



Faculty of Computer Science and Information Technology

***SUPPLY CHAIN TRACEABILITY
FOR BIRD NEST PRODUCT USING
BLOCKCHAIN FRAMEWORK***

Awangku Wazif Syahmi Bin Awang
Shahpuadin

Bachelor of Computer Science with Honours
(Information System)

2022

UNIVERSITI MALAYSIA SARAWAK

THESIS STATUS ENDORSEMENT FORM

TITLE Supply Chain Traceability for Bird Nest Product using Blockchain Framework

ACADEMIC SESSION: 2022/2023

AWANGKU WAZIF SYAHMI BIN AWANG SHAHPUDIN

(CAPITAL LETTERS)

hereby agree that this Thesis* shall be kept at the Centre for Academic Information Services, Universiti Malaysia Sarawak, subject to the following terms and conditions:

1. The Thesis is solely owned by Universiti Malaysia Sarawak
2. The Centre for Academic Information Services is given full rights to produce copies for educational purposes only
3. The Centre for Academic Information Services is given full rights to do digitization in order to develop local content database
4. The Centre for Academic Information Services is given full rights to produce copies of this Thesis as part of its exchange item program between Higher Learning Institutions [or for the purpose of interlibrary loan between HLI]
5. ** Please tick (✓)

- CONFIDENTIAL (Contains classified information bounded by the OFFICIAL SECRETS ACT 1972)
- RESTRICTED (Contains restricted information as dictated by the body or organization where the research was conducted)
- UNRESTRICTED


(AUTHOR'S SIGNATURE)

Validated by

Assoc. Prof. Dr. Jhazri Abdullah
Faculty of Computer Science & Information Technology
(SARAWAK MALAYSIA SARAWAK'S SIGNATURE)
43300 Kota Samarahan

Permanent Address
LOT 1103, Lorong 4, Jalan Alamanda,
Kampung Seberang, 96100 Sarikei,
Sarawak

Date: 24/07/2023

Date: 24/07/2023

Note * Thesis refers to PhD, Master, and Bachelor Degree
** For Confidential or Restricted materials, please attach relevant documents from relevant organizations / authorities

**Supply Chain Traceability for Bird Nest
Product using Blockchain Framework**

**AWANGKU WAZIF SYAHMI BIN
AWANG SHAHPUDIN**

This project is submitted in partial fulfillment of the requirements for the degree of
Bachelor of Computer Science with Honours
(Software Engineering)

Faculty of Computer Science and Information Technology
UNIVERSITI MALAYSIA SARAWAK
2022

**RANTAIAN BEKALAN PRODUK
SARANG BURUNG MENGGUNAKAN
KERANGKA BLOCKCHAIN**

**AWANGKU WAZIF SYAHMI BIN
AWANG SHAHPUDIN**

Projek ini merupakan satu keperluan untuk
Ijazah Sarjana Muda Sains Komputer dengan Kepujian
(Kejuruteraan Perisian)

Fakulti Sains Komputer dan Teknologi Maklumat
UNIVERSITI MALAYSIA SARAWAK

2022

DECLARATION

I hereby declare that this project is my original work. I have not copied from any other student's work or from any other sources except where due reference or acknowledgement is not made explicitly in the text, nor has any part had been written for me by another person.



.....
(AWANGKU WAZIF SYAHMI BIN AWANG SHAHPUDIN)

22/01/2023

.....
Date

ACKNOWLEDGEMENT

I would want to use this occasion to convey my sincere gratitude to my supervisor, Associate Professor Dr. Johari bin Abdullah, who has helped me through difficult times and has continuously guided me while I worked to complete this project. In addition, I wanted to express my gratitude to Ts. Hj. Ahmad Hadinata Fauzi, the project's examiner, for his input and ideas on how to make the project better. Finally, I want to thank my parents, siblings, and everyone else who helped to support and pray for the success of my initiative.

ABSTRACT

The lack of visibility and transparency in tracking the flow of bird nest goods in Sarawak poses a substantial barrier to entrepreneurs in the bird nest industry. Inefficiencies in the supply chain are caused by a lack of traceability, making it impossible to identify the source and origin of the goods. Without transparency, the bird nest supply chain was vulnerable to data fraud and manipulation, making it difficult for other parties to trust the information that was provided. To address this issue, a solution based on the blockchain framework is being created to provide traceability in the supply chain of bird nest. The expected outcome of this project is that the product registered in the system can be tracked using the product's address in the blockchain explorer.

ABSTRAK

Integriti dan ketelusan yang kurang dalam menjejaki produk sarang burung di Sarawak menimbulkan halangan yang besar terutama kepada usahawan dalam industri sarang burung. Ketidakecekapan dalam mengendalikan rantai bekalan disebabkan oleh pengurusan yang tidak cekap, menjadikannya mustahil untuk mengenal pasti asal produk. Tanpa integriti, rantai bekalan sarang burung terdedah kepada penipuan dan manipulasi dan, menyukarkan pihak lain untuk mempercayai maklumat yang diberikan. Bagi menangani isu ini, penyelesaian berdasarkan rangka kerja blockchain dibuat untuk menyediakan kecekapan dalam pengendalian rantai bekalan sarang burung. Hasil jangkaan projek ini ialah produk yang didaftarkan dalam sistem boleh dijejak menggunakan alamat produk dalam “*Blockchain Explorer*”.

Table of Contents

DECLARATION	v
ACKNOWLEDGEMENT	6
ABSTRACT	7
ABSTRAK	8
Chapter 1: Introduction	16
1.1 Background	16
1.2 Problem Statement	18
1.3 Objectives	19
1.4 Brief Methodology	20
1.5 Scopes	21
1.6 Significant of project	21
1.7 Significant economy impact	21
1.8 Sustainable Development Goals (SDGs)	21
1.9 Project Schedule	22
1.10 Expected Outcome	22
1.11 Project Outline	23
Chapter 2: Literature Review	24
2.1 Introduction	24
2.2 Birdnest Industry in Sarawak	24
2.3 Supply chain using Blockchain	25
2.4 Review of Similar Existing Systems	25
2.4.1 Bext360 coda coffee	25
2.4.2 Provenance tuna tracking	27
2.4.3 SiniSana crab storage	30
2.5 Comparison of features between systems	31
2.6 Review of Tools and Technology	32
2.6.1 Visual Studio Code (VS code)	32
2.6.2 Figma	33
2.6.3 Visual Paradigm Online	35
2.6.4 Alchemy	36
2.6.5 Solidity remix	38
2.6.6 Truffle suite & ganache test bed	39
2.6.7 Metamask	39

2.7 Summary.....	40
Chapter 3: Requirement Analysis and Design	41
3.1 Introduction.....	41
3.2 Introduction.....	41
3.3 Requirement Analysis.....	43
3.3.1 Questionnaire	43
3.3.2 Functional Requirements	45
3.3.3 Non-Functional Requirements.....	46
3.3.4 Software Requirements	46
3.3.5 System Architecture.....	48
3.3.6 System Design.....	48
3.3.7 Data Flow Diagram Level 0 (Context Diagram)	50
3.3.8 Data Flow Diagram Level 1.....	51
3.3.9 Data Flow Diagram Level 2.....	52
3.3.10 Entity Relationship Diagram	57
3.3.11 Data dictionary.....	58
3.3.12 Wireframes	59
3.3.13 Guest Page	60
3.3.14 Create Product Page	61
3.3.15 View list of product Page.....	62
3.3.16 View list of product own Page.....	63
3.3.17 Update product Page	64
3.3.18 View product individual Page	65
3.4 Conclusion	66
Chapter 4: Software Implementation	67
4.1 Introduction.....	67
4.2 Installation and Configuration of System's Components.....	67
4.2.1 Setting Up MetaMask	67
4.2.2 Installing Node.js.....	71
4.2.3 Installing all the node modules	72
4.2.4 Installing tailwind CSS	73
4.2.5 System's startup	73
4.3 Using the proposed system	74
4.3.1 Home Page	74
4.3.2 Data Page	75
4.3.3 Upload Page.....	75

4.3.4 Profile Page.....	76
4.3.5 Individual Data.....	77
4.4 Summary.....	78
Chapter 5: Testing	79
5.1 Introduction.....	79
5.2 Functional Testing	79
5.3 Non-Functional Testing	82
5.3.1 Reliability Testing	83
5.3.2 Usability Testing.....	83
5.4 Discussion on Results.....	85
5.5 Summary.....	85
Chapter 6: Conclusion and Future Works	86
6.1 Introduction.....	86
6.2 Achievements.....	86
6.3 Limitations and Constraints	86
6.4 Future Works	86
6.5 Summary.....	87
References.....	88
Appendices.....	90
Appendix A.....	90

List of Figures

Figure 1.1: Components of Malaysia's Exports in 2021	16
Figure 1.2: Skipjack tuna capture (2016)	18
Figure 1.3: Waterfall Model (Rajkumar, 2022)	20
Figure 1.4: Gantt chart Task Table for the Project Timeline	22
Figure 2.1: Bextmachine with the accompany of the Bext360's Ceo	26
Figure 2.2: Bextseller's app showing the status of coffee cherries collected	27
Figure 2.3: Provenance's solution for fisherman flow of product	28
Figure 2.4: Provenance's app	29
Figure 2.5: Blockchain explorer showing the transaction address of the product	29
Figure 2.6: QR code implement on the NeoCrab product	31
Figure 2.7: IntelliSense feature in VS code	33
Figure 2.8: Collaboration in same Figma file	34
Figure 2.9: Versioning systems in Figma	34
Figure 2.10: Visual Paradigm template	35
Figure 2.11: Alchemy Dashboard	37
Figure 2.12: Alchemy blockchain explorer	37
Figure 2.13: solidity compiler	38
Figure 2.14: Ganache explorer	39
Figure 2.15: Metamask UI	40
Figure 3.1: Winston Royce waterfall methodology	42
Figure 3.2: customer familiarity with blockchain	43
Figure 3.3: Respondent interested in project	44
Figure 3.4: Customer concern with quality standard of edible bird nest	45
Figure 3.5: System Architecture of the proposed system	48
Figure 3.6: Flowchart for the proposed system	49
Figure 3.7: Context Diagram for blockchain system for Bird Nest	51
Figure 3.8: Level 1 DFD for blockchain system for Bird Nest	52
Figure 3.9: Level 2 DFD for process 1	53
Figure 3.10: Level 2 DFD for process 2	53
Figure 3.11: Level 2 DFD for process 3	54
Figure 3.12: Level 2 DFD for process 4	55
Figure 3.13: Level 2 DFD for process 5	56
Figure 3.14: Level 2 DFD for process 6	56
Figure 3.15: Level 2 DFD for process 7	57
Figure 3.16: Entity Relationship Diagram for the proposed system	57
Figure 3.17: Guest Page UI	60
Figure 3.18: Create Product Page UI	61
Figure 3.19: View list of product Page UI	62
Figure 3.20: View list of product own Page UI	63
Figure 3.21: Update product Page UI	64
Figure 3.22: View product individual Page UI	65
Figure 4.1: MetaMask Download page	67
Figure 4.2: MetaMask Extension	68
Figure 4.3: MetaMask installation pop-up	68
Figure 4.4: MetaMask Starting page	69
Figure 4.5: Creating password page	69

Figure 4.6: Recovery password phrase page	70
Figure 4.7: Secret Recovery phrase page.....	70
Figure 4.8: MetaMask Portfolio Dashboard.....	71
Figure 4.9: Node.js download page	72
Figure 4.10: NPM installation for tailwind CSS	73
Figure 4.11: Tailwind CSS Configuration	73
Figure 4.12: Starting the project	73
Figure 4.13: Started project	74
Figure 4.14: BlockNest Homepage.....	74
Figure 4.15: BlockNest listed item	75
Figure 4.16: BlockNest Upload Page	76
Figure 4.17: BlockNest Profile page	76
Figure 4.18: BlockNest Data	77
Figure 4.19: BlockNest Data Owned	78
Figure 4.20: Data Stored in Sepolia testnet	78

List of Tables

Table 2.1: Comparison of Features Existing Systems and Proposed System.....	31
Table 3.1: Software Requirements	47
Table 3.2: Programming Language	48
Table 3.3: Smart contract table data dictionary	58
Table 3.4: Seller Metamask table data dictionary	58
Table 3.5: Buyer Metamask table data dictionary.....	59
Table 4.1: Node modules and its description	72
Table 5.1: Test Case 1 (Metamask Connection).....	79
Table 5.2: Test Case 2 (Viewing Item).....	80
Table 5.3: Test Case 3 (Creating Item)	82
Table 5.4: Test Case 4 (Profile Information)	82
Table 5.5: Test Module for reliability.....	83
Table 5.6: Summary of Ratings for System Functionality Evaluation	84
Table 5.7: Summary of Ratings for User Interface Evaluation.....	84
Table 6.1: Objectives and Achievement	86

LIST OF ABBREVIATIONS

DApss Decentralised apps

DFD Data Flow Diagram

ERD Entity–relationship model

FSCM Food Supply Chain Management

IDE Integrated Development Environment

NGO Non-Governmental Organisation

OS Operating system

QR Quick Response

UI User interface

UX User Experience

Chapter 1: Introduction

1.1 Background

The term of agribusiness that come from book created by Davis and Goldberg has been greatly influenced the present industrial economy especially in food production (Carbone, 2017). In food production, the process involved modifying raw materials into ingredient that satisfy the customer needs (Carbone, 2017). However, this process requires serious management for production and distribution. To handle this process, Food Supply Chain Management (FSCM) has been introduced to handle this complex process. According to Pawar et al. (2020), FSCM is an activity that keeps the quality and safety of the food in excellent condition during production, distribution, before and after arrival to potential customer for consumption. In FSCM, there are few characters that plays important roles in transforming raw materials into marketable items. Those roles include supplier, manufacturer, distributor, retailer and consumer (Malik et al., 2018).

Based on Ministry of foreign affairs, Malaysia (2021) report, there are RM 98.10 billion in total of agricultural goods that has been export by Malaysia last year. In the Figure 1.1 below, the pie chart shows the total exports including agricultural goods that has been transported around the world. Most of the exported agricultural product from Malaysia are palm, oil, coconut, and rice (Dardak, 2019). However, exporting of bird nest industry especially in Sarawak have been thriving for the past years.

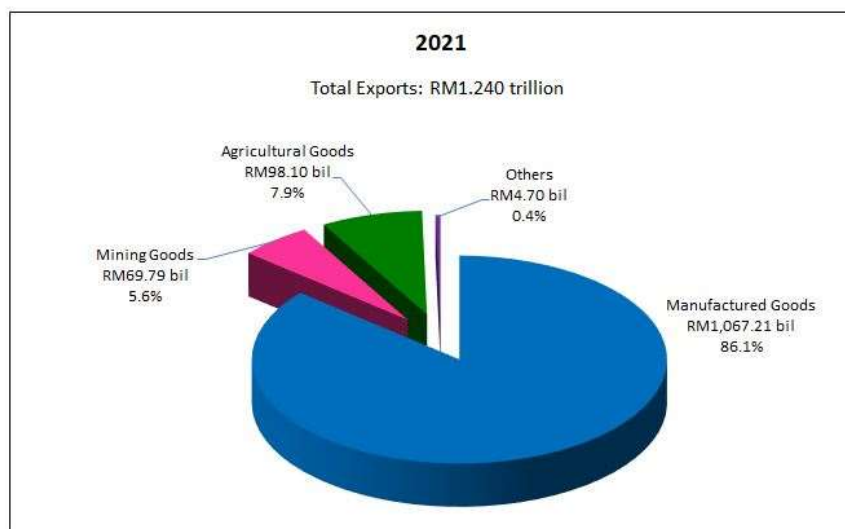


Figure 1.1: Components of Malaysia's Exports in 2021

Swiftlet bird nest is an edible-nest that are currently in demand especially in China, Taiwan and Hong Kong due to its rarity and benefits in culinary uses. (Ya'acob et al., 2021). Fortunately, the nature in Malaysia allows the swiftlet bird nest industry to be blooming, making Malaysia the world's second largest bird nest exporter (CGTN, 2021). With the involvement of exporting goods outside the country, supply chain management need to be handled correctly. According to Fernando (2022), Supply chain management is a flow of goods and services between supplier and customer which include from the transformation of raw material to final products. Many industries have switch from physical records to digital to monitor the movement of the product. However, the lack of visibility in the processing of unique product such as bird nest to the market poses a technical challenge on its traceability. Without traceability, it will be difficult to do reporting or even linking the product to where its coming from (BLUMEGlobal, 2019). This is where the blockchain technology come in to overcome this problem.

Blockchain has been popularized by Bitcoin as it play an important role in managing the cryptocurrency of the systems. However, Blockchain technology is basically a database, but it is more towards a ledger that is shared by nodes rather than centralized database (Hayes, 2022). The difference between this technology with a standard database is how the data or information is stored. Standard database centralized the data that have been collected and is manage by an administrator (Iredale, 2021). It is easy to store and manage the data in the typical database, but the centralized data have a chance to be corrupted or even be modified by anyone who has access as an admin (Iredale, 2021). In blockchain however, the data is distributed around the peers on the network. Peers can send information to one and another without needing an authority allow it. The information that is send also generate a transaction which is then needed to be verify through consensus algorithm (Iredale, 2021). This validation process where the ledger is kept safe from invalid transaction. Another feature that is unique in blockchain is it has timestamps every time a transaction is made for tracing purposes.

Back to supply management, there is a use case of blockchain that has been applied towards tuna tracking in Indonesia. Small-scale pole and line fisherman especially in Maluku, Indonesia, are currently facing many challenges including having to compete with Philippine purse seine fishing style (Provenance, 2016). Figure 1.2 below shows Skipjack Tuna captured by the local Indonesian fisherman in Ambon. Although the Indonesian

fishing style is more environmentally sustainable, their fishing got mix up with the purse seiners, resulting in their effort become unworthy (Provenance, 2016). Therefore, a company called Provenance use blockchain technology to trace yellowfin and skipjack tuna fish until it has been processed in the factory (Provenance, 2016). Based on Gaur (2020), blockchain is use for supply chain as it eliminates blind party whenever there are flows of information or transaction.



Figure 1.2: Skipjack tuna capture (2016)

In conclusion, the usage of blockchain is not only use for cryptocurrency but also as a distributed ledger to store data. If the information require verification such as verifying where the product is from, then it would be suitable to use blockchain technology as the data is immutable and transparent to users.

1.2 Problem Statement

With the increasing demand on bird nest product, this supply chain management need to advance in order to meet the recommended criteria. However, there are few problems that are restricting the growth of bird nest product in Malaysia.

Currently, most of the supply chain process in Malaysia are done in database. In the regular database, the information can be easily altered, deleted or destroyed since admin have full access and control over the data (Hayes, 2022). Therefore, it is not reliable to store important data in regular database especially storing information that is valuable.

The second problem that are affecting the most in supply chain especially when the inventory information value is priceless is the origin of the product. For example, Sara-Bif utilize its blockchain technology to trace its products origin, so that its beef halal status is retained (SINISANA, 2022). Most of supply chain, however, does not have this feature as the traditional databases is very centralized and can be modified easily if the person has an admin access.

The final problem for the supply chain process is that the product does not provide transparency for the party that is involved in the supply chain. In the standard databases, the data that stored are centralized and therefore make it difficult for other party, for instance, the retailer to verify the validity of the product information (Iredale, 2021). For the bird nest situation, the exportation of this product has been imposed with a stricter safety regulation by the Malaysia's Veterinary Services Department due to raw and unclean bird nest from bird nest industry in Malaysia ("Stricter rules on bird's nest", 2014). In China, the country has banned the bird's nest product with nitrite that is higher than 34 parts per million (Cheng, 2015). Only one bird nest product from Sarawakian entrepreneur is officially allowed in the year 2015 to export this product to China (Cheng, 2015). Therefore, the current situation for the bird nest product in Sarawak to export internationally is very difficult due to complication in providing the validity of the bird's nest processed information.

1.3 Objectives

The main objective of this project is to design and develop a blockchain platform to provide traceability and transparency for bird nest supply chain in Sarawak.

Other objectives include:

1. To design a digital platform for product record management.
2. To develop traceability module for system for product tracking.
3. To provide transparency for product quality and origin for customer.

1.4 Brief Methodology

For this project, it is better to choose Waterfall methodology as project development approach. Figure 1.3 shows the concept of waterfall methodology. According to ProjectManager (2022), waterfall methodology is in fact most straightforward and linear project management approach. In waterfall approach, the requirement of the project needs to be gathered in early stages before developing it. Therefore, a small project would be like this we suitable due to its simple and the progress can be observed easily.

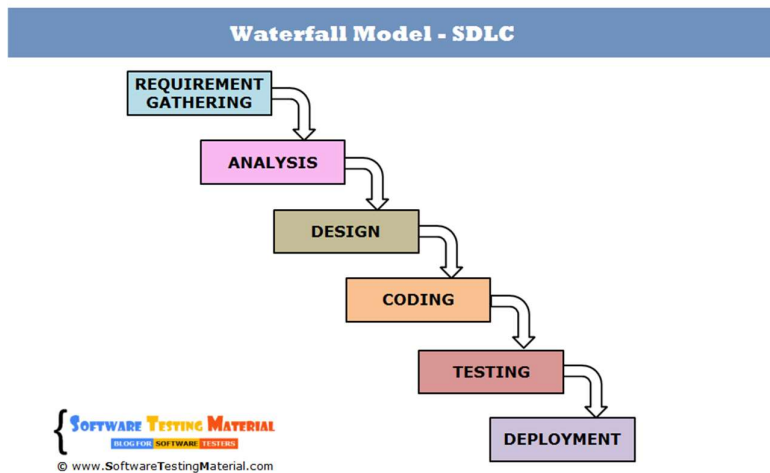


Figure 1.3: Waterfall Model (Rajkumar, 2022)

Waterfall model has 5 phases, which include analysis and requirement, design, development, testing and maintenance. During the requirement phases, all the data and questionnaire need to be created to gather information on bird nest product. This information gathering is targeted towards bird nest entrepreneur in Sarawak. Information gathering is done to ensure that all the possible requirement for the system can be implemented at the end of the project. Designing of the system is later done after requirement has been gathered and analyze. Using the data from the requirement phase, context diagram, use case diagram, and data flow diagram of the system are built to get the idea of the overall system design. During the development process, JavaScript will be mainly use as main language for the project. React will also be used as library to develop website front end while node.js will be handling the back-end part. For the blockchain, Solidity would be use for the interaction with node.js. Once

the project is completed, the maintenance will be initialized to fix some issue if there any bugs or any enhancement of the software.

1.5 Scopes

The scope of this project will focus on bird nest industry in Sarawak. This system will be using website as the platform for deployment as it is easy to manage and available most of the time through online. This system will implement web3 concept which let the user to have full control over their product creation and management. Although, the product creation on the website must only related to bird nest product as its purpose is to trace the origin of the bird nest product.

1.6 Significant of project

Upon the completion of this project, the processing of record can be speed up due to replacement of physical record into digital style. Besides, the originality of the product can be greatly improved since the blockchain enhance the traceability of the product. Moreover, it provides protection on the information that has been stored thanks to the blockchain immutability.

1.7 Significant economy impact

In terms of economic impact, the suggested system's implementation using blockchain technology would have several significant effects on the bird nest industry.

This impact include:

1. Increased consumer trust in purchasing and better earnings due to benefit of blockchain technology's ability to detect data fraud more easily.
2. Reduce the time necessary for product validation and verification, resulting in lower intermediary costs.
3. Allow for the introduction of fresh ideas and services to the market.

1.8 Sustainable Development Goals (SDGs)

In terms of economic impact, this initiative also contributes to the United Nations (UN) Sustainable Development Goals (SDGs) established in 2015. The United Nations has adopted 17 goals at the moment. This initiative also includes a couple of goals to aid the UN's goals.

The following United Nations Sustainable Development Goals (SDGs) have been included:

1. No Poverty: As blockchain transparency increases, the possibility of exploitation and forced labour towards workers can be reduced while also ensuring fair compensation and ethical corporate operations.
2. Responsible Consumption and Production: Increased efficiency in managing the supply chain within the bird nest supply helps reduce energy waste.

1.9 Project Schedule

The project is expected to be completed within two semesters which is around 9 months. This duration covers both Final Year Project I and Final Year Project II courses. The project use Gantt Chart for progress monitoring. Figure 1.4 below shows the brief Gantt Chart task table on the overview of the project schedule.

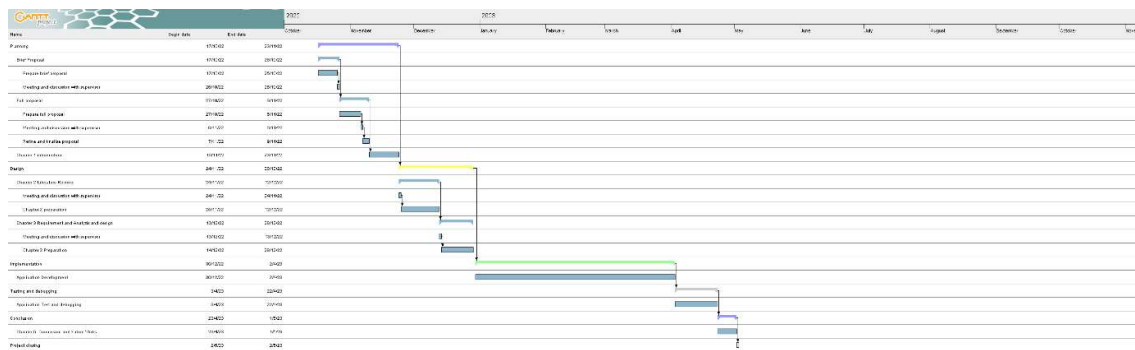


Figure 1.4: Gantt chart Task Table for the Project Timeline

1.10 Expected Outcome

The expected outcome of this project is to develop a web3 system that can manage the bird nest product using blockchain framework. The user of the system can view, submit, and trace their product with the help of Ethereum framework. The product flow can be track using address of the product transaction and its transaction is visible in Etherscan website.

1.11 Project Outline

There are five chapters in this paper to describe the system for the supply chain Traceability for Bird Nest Product.

Chapter 1: Introduction give brief intro towards supply chain of bird nest in Malaysia and its current problem. This chapter also contain problem statement, objectives, brief methodology, scopes, significant of project, project schedule, expected outcome and project outline.

Chapter 2: Literature Review will find similar topic on current system that will be developed. By finding the related topic of the system created, this chapter will also explore and evaluate the functionalities of the previous system.

Chapter 3: Requirement Analysis and Design list out the requirement analysis of the developed system. In this chapter, a few diagrams will be shown include Flow chart, Context Diagram and Data Flow Diagram (DFD). The low fidelity prototype of the system will also be included in this chapter.

Chapter 4: Implementation and Testing is where the development of the system will begin. The development will implement the design and requirement that has been created. This chapter also explain about the test run that is done towards the system to see if it meets the functionalities requirement.

Chapter 5: Conclusion and Future Work is the conclusion chapter of the project. It summarizes the works done in the project. It also describes the objectives achieved and project limitations.

Chapter 2: Literature Review

2.1 Introduction

In this chapter, there are three system that have same similarity in features with the proposed supply chain solution that have been mentioned. The systems that have been chosen are bext360 coda coffee, Provenance tuna tracking and SiniSana crab storage solution. These systems are chosen to be reviewed to study about its functionalities, and its solution with the current problem statement. All these solutions implement blockchain technology. Thus, the highlight features will be mainly tracing, tracking, immutability features.

After review on the existing system, there would a comparison between the system mentioned and the proposed system. Furthermore, this chapter would also include tools and technology used in the proposed system. Lastly, the chapter also include the summary of this chapter.

2.2 Birdnest Industry in Sarawak

Birdnest industry were originally come from ancient China, where swiftlet nests are used in both Chinese food and medicine (Hobbs, 2004). The consumption of swiftlet birdnests for culinary purposes is still a common practice until today. For the local communities of Sarawak, birdnest has grown to be a substantial source of income (Hobbs, 2004). Previously, the nest was traditionally harvested from the Niah Cave in Miri, Sarawak. However, as the years goes by, entrepreneur in Sarawak has begun to construct bird nest houses to attract swiftlets to combat the swiftlet bird's habitat loss.

The farmers begin the process of harvesting swiftlet bird nest by taking the nest from the bird nest house or cave. After collecting the nest, it would be cleaned by immersing it in water and vegetable oil to remove contaminants such as feathers, eggshells, and so on (Premium Nest, 2017). To further clean and decolorize the nest, hydrogen peroxide would be used (Premium Nest, 2017).