A PROJECT REPORT ON

Food Harvest Supply Chain using Blockchain

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
IN THE FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE

OF

BACHELOR OF ENGINEERING (COMPUTER ENGINEERING)

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2019-2020

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Acknowledgements

It gives us great pleasure in presenting the preliminary project report on **'Food Harvest Supply Chain using Blockchain'**.

We would like to take this opportunity to thank our internal guide **A.A.Chandorkar** and external guide **Mr.Sachin Deshpande** for giving us all the help and guidance we needed. We are really grateful to them for their kind support. Their valuable suggestions were very helpful.

We are also grateful to **Prof. Mrs. M. S. Takalikar**, Head of Computer Engineering Department, PICT for her indispensable support, suggestions.

In the end our special thanks to the college for providing various resources such as laboratory with all needed software platforms, continuous Internet connection, for our Project.

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Abstract

Blockchain is an emergent technology concept that enables the decentralized and immutable storage of verified data. Over the last few years, it has increasingly attracted the attention of different industries. Especially in Fintech, Blockchain is hyped as the silver bullet that might overthrow today's payment handling. Slowly, the logistics and supply chain management community realizes how profoundly Blockchain could affect their industry. To shed light on this emerging field, we conducted an online survey and asked logistics professionals for their opinion on use case exemplars, barriers, facilitators, and the general prospects of Blockchain in logistics and supply chain management.

Food supply chains are confronted with increased consumer demands for food quality and sustainability. When redesigning these chains the analysis of food quality change and environmental load for new scenarios is as important as the analysis of efficiency and responsiveness requirements. Simulation tools are often used to support decision making in the supply chain (re)design when logistic uncertainties are in place building on their inherent modelling flexibility. Mostly the underlying assumption is that product quality is not influenced by or does not influence chain design. Clearly this is not true for food supply chains as quality change is intrinsic to the industry.Through this project we emphasize on specific characteristics and modelling requirements of food supply chains. This embeds food quality change models and sustainability indicators in discrete event simulation models. A case example illustrates the benefits of its use relating to speed and quality of integrated decision making but also to creativity in terms of alternative solutions.

Keywords: Blockchain Technology, Food Supply Chains, RFID , agri-food logistics.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Blockchain is an emergent technology concept that enables the decentralized and immutable storage of verified data. Over the last few years, it has increasingly attracted the attention of different industries. Especially in Fintech, Blockchain is hyped as the silver bullet that might overthrow today's payment handling. Slowly, the logistics and supply chain management community realizes how profoundly Blockchain could affect their industry. To shed light on this emerging field, we conducted an online survey and asked logistics professionals for their opinion on use case exemplars, barriers, facilitators, and the general prospects of Blockchain in logistics and **supply chain** management. Food supply chains are confronted with increased consumer demands for food quality and sustainability. When redesigning these chains the analysis of food quality change and environmental load for new scenarios is as important as the analysis of efficiency and responsiveness requirements.

1.2 Motivation

For the past few years, food safety has become an outstanding problem. Since traditional **agri-food logistics** pattern can not match the demands of the market anymore, bui**lding an agri-fo**od supply chain traceability system is becoming more and more urgent. In this project, we study the utilization and development situation of **RFID** (Radio-Frequency IDentification) and blockchain technology first, and then we analyze the advantages and disadvantages of using **RFID** and blockchain technology in building the agri-food supply chain traceability system; finally, we demonstrate the building process of this system. It can realize the traceability with trusted information in the entire agri-food supply chain, which would effectively guarantee the food safety, by gathering, transferring and sharing the authentic data of agri-food in production, processing, warehousing, distribution and selling links.

1.3 Problem Definition

Design agri-food supply chain management traceability system using smart contract and Blockchain Technology.

Chapter 2

Literature Survey

2.1 Smart contracts and their application in supply chain management. Angwei Law - 2017 - dspace.mit.edu

In this thesis, we get to learn about proof-of-concept to explore the application of smart contracts in supply chain management. The proof-of-concept consists of three smart contracts, coded in Solidity, that can be integrated to determine the provenance of goods, track the chain of custody as goods flow through a supply chain, automatically execute payment upon fulfillment of criteria, and maintain an open database of stakeholders with a score indicating their reputation.

2.2 Feng Tian. (2016). An agri-food supply chain traceability system for China based on RFID c blockchain technology. 2016 13th International Conference on Service Systems and Service Management (ICSSSM).

In this paper, we study the utilization and development situation of RFID (Radio-Frequency IDentification) and blockchain technology first, and then we analyze the advantages and disadvantages of using RFID and blockchain technology in building the agri-food supply chain traceability system; finally, we demonstrate the building process of this system.

2.3 Traceability in Agri-Food Sector using RFID Arun N. Nambiar Department of Industrial Technology California State University Fresno, California 93740

With the proliferation of traceability systems using different technologies, it becomes imperative for these systems to be able to interact with one another and be integrated into the company's existing information infrastructure. This work aims to review the current research in this field with special emphasis on RFID systems. We also seek to identify future areas of research in this field.

Chapter 3

Software Requirements Specification

3.1 Assumptions and Constraints

The following assumptions are made based on ...

3.1.1 Assumptions

- The user should know about basics of traceability using RFID and BlockChain.
- The user should know basic about using BlockChain technology and smart contracts.

3.1.2 Constraints

The following constraints are imposed upon the ...

- Data-set should be provided.
- Basic Hardware and software should be installed.
- Solidity language , RFID usability to be known .

3.2 Functional Requirements

3.2.1 This project aims at providing Traceability Thrust

The integrity of traceability data requires a common understanding of the different key occurrences (termed Critical Tracking Events) for a product within agri-food supply chains and the key data associated with each of these occurrences (termed Key Data Elements). Then a means of ensuring that occurrences of these events are recognized and that the information associated with them is captured and kept is needed. This information will be stored in many different forms and systems, yet it must be collected and merged when tracing the source of a problem, or tracking down affected product.

3.2.2 Warehouse management and tracking of goods

Consumer satisfaction with the quality of your products is clearly important, but the service you provide before and after the sale is equally important to any business, but often overlooked as benefiting the bottom line. However, providing efficient tracking and tracing of shipped products enhances customer loyalty and your company image. Obviously, satisfied customers are a company's greatest asset. Track/Trace solutions including software and Automatic identification technologies such as barcoding and RFID are both reliable and effective in ensuring the efficient delivery of materials and components to you and to your customers.

3.3 Non-Functional Requirements

3.3.1 Food Safety and Identification

- Trade in agri-food and commodities are foreseen to see continued increase. Changes in the trading environment have led to growth in global production network. The structure of the supply chain has evolved towards increased fragmentation and complexity across multiple enterprises, and global reach of agri-food supply chains.
- Implementation of effective traceability systems improves the ability to implement verifiable safety and quality compliance programs. The resulting visibility of relevant information enables agri-food businesses to better manage risks and allows for quick reaction to emergencies, recalls, and withdrawals.

3.3.2 Scalability Requirements

- Clarify what the bottlenecks are and their scalability: The supply chain bottlenecks can be both internal and external; production lines, vendors, warehouse and logistics capacities etc.
- Determine what decisions are to be taken in which forums for which horizon: The purpose is to agree on the responsibilities for each decision – but also to be able to establish initiatives for increase of capacity
- Define what forecast aggregation level is needed for the decisions – dnd determine the forecast error and bias for those levels in the relevant horizons.

3.3.3 Security Requirements

1.Using RFID IOT based technology for keeping track of food supply from consumer and also tracking any plant diseases. 2.Efficient technique to remove middle man services using smart contracts ethereum web application.

3.3.4 Simplicity Requirements

Using solidity java based programming language for deploying smart contracts. Using RFID for security management.

3.3.5 Maintainability Requirements

To maintain the system , we need to continuously monitor the changes in supply chain. Like continuous track of food diseases if any ,update user changes and requirements for future use should be always kept as concern. Check Demand and Forecast Accuracy(DFA), Total supply chain cost from Direct Purchasing cost to customer service cost.

3.3.6 Software Quality Attributes

- Accuracy: The system should be able to accurately...
- Reliability: The system should give reliable results...
- Speed: The system should generate the results within few seconds.

3.4 External Interface Requirements

3.4.1 User Interfaces

- User Interface will be a Distributed Web Apllication. This will extract information from the blockchain to show in a simplified way.

3.5 System Requirements

3.5.1 Database Requirements

- For back-end purpose for storing and processing data in warehouse and in blockchain , we need to use SQL (Structured Query language) for storing data in RDBMS. Also we can use NoSql database MongoDB which is incorporated with Node.js language for processing data.

3.5.2 Software Requirements

Software requirements include Hardware and Software system requirements.

3.5.2.1 Software Requirements:

- Solidity language for creating smart contracts.
- Mongo DB language for back-end database.
- Node JS , WEB JS for front-end.

3.5.2.2 Hardware Requirements:

- Linux (64-bit) Operating system .
- 4GB RAM
- gedit
- GCC/JAVA compiler and JRE installed.
- Ethereum installed.

Chapter 4

System Design

4.1 System Architecture

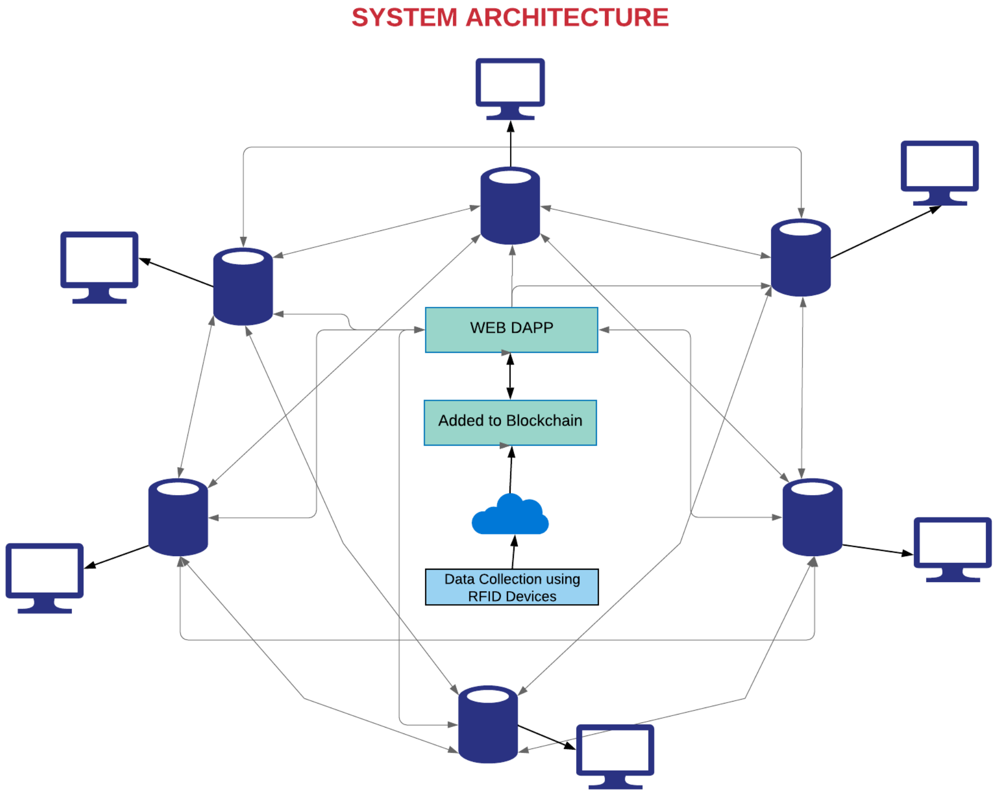

Figure 4.1: System Architecture

4.2 Data Flow Diagrams

4.2.1 DFD Level 0

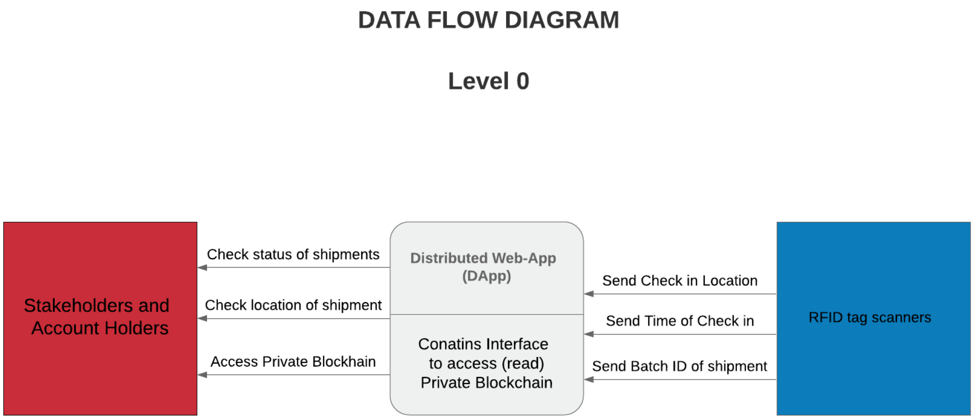

Figure 4.2: DFD Level 0

4.2.2 DFD Level 1

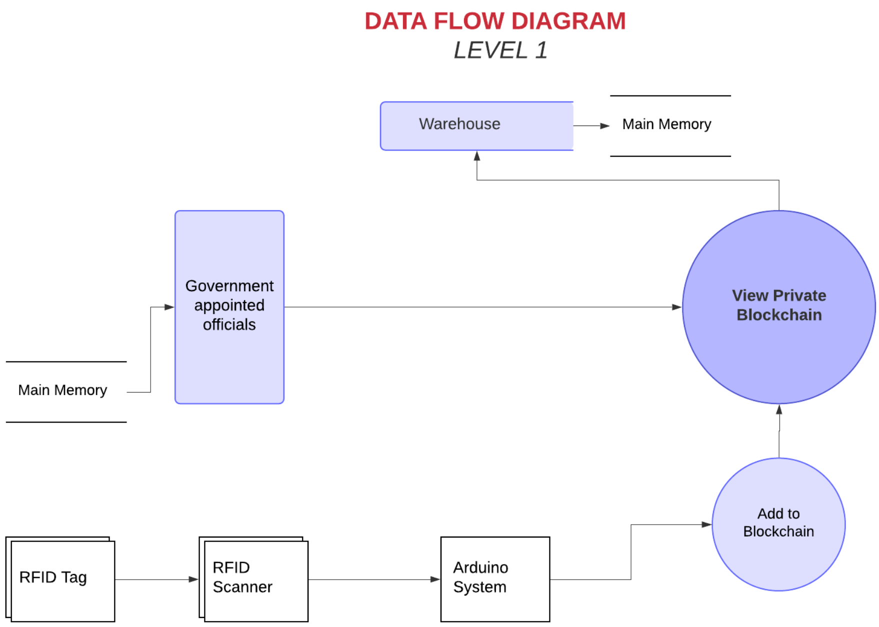

Figure 4.3: DFD Level 1

4.3 UML Diagrams

4.3.1 Use Case Diagram

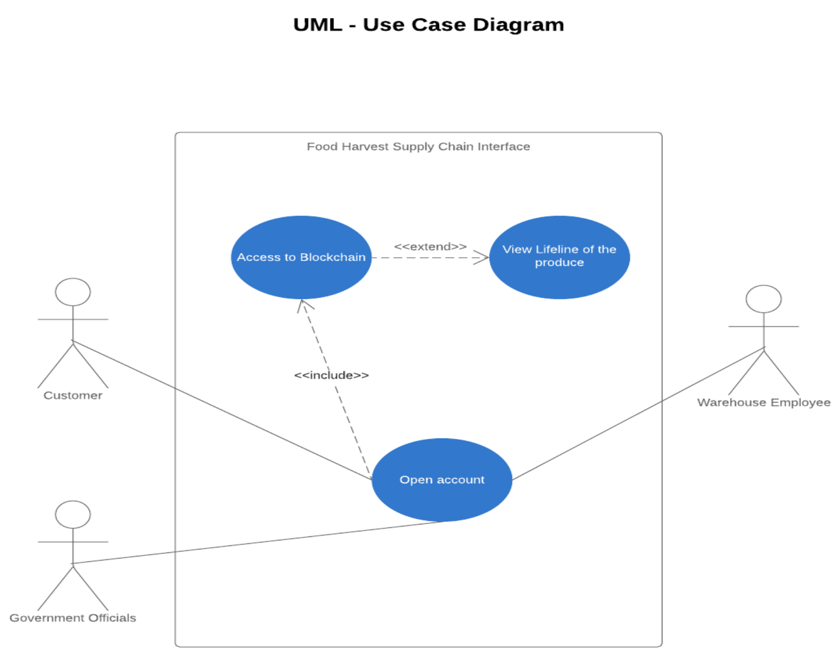

Figure 4.4: Use Case Diagram

4.3.2 Activity Diagram

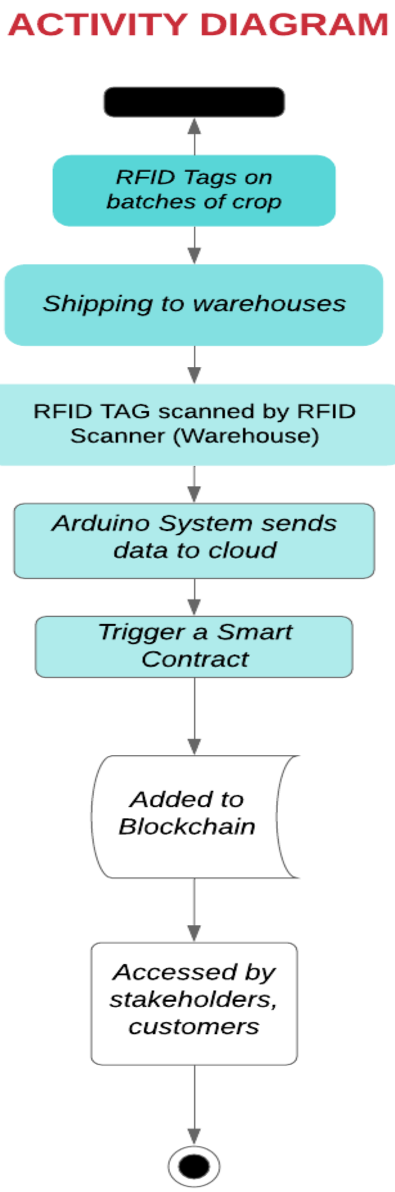

Figure 4.5: Activity Diagram

4.3.3 Sequence Diagram

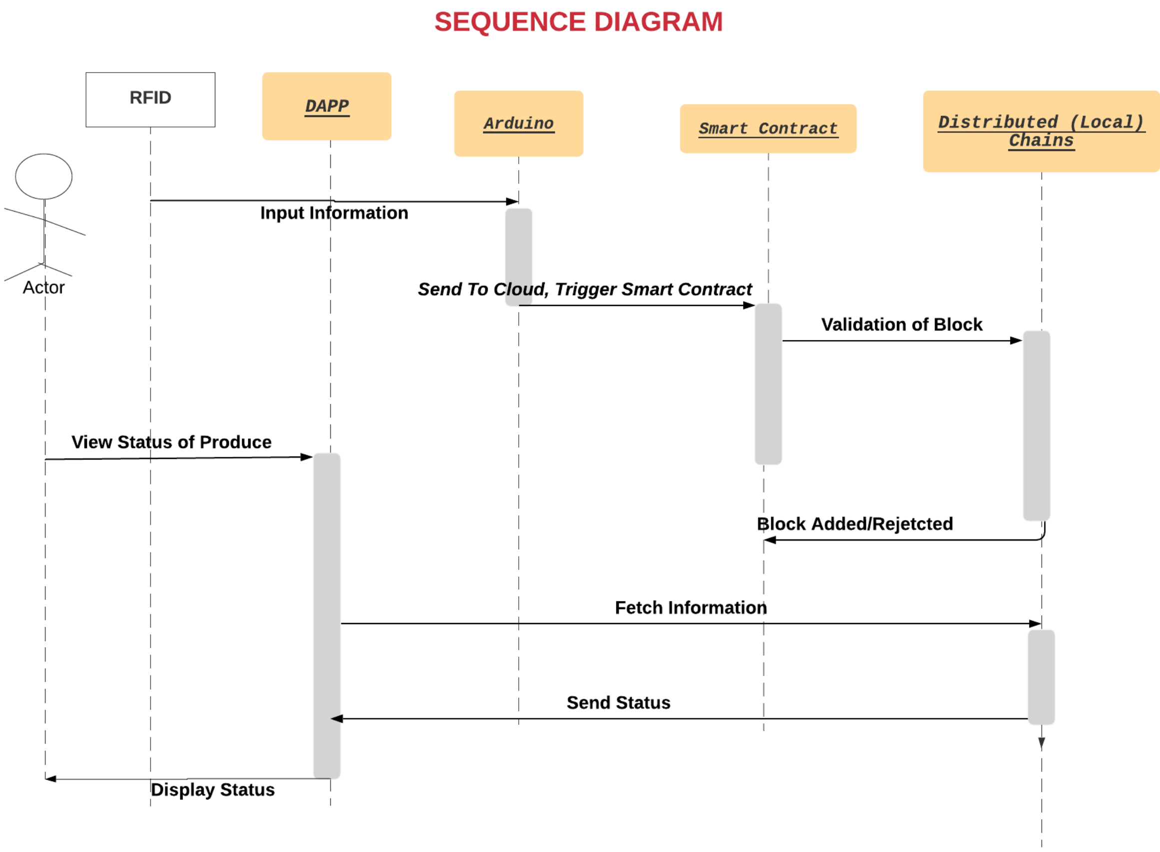

Figure 4.6: Sequence Diagram

Chapter 5

Project Plan

5.1 Project Resources

5.1.1 Human Resources

- Number of people: 4
- Skills:
  - Communication
  - Critical Thinking
  - Creativity
  - Decision Making
  - Situational Leadership
  - Technical Skills
- Geographic restrictions: None

5.1.2 Development Resources

- Data Collection Apparatus:
  - RFID Tag and Reader
- Hardware:
  - RFID Tag
  - RFID Reader
  - Arduino Uno Microcontroller
  - Wifi Module
  - Buzzer
- Software:
  - Ethereum
  - Node.js
  - MongoDB
  - Ganache CLI
  - Truffle
  - React js

5.2 Project Estimates

5.2.1 Hardware Costs

Component Name	**Cost in Rs**
RFID Tag	20
RFID Reader	250
Arduino Uno	450
Wifi Module	180
Buzzer	50

5.3 Risk Management

5.3.1 Risk Identification and Analysis

The risk analysis is performed using the following guidelines:

Risk Probability

a.	High probability -	$75\% \leq x \leq 100\%$
b.	Medium-high probability -	$50\% \leq x \leq 75\%$
c.	Medium-low probability -	$25\% \leq x \leq 50\%$
d.	Low probability -	$0\% \leq x \leq 25\%$

Risk Impact

a.	Very High -	Catastrophic
b.	High -	Critical
c.	Medium -	Moderate
d.	Low -	Marginal

5.3.2 Risks Identified

Risk ID	1
Description	Hardware failure
Category	Hardware
Probability	15%
Impact	Marginal
Response	Accept
Strategy	Replace with new hardware
Status	Identified

Table 5.1: Risk 1

Risk ID	2
Description	Logical error in Smart Contract
Category	Software
Probability	30 %
Impact	Critical
Response	Accept
Strategy	Code Debugging
Status	Identified

Table 5.2: Risk 2

5.4 Risk Justification

- Risk ID 1 is certain to occur, since Hardware failures are common and unavoidable
- Risk ID 2 deals with issues and complexities in the Smart Contract

5.5 Project Schedule

5.5.1 Task Set

Task	**Description**	**Start Date**	**End Date**
Task A	Problem Statement	02-09-2019	10-09-2019
Task B	Domain Study	13-09-2019	01-10-2019
Task C	Literature Survey	01-10-2019	10-10-2019
Task D	System Requirement Specification (SRS)	10-10-2019	20-10-2019
Task E	System Design	01-11-2019	14-11-2019
Task F	Smart Contract development	27-11-2019	01-01-2020
Task G	Backend development	16-12-2019	20-01-2020
Task H	IOT Module Testing	16-12-2019	30-01-2019
Task I	User Interface development	01-01-2020	01-02-2020

Table 5.3: Task Set

5.5.2 Task Network

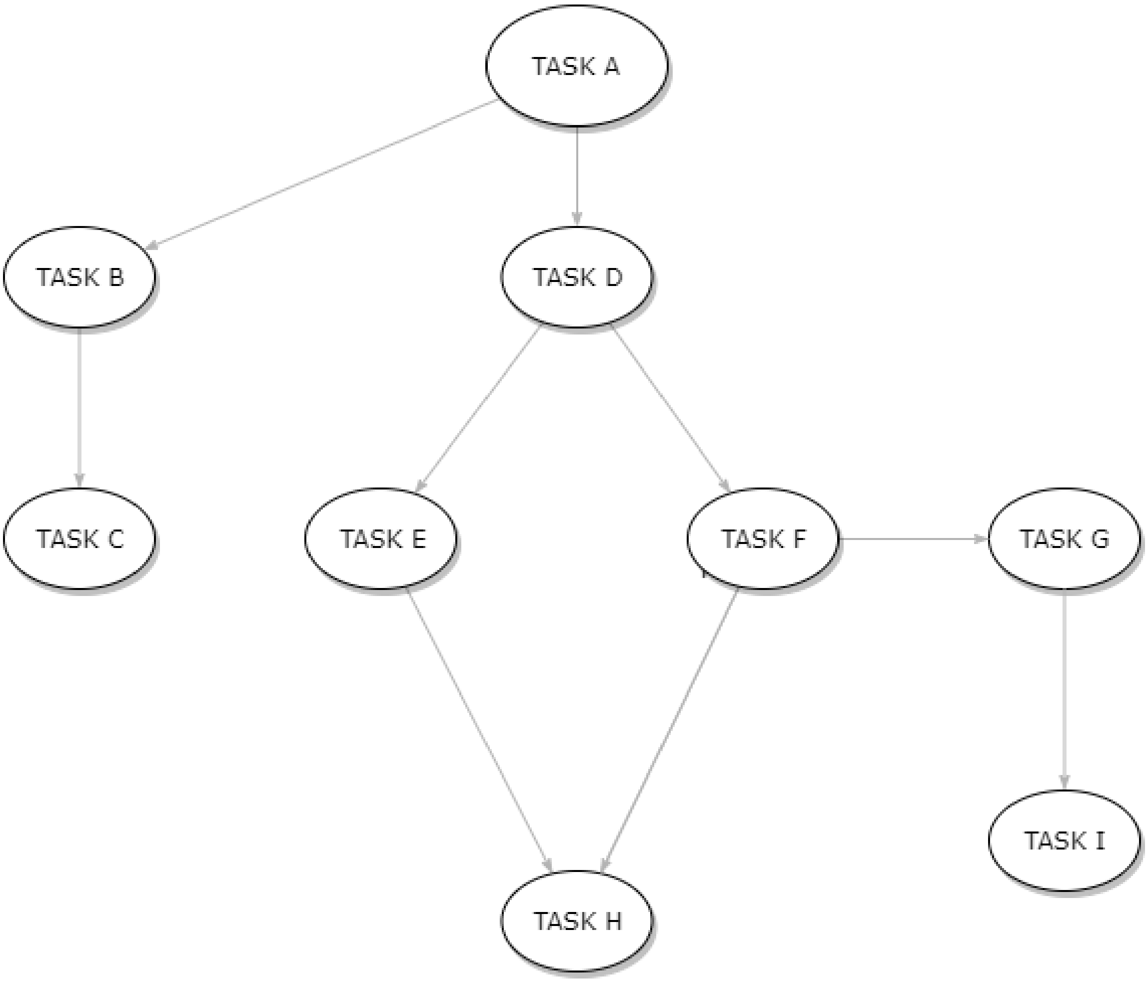

Figure 5.1: Network Diagram

Chapter 6

Project Implementation

6.1 Project Modules

The project is divided into three modules :-

6.1.1 Decentralised Application (Main module)

User will have to login on the application to access the blockchain. New users will have to register after which their data will be stored in the backend. Once the user creates an account, he/she becomes a part of blockchain and have a copy of their own blockchain. With the help of the tag ID of a particular shipment the user will be able to track the shipment and retrieve its current status.

6.1.2 Smart contracts module

Smart contracts are self executed when the conditions are met i.e. shipment enters or leaves a warehouse. Outcomes are then recorded on the blockchain permanently and updated across all the nodes. Smart Contracts helps in addressing three main challenges -

A. Determining the provenance of goods

To determine provenance, the first supplier (origin) records the details of the shipment to the blockchain. The current location and time is immutably stored. This allows any other users to access the information through the blockchain.

B. Tracking the progress of goods through supply chain

For tracking of the shipment along the supply chain, each user will record the details to the blockchain whenever they send out the shipment or receive a shipment. The IoT Module will sense the incoming or outgoing and will automatically trigger the smart contract to execute. The details are then recorded on the blockchain.

C. Building trust through an open database of supply chain partners

A reputation score is maintained for each user to determine the number of successful shipments handled by them. This score is stored with the other details of the user in an open database. This is used to incentivize users to work towards maintaining a good reputation and help build trust among users with greater transparency.

6.1.3 IoT module

IoT Module consists of the RFID scanner, RFID tag and the Arduino Uno which is connected to ESP8266 (WiFi module). When scanner recognises the tag, the tag ID is sent to Arduino Uno through the RFID scanner. The Arduino Uno then uses tag ID to trigger the smart contract deployed on the web via the WiFi Module.

Chapter 7

Other Specifications

7.1 Advantages

- Enhances transparency in the supply chain by recording the provenance of goods.
- Inventory tracking across supply chain, helps maintain continuity of supply.
- Simplified and automated processes result in less time and manual effort wasted.
- Reduced costs as less physical documentation are required.
- Build trust among the users with the help of the reputation score which is automatically updated for each user.

7.2 Limitations

- Smart Contract developers need to have appropriate knowledge of the agriculture supply chain.
- Installation of hardware is required to be done at each site.
- Hardware costs are high.
- Hardware faults may occur at warehouse sites.
- Blockchain can be tampered with if control of more than 50 percent of it is lost.

Chapter 8

Conclusion and future scope

8.1 Conclusion

We have hereby built a robust system in order to address the several issues discussed earlier in food harvest life cycle. We have hereby implemented a supply chain using blockchain and smart contracts.

8.2 Future Scope

Future scope of this system would be a scalable extension for implementation on a nationwide level. Addition of tracking technologies like global positioning system, Bluetooth and maintenance of a national database would be the steps to carry forward this project.

Annexure A

Plagiarism Report

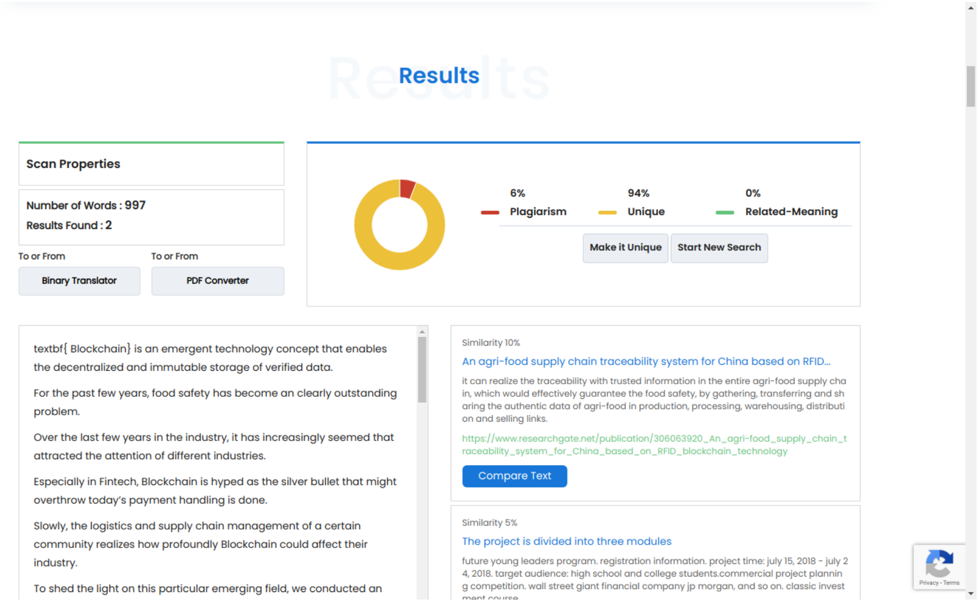

Figure A.1: Plagiarism Report

Chapter 9

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[1] Smart contracts and their application in supply chain management. Angwei Law - 2017 - dspace.mit.edu

[2] Feng Tian, "An agri-food supply chain traceability system for China based on RFID blockchain technology," 2016 13th International Conference on Service Systems and Service Management (ICSSSM), Kunming, 2016, pp. 1-6.

[3] Traceability in Agri-Food Sector using RFID Arun N. Nambiar Department of Industrial Technology California State University Fresno, California 93740

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[5] D. Tse, B. Zhang, Y. Yang, C. Cheng and H. Mu, "Blockchain application in food supply information security," 2017 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), Singapore, 2017, pp. 1357-1361.