the development process. Additionally, Solana offers a dedicated JavaScript library known as "@solana/web3.js," specifically designed to enable seamless interaction between developers and the Solana blockchain through Node.js.

### 2.2.3 Front-end framework: React.js

React.js is a popular JavaScript library for building user interfaces. With its widespread use and strong community support, it will facilitate to develop a dynamic, responsive, and user-friendly interface for the logistics system.

### 2.2.4 Decentralized file storage: InterPlanetary File System (IPFS)

IPFS, a decentralized and content-addressed file system, guarantees the preservation of data integrity, security, and privacy. In the supply chain system, IPFS will play a pivotal role in storing essential documents such as quality

check reports, receipts, and other pertinent files. To facilitate this process, the Node.js "ipfs-http-client" package can be employed to upload these documents to IPFS. Subsequently, a Content Identifier (CID) will be generated, serving as a reference to the uploaded documents. This CID will be stored on the blockchain, enabling retrieval of the associated documents using the same CID.

# Chapter 3

# Current Progress

This chapter explains the progress accomplished during the initial semester, focusing on the front-end component of the DApp.

## 3.1 Front-end Development

### 3.1.1 Home Page

There are three pages integrated into the decentralized application (DApp). The initial page serves as the home page, presenting users with the option to either update the product record or view an existing product record (see Figure 2).

### 3.1.2 Update Page

When the user selects the ”Update” option, they will be directed to the ”Update Page.” This page contains various input fields, including the product ID

that the user wants to update, the organization name, address, the wallet address of next owner, and a dropdown zone for uploading additional documents (see Figure 3). Once all the necessary information is filled out, the user can click the submit button. This action triggers a request sent to the back-end, which then invokes the smart contract.

If the user is the rightful owner of the product, the record will be successfully updated on the blockchain network. However, if the user is not the owner, an error message will be displayed on the front-end, indicating that the update cannot be executed.

### 3.1.3 View Page

When the user chooses the "View" option, they will be prompted to scan a QR code using their device in order to obtain the product ID. Once the scanning is successfully completed, a lookup smart contract will be executed. This contract will retrieve a list of records associated with the scanned product (see Figure 4).

To view the uploaded documents, the user can click on the corresponding "View" buttons located in the document column. Each button is associated with a CID (Content Identifier) value. When the user clicks on the button, a request will be sent to IPFS (InterPlanetary File System) to retrieve the respective documents. The retrieved documents will then be displayed in a new tab, allowing the user to access and view the content.

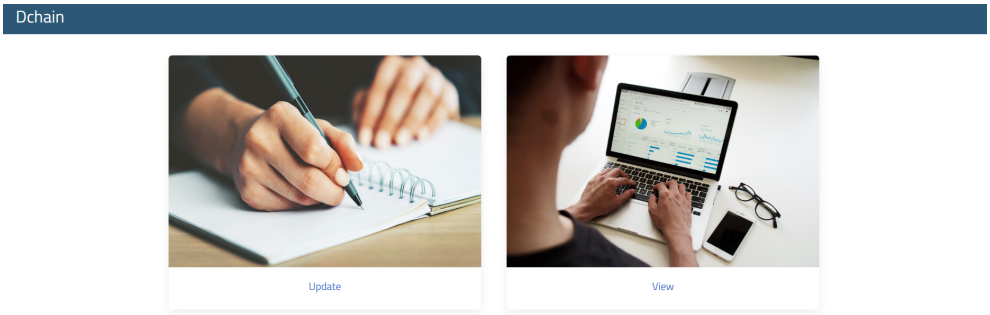


Figure 2: Home page

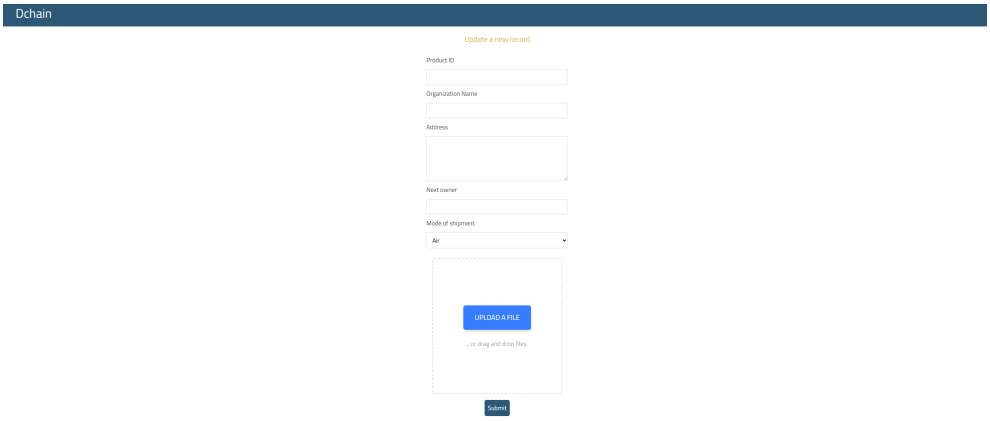


Figure 3: Update page


Figure 4: View page

# Chapter 4

# Timetable

This chapter presents the overview of the implementation of this project along with a timeline. In the upcoming semester, the focus of development will be on the back-end infrastructure and the implementation of smart contracts.

| Project Schedule | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Progress | September | October | November | December | January | February | March | April | May |
| Project Planning | | | | | | | | | |
| Data collection and manipulation | | | | | | | | | |
| Front-end and back-end development | | | | | | | | | |
| Blockchain implementation | | | | | | | | | |
| Report & Finalization | | | | | | | | | |

Figure 5: Project schedule

# Chapter 5

# Limitation

This presented project showcases a simplified blockchain solution for supply chain management. However, in a real-world application, it's crucial to have mechanisms in place to verify the authenticity and credibility of the documents uploaded by upstream stakeholders. This verification process can involve government supervision and the issuance of official certificates to enhance trust among the parties involved. Regulations can be established to ensure compliance with social, environmental, and legal requirements. By supervising and monitoring the activities of stakeholders involved in the supply chain, governments can help maintain transparency and accountability. Besides, various non-governmental organizations (NGOs) such as the Business & Human Rights Resource Centre and the International Labor Organization can also conduct investigations and assessments of multinational companies to evaluate their adherence to ethical practices (4). NGOs' findings and certifications can serve as additional layers of trust and assurance within the supply chain (7).

# Chapter 6

# Conclusion

This project demonstrates a blockchain solution for supply chain management, aiming to enhance transparency and traceability. The development of a web application using React.js is complete, providing a user-friendly interface for interacting with the blockchain network. In the upcoming semester, the focus will be on developing and deploying smart contracts and a back-end server to enable seamless integration between the front-end and back-end components. Once the integration is complete, the application's functionality will be operational, and thorough testing will be conducted.

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