



T.C.

ALTINBAS UNIVERSITY

Institute of Graduate Studies

Information Technologies

**Design a Tracing System for a Seed Supply Chain
Based on Blockchain**

Master of Science

Supervisor

Asst. Prof. Dr. Muhammad ILYAS

Istanbul, 2021

Design a Tracing System for a Seed Supply Chain Based on Blockchain

by

Student's Ayat Bahaa Abdulhussein

Information Technologies

Submitted to the Graduate School of Science and Engineering

in partial fulfillment of the requirements for the degree of

Master of Science

ALTINBAŞ UNIVERSITY

2021

The thesis titled “Design a Tracing System for a Seed Supply Chain Based on Blockchain” prepared and presented by Ayat Abdulhussein was accepted as a Master of Science Thesis in Department.

Asst. Prof. Dr. Ameer Kadhimi Hadi

Co-Supervisor

Asst. Prof. Dr. Muhammad ILYAS

Supervisor

Thesis Defense Jury Members:

Asst. Prof. Dr. Muhammad ILYAS

MDBF,

Altinbas University

Asst. Prof. Dr. Akhtar JAMIL

faculty of engineering and
natural sciences,

Istanbul Sabahattin Zaim
University

Assoc. Prof. Dr. Abdullahi Abdu
IBRAHIM

MDBF,

Altinbas University

I certify that this thesis satisfies all the requirements as a thesis for the degree of

Approval Date of Institute of Graduate Studies:
28/01/2021

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Ayat Bahaa Abdulhussein

Signature

DEDICATION

I dedicate my dissertation work to my family and many friends. A special feeling of gratitude to my loving parents whose words of encouragement and push for tenacity ring in my ears. My sisters have never left my side and are very special. I also dedicate this dissertation to my friends who have supported me throughout the process. I will always appreciate all they have done, for helping me develop my technology skills. I dedicate this work and give special thanks to my family for being there for me throughout the entire master program. Both of you have been my best cheerleaders.

ACKNOWLEDGEMENTS

First of all, I would like to express my deepest thanks and gratitude to Almighty Allah for giving me the strength and hope to complete this work and for everything.

I would like to express my special thanks of gratitude to my supervisors Dr. Muhammad Ilyas and Dr. Ameer Hadi, for the continuous support of my master study. For the guidance and help during my study and writing this thesis. Without their advice and active support, this project would not have been possible. I am thankful to them.

I would also like to acknowledge the Altinbas University – Department of Information Technology for providing all sorts of support in conducting this thesis.

Last but not least, I would like to thank all of my family and my friends who helped me a lot in finalizing this thesis within the limited time frame.

ABSTRACT

DESIGN A TRACING SYSTEM FOR SEED SUPPLY CHAIN BASED ON BLOCKCHAIN

ABDULHUSSEIN, Ayat Bahaa Abdulhussein,

M.Sc., Information Technologies, Altınbaş University,

Supervisor: Asst. Prof. Dr. Muhammad Ilyas

Co-Supervisor: Asst. Prof. Dr. Ameer Kadhim Hadi

Date: Jan/2021

Pages: 88

Blockchain technology performs a process of storing inside a record, and this ledger is raised on a large number of parties (computers, servers). Records are encrypted and cannot be tampered with, as happens in centralized systems. In order to solve the problem of manipulating or modifying information and knowledge of the origin of the product and increasing the consumer's transparency of the product coming from a series of the supply chain, this research suggests building a system to tracing the product. All product information is stored in serial blockchain through an algorithm that organizes the work of each part of the supply chain and the information it stores. Also, an algorithm to retrieve product information by searching for Blockchain. The results are expected to be important in terms of increased food security and increased competition between distributors. The entire purpose behind supply chain the management and coordination are to give customers the level and nature of administration that

they require and to do as such at less expense to the complete supply chain. Traceability is a big necessity in supply chain ventures, particularly for the agri-food industry. Building a product tracking system in a supply chain to enable the consumer and government agencies to track and know the source and origin of the product in an easy, safe and reliable way from tampering and provide the fixed system the just manager can approve accepted users that be trusted people because will add data that all world will see it for that in the system we build an algorithm to generate the activation key for adding a client.

Keywords: Blockchain, supply chain, Traceability, cloud computing, computers network.

TABLE OF CONTENTS

Table of Contents

ABSTRACT.....	vii
LIST OF TABLES	xii
LIST OF FIGURES	xiii
LIST OF CHARTS	xvi
LIST OF ABBREVIATIONS	xvii
1. INTRODUCTION	1
1.1 OVERVIEW	1
1.2 LITERATURE REVIEW	5
1.3 PROBLEM STATES.....	9
1.4 CHALLENGES	10
1.5 OBJECTIVE	10
1.6 OUTLINE	11
2. THEORETICAL PART	12
2.1 BLOCKCHAIN TECNOLOGY	12
2.1.1 Characterizes of blockchain.....	16
2.1.2 The blockchain advantages and disadvantages	17
2.1.3 How blockchain work.....	19
2.1.4 Types of blockchain.....	19
2.1.5 Applications of blockchain	20
2.2 SUPPLY CHAIN TECHNOLOGY	24
2.2.1 Supply Chain Management	26
2.2.2 Benefits of Supply Chains	27
3. DESIGN AND IMPLEMENTATION	29
3.1 INTRODUCTION	29

3.2	DESIGN OF PROPOSE SYSTEM.....	29
3.3	MODEL ARCHITECTURE	30
3.4	IMPLEMENTATION	31
3.5	APPLICATION REQUIREMENT	32
3.5.1	Functional Requirements.....	32
3.5.2	Non-Functional Requirements.....	33
3.6	USED TECHNOLOGIES	33
3.6.1	Django	34
3.6.2	Python.....	36
3.6.3	Database.....	38
3.6.4	PyCharm	38
3.6.5	SERVER.....	39
3.7	BUILD APPLICATION.....	39
3.7.1	Getting Permission	40
3.7.2	Store transactions into Ledger	42
3.7.3	Add digital fingerprints	43
3.7.4	Server and client in progress	44
3.7.5	Contact page	51
3.7.6	Login.....	52
3.7.7	Restore page	53
4.	TESTING & DISCUSSION.....	55
4.1	TESTING	55
4.2	USABILITY TESTING	55
4.2.1	Chosen tasks	55
4.3	EVALUATION	57
4.4	DISCUSSION.....	61
4.4.1	Application Strengths	61

4.4.2 Application Weaknesses.....	62
4.5 CHALLENGE WITH AWS.....	64
5. CONCLUSION AND FUTURE WORK.....	68
5.1 CONCUSION.....	68
5.2 FUTURE WORK	68
References.....	69



LIST OF TABLES

	<u>Pages</u>
Table 1-1: some related work	9
Table 4-1: Permission of staff in system.....	56
Table 4-2 : Roadmap of Web Application.....	63



LIST OF FIGURES

	<u>Pages</u>
Figure 2.1: Parts of blockchain	13
Figure 2.2 : characterizes of blockchain	16
Figure 2.3 : Map of paper supply chain	27
Figure 3.2 : Procedure of work for the system.....	31
Figure 3.3 : Classic defaulting Django admin site	34
Figure 3.4 : Home page of Django.....	36
Figure 3.5 : Default Python interpreter	37
Figure 3.6 : IDE PyCharm	39
Figure 3.7 : window for PowerShell	39
Figure 3.8 : The main interface of seed application.....	40
Figure 3.9 : Permission provided by Django Framework.....	40
Figure 3.10 : Specific permission that provided by Django framework for users.....	41
Figure 3.11 : Authentication and authorization system in Django	41
Figure 3.12 : Blocks that saved.....	43
Figure 3.13 : Activation Key process	44
Figure 3.14 : Chains for product before register users.....	45

Figure 3.15 : Chains for product after register users	45
Figure 3.16 : Information that needed product in chain1.....	46
Figure 3.17 : Information the needed product in chain 2.....	46
Figure 3.18 : Information that needed product in chain3.....	47
Figure 3.19 : Information that needed product in chain 4.....	47
Figure 3.20 : Information that needed product in chain 5.....	48
Figure 3.21 : Ways for search.....	48
Figure 3.22 : Home page with Register Button	49
Figure 3.23 : Register page	49
Figure 3.24 : client and server mechanism	51
Figure 3.25 : Contact interface.....	51
Figure 3.26 : Message from web page for contact form	52
Figure 3.27 : login Button.....	52
Figure 3.28 : Logout button	53
Figure 3.29 : Reset Button	53
Figure 3.30 : Reset page.....	54
Figure 4.1 : Home page.....	57

Figure 4.2 : Showing Data	58
Figure 4.3 : Adding Data for every chain	58
Figure 4.4: SearchPage	59
Figure 4.5 : RegisterPage	59
Figure 4.6 : Contact Page	60
Figure 4.7 : First bill from AWS	65
Figure 4.8 : Home page for AWS Blockchain	66
Figure 4.9 : Selecting Fabric Hyperledger	66
Figure 4.10 : Sawtooth Hyperledger home page	67

LIST OF CHARTS

	<u>Pages</u>
Chart 3.1: flow chart of design	30



LIST OF ABBREVIATIONS

ISO	: International Organization for Standardization.
IDs	: Identification Detect.
GFSI	: Global Food Safety Initiative.
CTEs	: Critical Tracking Events.
FDA	: Food and Drug Administration.
KDEs	: Key Data Elements.
SC	: Supply Chain.
GS1	: Global Standards.
RFID	: Radio Frequency Identification.
WIP	: Work-in-process.
GPS	: Global Positioning System.
IBMs	: International Business Machines.
CDC	: Centers of Disease Control and Prevention.
RF	: Radio Frequency.
OEMs	: Original Equipment Manufacturers.
IOT	: Internet of Thing.
SCM	: Supply Chain Management.
GUI	: Graphic User Interface.
URL	: Uniform Resources Location.

IDE : Integrated Development Environment.

QR : Quick Response.

MVC : Model View Control.

AWS : Amazon Web Services.

CLI : Command Line Interface.

SDK : Software Development Kit.



1. INTRODUCTION

1.1 OVERVIEW

Food safety has become the central point of the general public where become gradually worried about what they eat and where to find the original product. Many individuals no longer satisfied to the food items and their data offered at the markets. It became the focus of the food security attention in what is the purchase originate either from reliable resource or if there is a mistake in altering the item. After it has become a worldwide issue, constructing a food traceability framework is to be increasingly critical [1]. Effective seed germination is significant for agriculture [2] using data and information that is necessary to make better output and sustainability [3]. The goal of food Security is to expand understanding of food insecurity and process of causing drivers starvation.

A possible solution for mitigating the issues and concerns is the utilization of blockchain technology, which is another advanced mechanical methodology supported by guaranteeing information integrity and prevent the editing and any failure [4].

Food Systems is the aggregate of actors that start from input supply and output of harvests, animals, fish, and other agrarian items to transportation, handling, retailing, wholesaling, and planning of food to utilization and removal.

Transparency is the point of trust in blockchain and simultaneously a controlling element for applications that require total or even some level of security (e.g., social insurance, banking, and supply chain) [5].

The excursion experienced by the food business and buyers in the course of the most recent one hundred years, since it identifies with food safety and quality, was difficult. At the beginning of the 20th -century, along with development in science and technology, the food business, just because, started to know the procedures of food made progress which increasingly available to general society. Through the development of fast international delivery, enhanced conservation strategies and the capacity of media and, by expansion, publicizing and showcasing efforts, to arrive at an expanding number of purchasers, the food business immediately altered. Food

processor could quickly transport for and deal anyplace in the country an expanding exhibit of perishable items [6].

Traceability was initially characterized in ISO 8402 as: "The capacity to trace the location, history and application location of the element using methods for recorded identify". A definition illustrates what ought to exist followed (zone, application and history) also how the following ought to be finished (by methods for registered IDs). According to the description at ISO 9000 detectability characterized as "Capacity on follow the area or application and history of which is getting looked at it [7].

Despite the fact that there are numerous meaning of traceability, with regards to understanding the way subsequently the food and its components, the proper description reaches on a similar general summary. Traceability and item tracking are used to illustrate the development of food items all through a supply chain, include of developing, collecting, repacking, fabricating, store, distribute, and deal with the buyer so the traceability is the capacity to trace items exactly. In the past, the information identifies to item development. Responsibility for creating, saving, and getting to traceability linked data from farm to client lies with numerous jobs inside an organization, and numerous organizations in a supply chain. The food safety issue incorporates food industry it discusses traceability. For the general health, food safety, particularly during pollution examinations, is an essential in order to enhance traceability. Although the food business state food safety as the main priority, the source is, for the most part, assign toward keeping pollution occasions from happening, traceability is being suitable to food safety procedures [8]. So the official traceability definition can be: "The ability to access any or all information relating to that throughout its entire life cycle, by means of recorded identifications" [9].

Trackback of foods in light of foodborne disease episodes or food tainting occasions is definitely not a new idea. Agents connected to number of diseases such as tuberculosis and streptococcus episodes for crude milk utilization in the end of 1800s and mid-1900s. Also, Typhoid fever episodes was connected for the utilization of crude molluscan shellfish, especially clams, in the midmost-1900s. These discoveries were a piece of the driving force behind a portion of the main food safety and the ability to trace administrative necessities in the United States. As a result of that, they have prerequisite food bundle marks to incorporate the label and heading of a maker,

packer or wholesaler. Food bundles plus holders frequently likewise include a ton code and additionally fabricating date that can additionally encourage an item to follow [10].

Codex additionally recognizes that traceability does not enhance the safety of food results itself [11]. This is on the grounds that traceability doesn't keep food from pollution. Be that as it may, fast and dependable traceability frameworks can't permit the additional divide with utilization of pollution food, which is gainful to general health. A food office certification to a GFSI-benchmarked review system is counted by various individuals to be the "best quality level" in food safety [12].

Organizations try to apply the path of food items associated with causing food disease together with general public health official's data. There are a few parts of inward traceability and outside that obstruct a quick and well-organized following of food items even after the dangerous item has been distinguished.

There are many utilizations of traceability such as: required a safety of food, Enhance the efficiency of operational, Permit the user to impart the requested data, Helped in trusting claims. [11]

The tracing of the food that makes road tables has critically been to American buyers. In spite of the fact that, from numerous points of view, the level of interested has developed and changed throughout the years, what has stayed steady is the safety and basic quality and security of food [6]. The aims of a traceback implementation are to recognize a common element in the pollution of food.

The industry cooperation with the government, free watchdogs, and buyer association interceded to empower better transparency of data and make trust among partners in agri-food supply chains [13].

In [14] the food Safety renewal FDA to investigation of approaches to advance traceability in the food supply chain utilizing incorporated information frameworks and indicated extra record-keeping prerequisites for food organizations. Quicker traceback examination depends on the food business gathering and keeping up more data in an organization that is effectively open and can be quickly broken down by agents. As a result of this experimental study proposed a procedure

depend on the way to deal with detectability, like the Hazard Analysis Critical Control Points process previously utilized by the food business, called Critical Tracking Events (CTEs) and Key Data Elements (KDEs). This adaptable traceability pattern permits food organizations to recognize key focuses in the gathering, making and distribution process were key information reliably caught and put away for the timeframe of realistic usability of the item. This increasingly efficient way to deal with information assortment which make directing traceback examinations quicker and progressively precise, in this way assisting with mitigating a segment of the "quick and right" problem.

Supply chain vision operation, similar to traceability, are cooperative attempt between exchanging accomplices that depend on the supply-chain guidelines. As it deals with supply chain members, trade association and administrative offices over various industry divisions, GS1 US1 has an interesting point of view and level of skill on supply chain vision, just as the advantages that it offers [15].

In [16] the traceability of bulk food items, both in backward or forward, represent a novel test inside the food business. Regardless of whether in dry or fluid-structure, mass items will, in general, be dealt with comparably to liquids when followed all through the food framework in view of the idea of the items. The bulk food items supply chains are all the more precisely depicted as a food framework in light of the complicated web that is made by mass items. Their way from the provider, right to their endpoint is definitely not a straightway. The item is frequently mixed with similar items from various parcels or clusters, (for example, in storehouses or big haulers), or with different items completely, (for example, in the assembling of prepared nourishments).

For a traceability framework to be practical and work effectively, it must be all in all comprehensive and without any breaks. Framework of food must include all sources of info and yields followed. Mass equalization should be kept up where whose it come into the framework must come out at a negligible safety buffer. For mass items to be totally followed through the food framework, at each purpose of the gathering, fabricating, assortment focuses and transportation process. There should be an entry of all the pertinent data containing, however not restricted to the clump or parcel number (which might be reap or creation date), loads, taking care of conditions, and handling data [16].

1.2 LITERATURE REVIEW

Newly years, traceability of food scientists have extended their concentration past the safety of food to incorporate the efficiencies operational– item newness, stock accessibility and waste decrease, for instance. Allowing technologies for quicker, increasingly exact and more affordable item ID of mass food items incorporate RFID tools, organize allow sensors, straight and two-dimensional scanner tags and advance diagnostics frameworks. These devices combined with web-associated versatile figuring tools can help rapidly recognize, catch and offer data about item parts and groups (though for careful measures of the item). For instance, Internet-associated sensors are currently broadly utilized as a portion of incorporated wet observing and traceability frameworks for mass powder and ware food items [17]. Their system take in account the well the safety of food and the control of quality and, it can have advantages for improving the traceability of the whole framework. Additionally, the challenges despite everything occur between what data is gathered and shared all through the framework. Regularly farming items have long, compound supply chains that length big geographic regions cross many fringes and range organizations of different sizes and technologies modernity. The result makes a difficult for keeping up mass food traceability.

In [18] the seafood traceability is evaluated as aware below the multi-organization guideline. At 2002 the Bioterrorism act as the primary demonstration of parliament to involve records of the prior and followed by foundation of food. Seafood is ready to be on the route in traceability since it globally traded product sold, frozen, and fresh.

The seafood business traceability it has been practiced over an assortment of strategies which differ in multifaceted nature and fee and have been commonly actualized to meet a specific commerce requirement for the customer. Traceability is a system that support business improvement and particularly in observing the safety of the food to follow-back. The safety of food in seafood is commercially critical. There are different uses of recognizability that assistance impact the expense of following procedures [19]. The shellfish tracing is done through tag sorting (one of the primary implementations of traceability). In like manner, processor have discovered that using written by hand labels, cards or records give the capacity to catch and hold significant follow the information which is then connected with the "part" or "group" of procedure yield, for example, completed items or work-in-process (WIP).

The historical style of keeping up-to-date information in writing by hand records makes huge hindrances to successful and efficient trace the movement. Conducting trace forward and trace backward reverse activities are inalienably moderate and subject to blunder, particularly in bigger, compound supply chains. Manually written records make it considerably harder to lead examination to help business enlargement and to proactively recognize issues or patterns [18]. Database programs such as Excel, Access, and others are being used viably. Lately, there has been a multiplication of 3rd-party technology suppliers providing start-to-finish follow-up apparatuses to the fish business. The coding symbology integration, RFID labels, GPS gadgets and broad utilization of the web is empowering dynamic fish organizations to impact detectability continuously and to give a degree of straightforwardness in item information to give significant purposes of separation in the commercial center. Some fish organizations are providing instruments to shoppers which permit them to insert coded data, check the code lines or take pictures of items and promptly get point-by-point item data, remembering it's sourcing for their PC or cell phone.

In 2016 reaction to food pollution around the world, Walmart is a food safety system that utilized blockchain technology in the supply chain [20]. Walmart established in the same year of food safety association center in Beijing. Furthermore, it got to contribute \$25 million more than 5 years to investigate worldwide food safety [20]. Applying IBM's blockchain solve depending on "Hyperledger Fabric", Walmart efficiently complete two of blockchain guide: the pork in China and the mangoes in the Americas [21]. Along with from a farm-to-customer method, Walmart's blockchain solve diminished interval to following mango sources from seven-days to 2.2s and advanced extra prominent straightness through food supply chain of Walmart's [21]. This IBM called it "traceability for complete from start to finish" [22]. The case study focuses on features of actualizing a blockchain technology in the food supply chain and the open doors to sending blockchain to solve all through the worldwide food environment to expand safety and diminish waste.

Around 48 million individuals in the United States contract foodborne illnesses consistently that is according to the centers of disease control and prevention (2011). According to evaluated by the World Health Organization that one from 10 individuals experiences food contamination around of the world, with 420,000 death, every year (2017) [20].

In July 2017, papayas in the US advertise were connected to a multi-state outbreak of Salmonella. By mid-August 2017, the CDC reported 173 instances of salmonellosis, 58 hospitalizations, and one demise across 21 states (2017). Health authorities prompted customers to abstain from eating papayas and retailers not to sell them. Indeed, even by duplicating measures in the spinach flare-up, health authorities took very nearly three weeks to follow the source to a solitary homestead in Mexico. Papaya ranchers from unaffected regions endured financial misfortunes on account of the failure to quickly track and follow food items [23]. In suspected pollution, specialists audit paper documentation stage by stage. Wrong or fragmented information can additionally postpone their investigation. Multi-fixing nourishments may incorporate components from an assortment of various sources and multiple countries and traceability gets to make more complicated [24].

In 2011, China saw huge pork mislabeling debacle, alongside a tainting trick in which donkey meat items were reviewed on the grounds that they were found to incorporate fox meat as stated in [25]. Extra pollution, for instance, Sudan red, melamine, Sanlu poisonous milk powder, channel oil and clenbuterol. All of which had penetrated the food supply chain—further disintegrated Chinese trust in food markets [26]. In 2013, the lawbreaker people in the Europe supply chain swapped sheep meat by horsemeat. The unlawful replacement influenced more than 4.5 million handled items speaking to in as minimum to 1,000 tons of food [25]. This fraud made permeant distraction to and trade notoriety. China is both a main merchant of pork and a maker of about portion of the world's pork; enormous, industrialized pork creation frameworks like those in the United States have been uprooting small-scale “backyard” pork producers [27].

American buyers quit eating spinach out and out, whereas restaurateurs and supermarkets take spinach off their racks and menus. Health authorities took right around fourteen days to distinguish the contamination source: one provider, one day's creation, and one parcel number. The powerlessness to quickly trace and follow the polluted spinach source in order to bring the noteworthy and enduring monetary mischief to spinach ranchers and disintegration of trusted buyer [10].

Walmart operated with IBM to create and perform its food source pilots utilizing blockchain technology [28]. As indicated by [23] "Blockchain takes care of business issues where trust is a piece of the arrangement" by giving what conventional databases can't: information permanence

just as speed and security. IBM's blockchain depends on Hyperledger Fabric, which underpins measured design and attachment and-play parts, for example, agreement and participation administrations. It permits both productive information catch and information control. Most importantly, clients have a common point on reality anytime just as ownership and authority over their own data. [29]. Walmart built the Food Safety Collaboration Center in the middle to study the foodborne contaminants and creates risk evaluation models that different enterprises and associations will have the option to utilize.

The process for pork starts where each pig is brilliantly labelled associated with bar code followed by packaged of pork. Despite the fact that using radio frequency (RF) identification and cameras, and the staff document the pig's motion too, and cameras hosted in slaughterhouses catch the full process. These processes protect pigs and modify the temperature even stay fix [30]. In pork production, dispatching trucks have sent temperature and dampness sensors, alongside worldwide situating and geographic data frameworks, to guarantee the meat shows up at retailers under safe conditions; Walmart can track the locations of trucks and screen monitoring in each refrigerated compartment and, if the environment conditions exceed built-up limitation, will alarmed to prompt corrective action [27].

In 2014 Walmart has do his experimental using IBM's Hyperledger based on blockchain on sliced mangoes starting from south and central America to it north. Where mangoes are shipped worldwide that will become susceptible to pollution. Blockchain traceability will enhance trust between the public in the information. For mangoes, Walmart examines organic product quality all through the supply chain on the tree, at collect, at markets and at retail outlets to decide the quality and marketing able at each step. Such an examination could assist with foreseeing possible losses [31]. All the information is saved and tracked on the blockchain. In the distribution stage, blockchain linked number of devices and sensors in order to be able to register harvest damage due to temperature and humidity condition [32].

In 2016 the researcher [33] propose the blockchain technology that applied on some of the application that supporting supply chain in industry field. They demonstrate the favorable impact on the quality of supply chain for products using blockchain technology.

In [34] a method has been designed to merge radio frequency (RF) identification with blockchain technology to enhance agri-food quality by constricting on Chinese agri market because they have a complex supply chain system.

Table 1-1: some related work

#ref	#Year	#idea
[18]	2019	The seafood business traceability it has been applied over a set of strategies which differ in multifaceted nature and fee and have been commonly actualized to meet a specific trade requirement for the customer.
[19]	2012	The shellfish tracing is done through adding a tag, the processor has done using written by hand labels, cards or records which is then connected with the "part" or "group" of procedure product.
[24]	2017	Foods may include components from a set of various sources and multiple countries and traceability get to make more complicated.
[25]	2014	China found set of mislabeling wrong on the pork this causes damaging all pork.
[25]	2014	Donkey meat items as assumed, were found to contain fox meat.

1.3 PROBLEM STATES

- Lack of knowledge of the origin of the product and the inability to track its source in the supply chain. Which leads to damaging the product fully in the case of injury part of it.
- The fake product information that leads to the consumer safety threat. For example, food information is inaccurately affected by allergy and diabetic patients. As well as, it could be incorrect information about halal food in non-Islamic countries, or the validity date does not match between the packaging and the case.
- Uncertainty that the fair trade principle supports workers giving low wages and violating their rights.

- Lack in central product tracking which caused the exposed to deliberate and unintentional change, leading to the inaccuracy of the information.

So it can understand the traceability along with confidentiality in the whole data of agri-food supply chain, which ensure the food safety, by a collecting, moving and participating the genuine information of agri-food handling, warehousing, conveyance and marketing.

1.4 CHALLENGES

The fundamental challenge to keeping up the trustworthiness of a system is interferences by vindictive customers who attempt to control the system for their own benefits. Where Bad nodes try to send infection records to different nodes to manipulate with exchange data compromising trust in the system. This issue prevents the execution of a helpful distributed system. Conversely, blockchain technology has a solved this issue. Blockchain technology makes sure about the respectability of a distributed system through an agreement algorithm, which advantages to constant transparency as will discuss in chapter 2. This technology provides solutions to matter of food quality and safety, which are highly conceder by consumers, government, etc.

1.5 OBJECTIVE

The purpose of the thesis is to explain current effect of blockchain technology on the supply chain management of food safety to know the manner of the system.

Building a product tracking system using supply chain leadto enable the consumer, government agencies to track and know the source and origin of the product in an easy, safe and reliable way from tampering.

The system will provide high transparency in the topics of product quality and integrity of the working conditions to increase competition companies.

The elimination of fraud occurs on large packages and cans especially dangerous stuff like medicine.

Using the distributed system (blockchain) prefers on the centralized system as a result of their quicker computation, diminished upkeep costs, more noteworthy dependability, and simpler overhauls.

1.6 OUTLINE

This thesis reviews one of the blockchain technology application in the agriculture and food.

Chapter one consider the examples of organizations that have implemented this technology.

Chapter two study the basic concepts, metrics and techniques of blockchain technology as a theoretical part will be based on a document examination that incorporates getting data from different kinds of archives: books, articles, diaries, logical reports and others. Additionally, it will explain the advantages and disadvantages of blockchain technology in terms of its adoption.

Chapter three will have the system design, system functionality, technologies used in application, the application building and the implementation.

Chapter four will demonstrate the testing along with strategies and the result and discussion.

Chapter five will be contain the conclusion and the future recommendations.

2. THEORETICAL PART

In the previous chapter explained the problem that needed to solve it and described the challenge that met. In this chapter, focused on systematic writing intending to describe applications that applied using blockchain technology. Will explain current or future usage that wrote at the papers and examine the effect of a blockchain that have a various enterprises. Additionally, describing about potential worries that emerge from the adding an application of blockchain to different sectors.

2.1 BLOCKCHAIN TECNOLOGY

It is a way for record digital data utilizing a ledger approach.

The following basic attributes:

- organized ledger,
- automatically Increment of records when added data ,
- Encrypted and
- Digital.

Different attributes, for example, distributed and immutable. [35]. A blockchain is made out of a group of blocks that connected cryptographically. Blocks connected in a series utilizing hashes cryptographic. Hash is a specific-length num that get a given message or report.

Blocks are consist of three major parts:

- Data of block: it is a collection of dealings and/or messages.
- Hash of previous block: it is value of hash for previous block.
- Hash block: A hash block value for data and/or transaction in addition to that the chaining hash value [36] as see in figure.

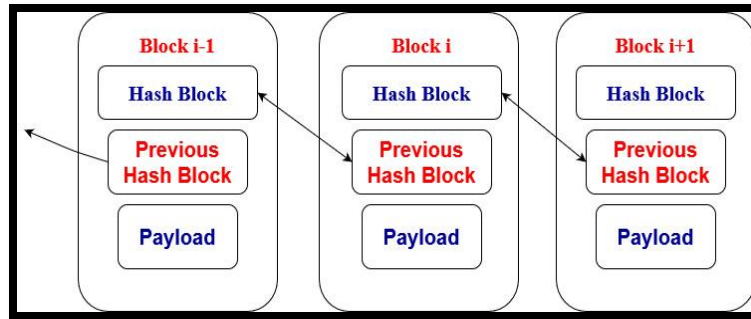


Figure 2.1: Parts of blockchain [36]

Around 2008, an anonymous called Nakamoto wrote a paper around achieving transaction and money such as transaction with not needing the association from any person at an outsider. This was blockchain first utilize, the technology after Bitcoin digital money, an idea was very clear. Assume that client called X needs to transfer money or information to client called Y, while transaction occur, it working to as a block who is communicated to node /client on the system. At that point, the clients need to confirm if a transaction is legitimate. [37]. A puzzle requests utilization proven computationally. A riddle tackling strategy is mining classified, where the top miner that discover an arrangement obtain reward that is a bitcoin, so that miners are contending to be quickest to resolve puzzle-game. A transactions finished when fifty-one percentage of a client's endorse on given solution. At that point, block of transactions is inserted to a blockchain. A blockchain a ledger and keeping records as blocks incorporates every transaction [38] [39]. Despite blocks available to each clients, they can't be altered. A blockchain is getting progressively well-known and appear to utilize at a huge assortment of enterprises. A European Commission introduced an article at Apr 2016 [40], explaining that blockchain can ability essentially repair business models that exist. At a similar article, it was evaluated savvy contracts, in light of blockchain technology, could reduce foundation expenses of banks yearly by 2022.

Consider blockchain a working framework like as Microsoft Windows or macOS, and Bitcoin is just one of the numerous applications that can run on that working framework. Blockchain gives the way to recording Bitcoin exchanges the mutual record however, this common record can be utilized to record any exchange and track the development of any benefit whether unmistakable, immaterial, or digital. For instance, blockchain allows protections in minutes rather than days

also used to assist organizations to dealing with the progression of merchandise that related instalments, enable makers to share supportive of diction logs with unique hardware makers (OEMs) and controllers to diminish item reviews. The blockchain architecture permits members to share a records that is refreshed through distributed repetition each time an exchange occur [41]. A blockchain is working as a ledger which workers record data for production, implementing and consumption an item for consumption or service. A ledger administering is by the parties that share usually through a network type peer-to-peer usually over a peer-to-peer network. A network verified from a new register before joining it to the blockchain, edit a data registered should follow up agreement protocol for decision-making, this meaning the lump of the parties contributory must approve about edit. Furthermore, edit to one of the registers leads to the edit of all the next registers thus, it is impossible to modulation the data registered in a blockchain [42]. Peer-to-peer repetition indicates that every member (also called a node) in the system works as both a distributor and a subscriber. [41]

History of technologies recommends that two-factor influence on a central technology and how its business advance. Firstly is modernism it describe how much an application is modern to the world, the more modern it is mean will be needed to exertion will be guarantee clients comprehend what issues it process. Secondly is complexity, expressed to by the degree of environment management included the number and variety of parties that require work together to deliver an incentive using the technology [42].

Blockchain is a distributed system that operational using the internet. It was presented at Oct 2008 a major aspect of proposition for bitcoin, which is virtual money framework which avoided for giving cash, moving proprietorship, and affirming transaction. It is well-defined as “an open distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way” [42]. It allows deal with transparently without the need for an intermediate like a bank or an intermediate in the agriculture section. The technologies change where a method for confidence is granted, confidence in a peer-to-peer architecture, this assistances return a confidence between provider and customers, which be able to minimize the deal costs [43]. Blockchain technology displays a trustworthy process of tracking transactions among unknown participants. Fake and crash be able to detect speedy. Moreover, troubles could be notified in actual by mix smart contracts [44]. Transparency is given by blockchain technology,

it gives for all participatory and eases a gathering of credible data. Blockchain able to register each step at the chain of a product's value started with a product's establishment and ended with its expired.

From of makers' viewpoint, utilization of blockchain technology aid set up a confidence connection with purchasers and planning the vogue of their items, by given transparently about item data in the blockchain. This make it hard for providers of fake or items that have low quality to remain at business sectors, it also gives to providers for enhance the nature of items in the entire agrarian and food parts. A consumers' viewpoint, a blockchain consider reliable plus truth data of how food is created and deal with it. It helps customers' to process worry about security, environmental and quality of food [45]. The utilization of blockchain gives the potential to clients to act together with makers since buyers able to know a process of food creation more helpful and more detail. It backing the buyer through taking out hindrances that is found in a trading to fix a relationship plus subsequently fortify buyer trust in safety of food. From the viewpoint offices' of regulatory, blockchain makes dependable and exact data accessible for them to complete educated and productive guidelines [46].

Blockchain is able to record the data of an item from its provenance to the retail location. It gives a protected and static method of putting away information gathered toward the beginning of the supply chain. Such as able to check and confirmed of data via any party associated with the supply chain of item. Also gathering information about all items may be expensive. In additionally, the transparency of such data help the control of disasters of horse's meat that occurred in the 2013 in Europe [47] [48]. Many organizations have focused on search the utilization blockchain technology in a field safety of food management and effectively completing. For instance, JD.com , Wal-Mart and Alibaba are effectively applying traceability of food utilizing blockchain technology to follow a whole procedure of food creation, sales and preparing [43].

A blockchain is essentially an appropriated database or open record for all digital transactions that been achieved then common among an interested parties. A transactions in the record are checked and agree on it from a big number of members in this a framework. Note if the data inserted, it never be deleted. Blockchain comprises a certain plus clear records of each transaction. [49].

Blockchain is a method of placing digital info in records, this information can be anything the client want to save it. First applying of blockchain it was Bitcoin, it is an exchanges of money transaction. A transaction is putting as blocks, whose are connected (or fastened) together using cryptographic with hashes functions, then called "blockchain" [50].

2.1.1 Characterizes of blockchain

The blockchain has numerous highlights that make it extremely appealing to explain it. As shown in Fig.2. According to [51].

Immutability: Permanent records is one of the primary keys of blockchain, when nodes approved into transaction after that logged it, it impossible to be changed.

Privacy: Secrecy gives effective method to concealing of character to the clients and it keeps the personalities private.

Decentralization: Absence a controller centralize it guarantees strength plus scalability by utilizing assets, Which thusly diminishes inertness and take care of the issue of the single purpose of failure of point that be present at centralized model.

Better Security: A blockchain gives well security on the grounds that there is no single point of ability to close down the whole system.

Increased Capacity: Blockchain able to build a whole system, this system has a large number of PCs cooperating all in all can have more prominent force than a couple of brought together.

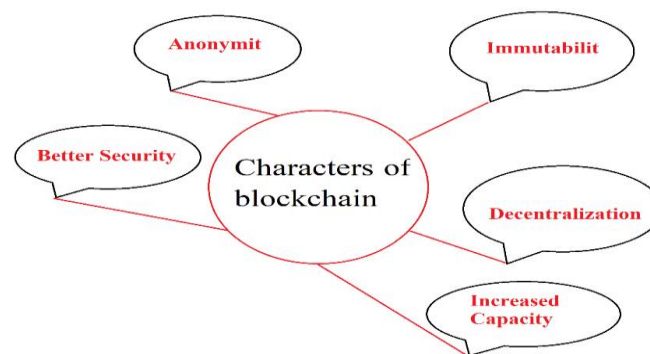


Figure 2.2 : characterizes of blockchain

2.1.2 The blockchain advantages and disadvantages

2.1.2.1 Blockchain advantages

Blockchain technology is a decentralized approach and this consider fundamental feature, it means not required to work along with the administrator central implies working without mediator and the members in blockchain make a decision. Procedure of security to central database may take a big time and may be spend a lot of money. Instead of utilize it, the Blockchain technology that have verification from the transaction, and then approval to add. Also, the transaction has the ability to be checked and exchanged independency [52]. Each activity in blockchain is recorded and the members has accessible for records but this records and can't be edited or deleted. The positive effect is give to blockchain trusty, transparency, and immutability [53].

Blockchain trusty depends on the truth that is at least 2 participants that don't have contact previous with another. The base thought is the real not useless transaction between these no-known persons. It can expand this trust further, in light of the reality that there may be more mutual logs and procedures. [54].

Immutable is mean the approved on a transaction over the blockchain. At the point when the transaction is associated with blockchain, unable to change or delete it. In additionally, this is depend on the system's type where it is a centralized system, will be tends to be changed or delete it, on grounds the option left to one individual (administer). Also, if system is decentralized like as, blockchain, the procedure of transaction as following, transaction will be duplicated in each PC for blockchain chain. This feature makes blockchain is strong plus everlasting. The members on a blockchain have ability to regulator of data equally. To alteration or delete data from the blockchain is possible when an intruder has the fabulous capacity to access for all PCs, which combine into blockchain before block recorded to it. If blockchain consists of small number of the PCs, blockchain will be more offered to attack, if it consists of ton of PCs in the blockchain framework will become more secure and more clear. [55].

Transparency to blockchain is accomplished when introducing fake transaction. As each transaction duplicated into another PC in blockchain series. Every member in blockchain able to

view the transaction, likewise, it means every activity appears to members of the blockchain. [54].

Structures of blockchain able to view issues and fix them fundamental. This advantage makes the blockchain able to tracking. High level of security in blockchain technology is accomplished on the individual login to system. Where each member who goes in the blockchain will be become member whose is connected to his record. Different explanation of security of blockchain is the reliable using cryptographic hash. At the point, if building a new block, it's important to compute hash to a new block. The new hash is dependent on the previous hashes worth. A hash function comprises of the block, previous hash value for block and ID num for block. This hash is created naturally by using node key. This mean, the data will be difficult to change [56].

The last advantage of blockchain is the quicker of processing for transaction. Generally, in banking organization the transactions take a lot of time to handling and initialing. Utilizing blockchain will assist in reducing the time of processing from around 3 days to a few second or even min. [56].

2.1.2.2 Blockchain disadvantages

Primary disadvantage of blockchain is it using high-level of energy. Using energy required for saving a record. Each time when a new node is made, in a similar period, it views every and another node, so at this process transparency is building. The miners in the system are try for understand a lot of solution in each second in endeavors for approve on the transaction. Miners using PC that hold high-power. Where it try to stay node working in all time to guarantees that information putting on a blockchain is monitoring and safe from changing, these activities consuming power and time. [56]. The signature is a challenge of blockchain, in light of fact that each transaction must marked using a cryptographic function. It consider reason for the power consumption utilization. Another problems of blockchain is split the chain, this mean it node doesn't know the next chain in blockchain [57].

Another issue of blockchain is great cost for clients and nodes. Currently, there needed to working on a node that is effectively in blockchain. In this situation, the cost will be high, consider that the node got the higher award when solve the puzzle. [55].

The significant cost is a major detriment of the Blockchain. The range of cost to transaction is 75 and 160 dollars and a large amount of this cost using for energy [56].

2.1.3 How blockchain work

Information keeping as a block then added to a series of blocks called blockchain, as a name recommends, it comprises of numerous blocks linked together. To adding blocks to the blockchain, number of stages must be happen: [58]

- Must a transaction happen.
- Must verified from transaction.
- A transaction should kept in a block.
- Each block must have a hash key.

2.1.4 Types of blockchain

In general, there are various kinds of blockchains relying upon the managed information, the accessibility of information and on activities that able to perform by users include:

- Permissionless
- Public permission and,
- Private.

Each info put on the blockchain it considers permissionless, it is available plus obvious for people in general but, some parts of it could be encrypted to protect a member's identifier. [59]. Blockchain permissionless, it means anybody can join to it without authorization and could work as a basic node or as a miner (node) [60].

The second type of blockchain called public permission is given permission just for a selected group of nodes that contribute agreement process [59]. This type considers it very well may be utilized inside one or over a few enterprises. At the point when a public type of blockchain is set up inside the industry sector (e.g., monetary segment), it will be used for restricted record and mostly unified.

The third type of blockchain is private, it just enables picked nodes to enter the system. [59]. This type consider permissioned systems so, it will be controlled the nodes that perform a transaction and execute smart agreements or working as miners. It managed by association authenticated party, as a result this type using for purpose that consider private or personal. Ripple and Hyperledger Fabric are consider examples platforms of blockchain that support only private networks of blockchain [61].

2.1.5 Applications of blockchain

In this thesis, concentrated on six sectors for apply blockchain technology were discovered started with cryptocurrencies, electronic-Government, social insurance, supply chain, energy, and banking, which will broadly explain it.

2.1.5.1 Cryptocurrencies

Cryptographic consider on of significant application for the blockchain technology. Principally centered on using of cryptographic forms of money as a solution for payment. In [37], an author's investigate about most cryptographic forms of money such as Ethereum, Litecoin and Bitcoin. In additionally, introduced an examination among these digital monetary standards, with respect to limitation of coin, algorithm, and reward for block.

In [39], it analyzed boundary of computational cost (gas) and propose technique for lessening cost of gas while doing business using Ethereum blockchain. Digital currencies could likewise be utilized as a motivation component for proposing thoughts in useful ventures. In [62], the authors exhibit Open Bazaar, it is decentralized commercial, and it based on bitcoin multi-signature ensured which empowers free internet business transaction with not required any fees. In [63], IOT is foreseen to incorporate number of sensor that will be associated to the Internet, plus this sensor are anticipated to take place and produce an enormous data. By this path, data will producers make a smart contract that acknowledge as info of virtual and will yield a payment reception.

A researchers of [64] focus utilize a protocol of blockchain technology for bitcoin to payment, furthermore utilize direct regression for probability of bitcoin and the of bitcoin proprietorship. An execution to network digital currency based on bitcoin is explained in [65] . Proposed model

incorporates network support and individuals and ability to take loans that are affirmed via vote individuals of the network.

2.1.5.2 Electronic-government

As of late, there are a huge development of electronic government supported organizations citizen, organizations and public groups. A Blockchain technology able to work like a platform that encourage technology applications to included exchanges of data where are included digital data of asset (e.g. stocks, cash, and ground properties rights) and decentralized trade (distributed trade). In [66] propose electronic voting based on blockchain frameworks, it describe how votes directly, securely and transparently as method that ensure the governments can't control polling where everybody is able to peruse and check the polling.

In [67] the authors analyze framework of blockchain that checks validity of information in the electronic-government when transmission it to open administrations, executed in China. A Blockchain uses structure of protected information which able to distinguish, following transaction carefully and in the final stage sharing this data across systems of PC. In [38], the utilization blockchain technology as assistance bolster framework in public sector systems, for example, Digital ID management and secure report. The authors of [68] propose development of system for identity management based Ethereum and bitcoin equally. The writes suggest framework to technology blockchain to outdo on case of fraud tax by expanding transparency. Specifically, another protocol of blockchain is made called Pajakoin, it is basic, simple and securing for added tax [69]. In [70] presented a database potential for blockchain, for controlling profit streams for reduce it, however to reduce problem of double-spending at public tax department. Another utilization for blockchain technology where academic certificates are put away in a safe manner is broke down in [71], a methodology that may be extremely helpful in the public division. In [72], a framework proposed that enable private information to be participate with numerous associations according to request of client Clients of framework have fully control in their information and data is consequently refreshed at each organization so, access to information. Finally, blockchain is referenced in [73] where this technology using to follow government officials' actions and put in as a direct to residents' hands.

2.1.5.3 Healthcare

Another area of blockchain technology successful is healthcare. Utilizing blockchain, associations of healthcare can achieve high level of information and high-level preparing throughput for transaction. In [37] focus on case Estonia where using blockchain for sharing medical documents. Where using blockchain as a method to putting and getting of medical items during coordination's procedure at medicine supply chain [66]. In spite of, blockchain it using for sharing and managing data about health in safety and secretly method, guaranteeing namelessness also trustworthiness via suppliers during patient life [74].

The authors of [75] give an answer by means of blockchain to control Electronic Medical Records so that information treatment of the patients turns out to be safer, private and not complex. All the more explicitly, MedRec (model that give patients permits to access for their own data about medical to specialists and medicinal services suppliers), ARIA (is a stage that integrate medical ray, oncology data and help medical to oversee various types of medical information, create oncology-explicit consideration plans, and screen radiation portion got by patients).

Authors in [73] an exhibit of a checking framework is presented where the assortment of individual medical information and the warning of the patient (if there should be an occurrence of emergency) occur in actual.

2.1.5.4 Energy

Authors in [76] using blockchain technology for execute transparent of transaction in the energy sector among buyers and consumers at local networks comprising that have ability to be renew power source assets. Specifically in [77] suggest decentralized framework for exchange a token-based energy, where participants negotiate about energy costs and can safely perform a transaction. In [37] some of features for blockchain technology that using in local power network it permits the conveyance, measure and charging of the power that regulated by the network itself without needed to a dependent outsider interference.

2.1.5.5 Supply Chain

A blockchain technology guarantees recognizable proof for item origin [78] it also encourages the tracing process [79]. Moreover, in [78] item ownership the management system is described to not able fakes once the items arrive at the end of supply chain. Along with that, tracing of source item could be by executed subsequently buying as well as securing. In [62] Authors contended blockchain technology its gives security for supply chain, it mean ability to determine the risky section and ability to guarantee the reliability among supply chain accomplices. [71]. Everledger utilizes blockchain which establishes an overall record of precious stones (diamonds) in the extravagance merchandise showcase and guarantees their possession.

The authors in [73] notice blockchain able to improve the food supply chain. In briefly, it exhibit Eaterra, which is consider a decentralized shop interfaces makers with customers by guaranteeing food traceability.

2.1.5.6 Banking

Various money related establishments are at present testing transaction on a blockchain platform. Some of authors established financial business man labs own of their working together with blockchain. One of standards that using for execute first transactions called "Ripple" [80]. It take 10 second to finish a procedure, but in normal framework it take 2 day to finish transaction. Additionally provides an exhaustive study of how can blockchain accomplish resource digitization, highlight fact esteem move, subsequently remaking the monetary framework. This plainly expands the proficiency of clearing and settlement of money related resources after the transaction. There was some of estimating, the expense of transaction in organizations can be much diminished by use blockchain. All the more explicitly, in [79], a framework of blockchain that based on outskirts payment actualized using in blockchain for banking. Notwithstanding that, blockchain application could assist saves money with encouraging foreign exchange trades and continuous payment by social affair hubs in a blockchain, as opposed to having a national bank to manage payments [81].

2.1.5.7 Other Business Sectors

Aside from outcomes, blockchain could be assume a significant job at different sectors of business that not broadly dissected in researches. It very well may be an answer for protection of cars application by a pay-as-you-go. In more explicitly, all information spilt from vehicle observing motor is put away in the blockchain database, which ensures that the information is carefully designed and discernible giving a snappier and better client experience and less working expense just as maintaining an operating from frauds [82]. Besides, by exploitation for smart contracts, blockchain able to be utilized in seeding protection by social occasion climate information, where ranchers need protection security against the results of awful climate.

Despite the possibilities for blockchain technology for using construction management. It able to give a solid setup for construction management data, legitimate contentions plus will be secure storing of sensor information during life-cycle stages with not needed to utilizing a central structure data typical maintaining and not needed to third part trusted [83].

2.2 SUPPLY CHAIN TECHNOLOGY

It explains an improvement in the flows of items and/or services and data during the network of the supply chain. Recently, concept of a supply chain technology has been increasingly discussed in both practice and academic circles [84]. The idea of SCM (supply chain management) started at last part of the 1980s and got well known during the 1990s. Before the appearance of this idea, the organizations were using terms operations management and logistics. According to [85] the definition of a supply chain is a sequence of organizations and actions executed during a move this material from major provider to end consumer.

It is a collections of providers which mostly contribute to creation, storing, steering, and lastly conveying a particular item to end clients. The chain is comprised of links between such providers to empower customers to have a sequentially requested history of what they are buying. Each link carries data with respect to time, cost, stockpiling conditions, and so on. Every one of these links is put away in the supply chain the management system which are halfway controlled stores that outfit such history to buyers. All providers are approved by a focal substance that controls a given flexibly chain the executives framework. Instances of the retail supply chain the board frameworks incorporate Coca-Cola, Amazon, and so forth. Furthermore,

such frameworks have a supply chain for each line of items, along these lines, for instance, Amazon's framework has many supply chains for various items [86].

The idea of the chain is significant on the grounds that it implies then the following link can't be reached without experiencing the past one which consummately reverberates with blockchains. In like manner, planning supply chain elements to our framework imply that all providers are "owners" partnered with hierarchical gatherings in Mesh where their wallet accounts get approved by Mesh worker, Mam [86].

Features of a supply chain it focuses on the make and transfer of merchandise from the stage of obtaining on it to receive by the consumers. Nowadays, the supply chain have ability to consist of in stages and areas various. Thusly, it has gotten harder to keep track of activities in the entire chain. In addition, if the transparency is absences in the supply chain, buyer and consumers don't have the ability to know the true value of the products or services. In the supply chain, there are some of the components that don't have the ability to follow it such as the natural occurrences. [87].

For most big associations, supply chain consider feature of a business, it enabling advance management for cost and flexibility. However, the term of fraud is found inside business department and it spreading in worldwide and is getting all the expensive associations consistently advancement. [88].

By the way, intricacy and length of supply framework makes it easy to impostors to abuse supply chain. In a specific area of food frauds, the supply chain of the food business is distinguished to become modern and so mind-boggling in worldwide. It frequently harder to checks what goes in an item or where from have been obtained on it. It is on the grounds that as organizations progressively redistribute assembling, coordination and different jobs, they have less permeability and control of key procedures. The issue has been exacerbated by the way that food costs are ascending amidst a profound financial downturn, a circumstance that has squeezed providers to scour the world so as to discover less expensive fixings. The outcome of this has been the rising fraud saw over the most recent couple of years. [89].

Food fraud occurs when providing food intended aiming to monetary profit and forwarded in mistake forms [90]. Supply chain procedures need a complete outlook to system on link in a

chain that cooperate productively to make consumer content satisfy at the sending to the purchaser. Frauds in the supply chain are various and are done by providers, merchants, workers or the board among others at any stage of the chain. Subsequently, it isn't generally an instance of willful blindness impairment with respect to a portion of the players associated with the supply chain. Regardless of whether these impostors do everything possible to monitor every single connection in the supply chains intricate, it almost doesn't to forestall a lot of deceitful activities, for example, scandal about the horsemeat [91].

2.2.1 Supply Chain Management

It considers a method to plan and keeping up the activity to materials and items between various organizations to supply merchandise and enterprises to final purchasers [85]. For instance, assume needed to purchase another vehicle on the grounds that your present model has exhausted. Required the vehicle be a four-cylinder with automatic gear, cooling and 4 doors. To make this vehicle needs to 8,000 pieces from 300 providers' worldwide. In actuality, organizations don't work in isolation, when goes a customer to purchases material from having providers, it goes as a supplier when conveys materials to buyers. For example, a distributor goes as a buyer if want to purchase products of makers, afterwards as a dealer when offering merchandise to shops. Purchaser able to take crude materials from providers, gathering it and sales it to different makers. Most items in a chain of the organization's transport among an essential providers and terminus clients. For example, Milk transfer from a farm, dairy, packaging plant, wholesaler, and grocery store before we buy it.

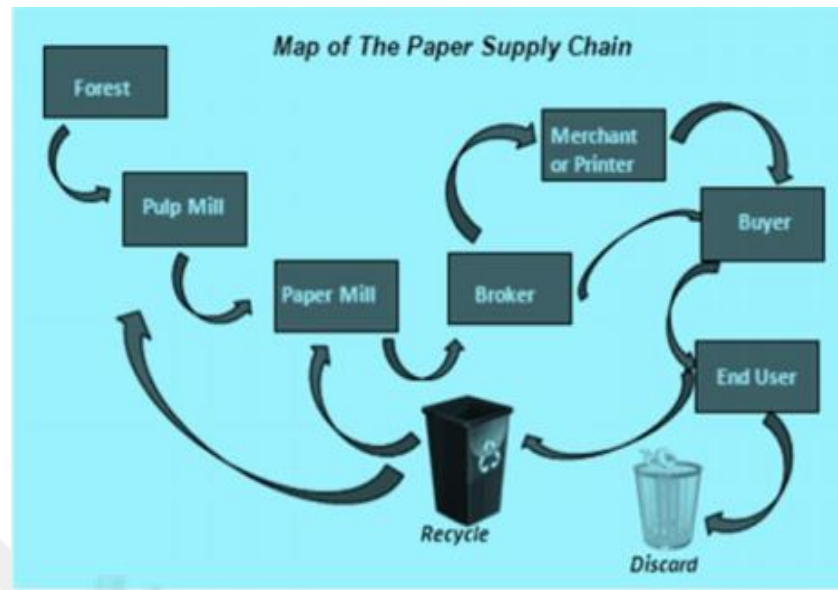


Figure 2.3 : Map of paper supply chain [85]

In the following figure 2.4. Explain the supply chain to piece of paper travels through various organization before you put it your work desk

Every item select own supply chain for it and ability to broadened of supply chains. The supply chain describes the whole excursion of materials utilized 'from earth to soil'. During the transporting steps, resources move from crude materials providers, completing activities, producers, coordination focuses, outsider administrators, distribution centers, transport organizations, wholesalers, retailers, and a whole scope of different tasks. From time to time, supply chain skip end client for include reuse of materials.

2.2.2 Benefits of Supply Chains

Authors in [92] illustration the benefit of supply chain as following:

- Preserving on the competitive features
- The percentage of transparency big
- It is considered a better for making-Decision.
- It reduced from the level of merchandise that are stored.

- It helping in raise sales and profit.
- It make on reduce the time of delivery.
- It assist in understanding of requirement of customers in better form.



3. DESIGN AND IMPLEMENTATION

3.1 INTRODUCTION

In previous chapter explained everything about the theoretical part of blockchain, type of blockchain, application of blockchain, supply chain . . . etc. This chapter will describe the practical part which contain the system design and the implementation in order to keep the data on a cloud to be seen all over the world. This data will be implementing some recent programming languages and advance platforms. The purpose of building this application is to permit the trusted clients that have the permission from the ministry to share these records by posting them. Since the content will be put on the blockchain that work as decentralized ledger, it will be changeless and permanent. A clients will be interact with the application through a direct web GUI.

3.2 DESIGN OF PROPOSE SYSTEM

Firstly, the purpose system design covers the stages starting from inserting the data to the web application for the trusted user, adding new records to blockchain ledger (which means entering the data to chains that web application contained), this data will be saved in the blockchain ledger after validating them. This chain has a field contains the serial number of the product, this field will be used to search about particular product. In other word, when a user would like to search a product in search site must enter its serial number or the QR if the product has it. This process can be done by using the camera of the device and in order to read the QR, the user must put the QR on a camera head as to shown in figure.3.1.

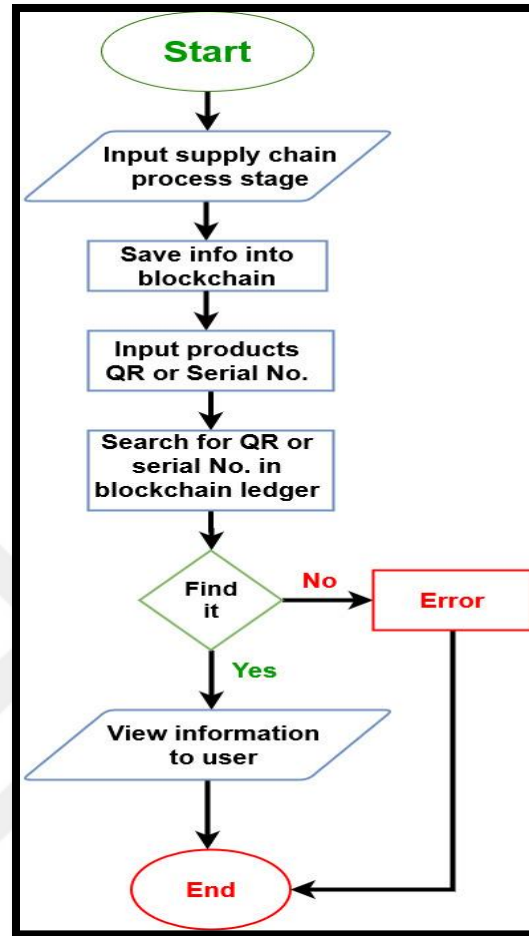


Chart 3.1: flow chart of design

3.3 MODEL ARCHITECTURE

This structure helps in tracking products by using the supply chain because of it provide the transparency and security that needed it in the agri-food system. The total of the work will consume this information in the manner of adding them to the blockchain. A blockchain is essentially a distributed ledger that include requested information, with a number of limitations, for example:

- Blocks can't be altered or edited after adding them.
- Clear principles for adding information to it.
- Its structural design is distributed.

- Implementing these requirements give the following advantages:
- Information immutability
- No single point of control or failure.
- A clear check path of the request in which information was included.

The procedure of work explains the method that the system will work on it, firstly the user must be trusted which means taking the permission for the user and the application. After taking a permission the trusted user can add a transaction to one peer (node) and this peer will publish the transaction to all the peers that participate in the system thus mean this transaction all peers can see it and this will be done by validating procedure using the blockchain, and finally this transaction will go to ledger as summarized in the figure.3.2.

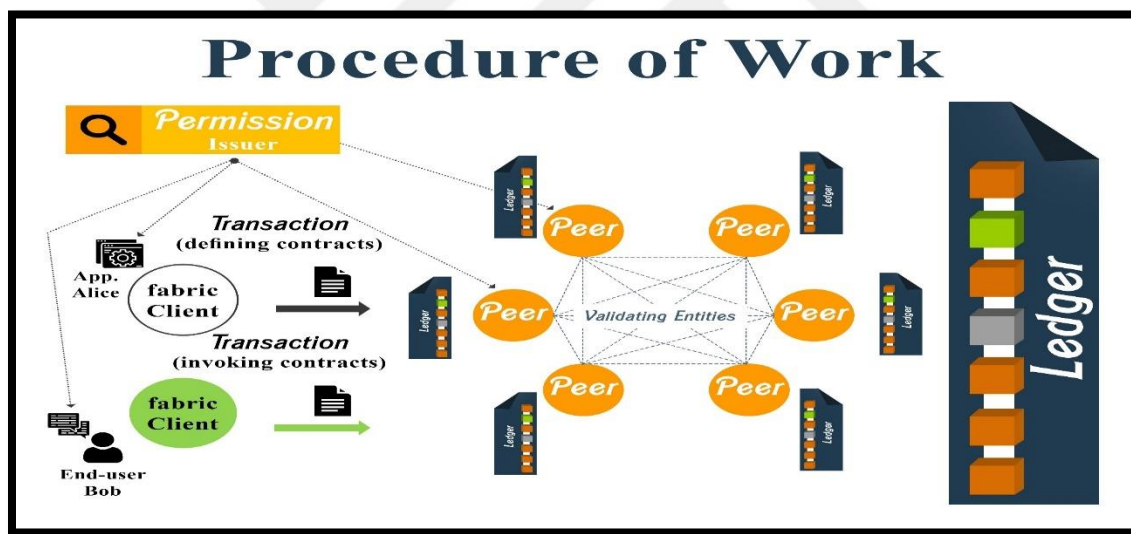


Figure 3.1 : Procedure of work for the system

3.4 IMPLEMENTATION

In the novel various world of programming, there are various approaches to plan and execute an application. There are virtually endless possibilities and choices to browse, starting from the choice of the application type, followed by the choice of environment, programming language, technologies, and systems. This section will describe these decisions. Besides, this part contains a section about information base structure.

The best option that must be made is sort of application that suitable on particular conditions. Thinking about the domain of the applications, the expected clients, and use instances of the application, there are two primary methodologies which would be conceivable – either actualizing local applications both for PCs (for the chairmen) and cell phones or making a web application – or, obviously, consolidating the two methodologies.

Obviously, web applications do have their drawbacks – it is hard to ensure acceptable client experience for clients of all web programs and devices of every different size, and they will, in general, they tend to be slow adjusted than their local partners. Nonetheless, in this situation, the favorable circumstances appear to exceed the weaknesses, so it was decided to build up a web application, with a likelihood to change it to progressive Web App, or developing native mobile applications as a future recommendations.

3.5 APPLICATION REQUIREMENT

In this section, two kinds of requirements will be introduced – functional requirements, summing up what tasks should the client of the application have the option to do, and non-functional requirements, summing up the rest of the application however the usefulness – for instance, reliability or ease of use.

3.5.1 Functional Requirements

The functional requirement are logically separated into bunches by their relation to a similar kind of subject. Additionally, there are three approval levels in the application: client, staff and Superuser manager. Since a Superuser can do everything a user ready to do, staff can do everything manager is ready to do. The functional requirements of these users start from a client along to the higher approved job – this applies to every requirement gathering. Exemptions to this standard are unauthorized users and Superuser, which both have unique requirements.

Account management

Unauthorized User is able to:

- Register into the application
- Log in to the application.

User is able to:

- Adding data to application.
- Leave comment including his contact information.

Superuser is able to:

- Control the application by get every user authorization that needed.

3.5.2 Non-Functional Requirements

This part will comprise of a brief of non-practical requirements, except the choice of programming language, stage, and structures – these significant aspects will be discussed in details next section.

- **Accessibility:** application is available through all normal internet programs on stable URL to everybody with web access.
- **Adaptability:** the framework can be utilized for a wide assortment of utilization cases, and subsequently is genuinely adaptable.
- **Integrability:** system currently provides several API endpoints, because we used python language enabling usage by third-party applications with proper authorization.
- **Security:** core usefulness is accessible just too approved users, moreover isolated by client jobs.
- **Usability:** this application is easy to use for individuals of any age and education levels.

3.6 USED TECHNOLOGIES

While picking the creation environment and programming language, a few factors must be taken into consideration – initially, the choice made about the kind of the application must be considered which makes the list of technologies possible to utilize significantly smaller. Another viewpoints worth considering is the ubiquity of a language and environment, as more famous languages have greater communication and hence it is a lot easier to find a solution for problem which will without a doubt happen. Considering all the previous points.

3.6.1 Django

Django is a framework for web development dependent on python. It was initially evolved to avoid setting up new applications web completely without any preparation. Django was brought into the world in 2003 at Lawrence Kansas. The online world group was responsible for a few nearness news websites maintenance and creation. Moreover, in 2005 when Django turned into open-source programming. These days several thousand clients are utilizing this established project open source.

There are two key feature of Django. It is an open source platform, well focused on managing everyday issues in the web programming that Django developers are confronting or have confronted And, it contains number of helpful highlights for example, an administrator page as shown in figure.3.3.



Figure 3.2 : Classic defaulting Django admin site

Despite the fact that Django is well for this type of sites, it is additionally a viable tool in building such a unique web sites. Django began as an inside project in 2003. Django was created to comply with the quick time constraints, while simultaneously keeping the development procedure clear and viable. By the mid-year of 2005, it gets develop enough to deal with destinations, and the engineers choose to deliver it to people in general as an open source venture. The project was called jazziest Django Reinhart [93].

Django is a group of segments that are designed to work together, and they cover a significant number of regular parts of web improvement. At the point when a user peruses the web, experience a wide range of sites that, on the exterior look as different, but in the real it contains

the same pattern [94]. Each web site serves HTML that is the language that includes the content of the site, CSS is responsible for explains how the content is showing, pictures, etc. Most sites take the ability to sign in to the personal zone, where you can see a dedicated region for the client and information that may not be open for entirely clients. Django provides this with their components [94]. A significant side of Django is that a number of its segments are autonomous and, accordingly, can be utilized separately with no needing to gather every one of them. In the past, The designers of Django Framework perhaps focusing on solving the problems specific for newspaper , nowadays the Django framework is fit to process any domain [95].

Django is a structure that follows the model-template-view pattern, whose is fundamentally the same as the model-view-controller pattern design whose numerous different systems have. The model layer describes the database layer, utilized for data keeping. Django redeems the user from composing SQL inquiries. Rather than the SQL, a user can utilize Python objects, and the load/save activity is taken care of user. The template layer is in charge of making the HTML responses. It permits the users to separate the HTML into segments, merge these segments in numerous sites, do fasting changes, creating of information, and numerous different activities. The view layer is consider as a bridge layer between the database and HTML, and ordinarily is the greatest layer in an application. It is the place most business rationale is found. It is in charge of for telling the template layer what yield to produce, to pass the information that should become back to the client, to deal with structure entries, and to interact with the model layer for persisting information [94]. Figure.3.4 explains the home page of Django.

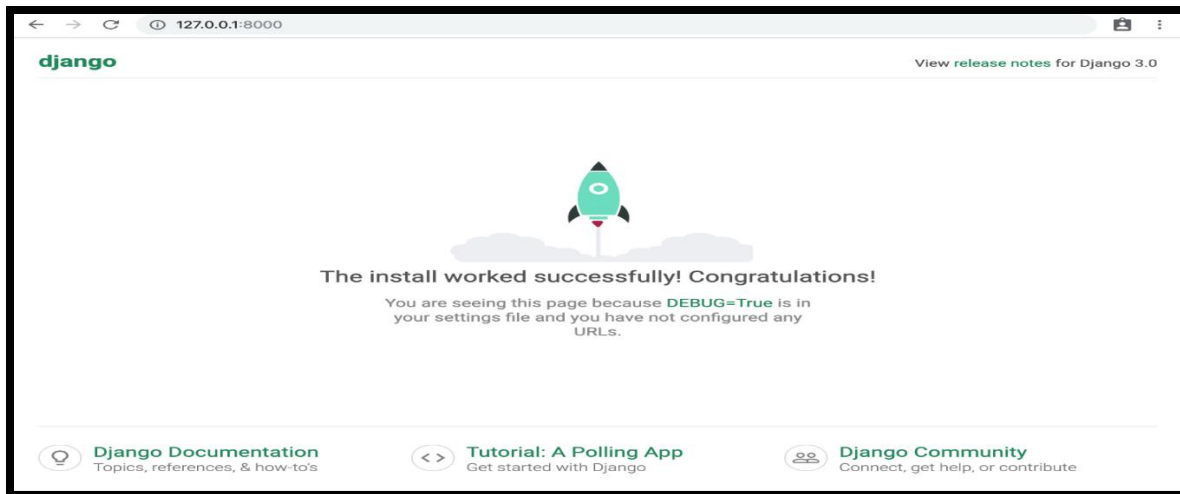


Figure 3.3 : Home page of Django

3.6.2 Python

A python is a well-known significant grade powerful language programming. It is modern and quick. Python libraries spreading everything from synchronous handling to compress documents. It has many features that make it more powerful than the other programming languages, for example, Java, Ruby, Perl and others. Proposals highlights are:

- python language is an object orientation program
- understandable and clear syntax
- perfect quality, supportive various packages
- broad libraries standard and outsider modules for each conceivable undertaking
- high-level powerful information kinds
- additions and modules are easily written in C++, C(or Java for Pythons, or .NET dialects for Iron Python)
- enable embedded application inside as scripting interface

A python is additionally utilized in different applications, for example, Internet and web development, Desktop graphic user interfaces, Education and in other applications. Besides,

python coordinates well with different articles such as .NET. Python runs on most working frameworks like Linux/Unix, Windows, and Mac [96]. It is easy to understand, so that's it has been chosen for this project. Since there are many programming languages accessible today, Python is a broadly useful programming language. Despite the fact that it is utilized for a wide difference of application, Python is entirely appropriate for creating applications web. It has perfect and sophisticated syntax, and is upheld by a huge library of standard and contributed modules, which covers everything from multi-threading to the files zipping. Also given that there are about 1 million Python clients out there at the moment, the decision of advancement apparatuses is at times dependent on novel imperatives or individual inclination [96].

Python is totally free to utilize and distribute. Similarly, as with other open-source software, such as Tcl, Perl, Linux, and Apache, you can bring the whole Python framework's source code for nothing on the Internet. There are no limitations on duplicating it, implanting it in your frameworks, or transportation it with your items. Truth be told, the user can even sell Python's source code, in the event that so disposed. However, don't misunderstand the thought: "free" doesn't signify "unsupported" [96]. Moreover, it is not difficult to learn in view of the fully written documentation composed, availability of the books, wiki pages. At long last, Python is an open-source license and implies that it is uninhibitedly distributable and usable in any event, [97] as shown in figure3.5.

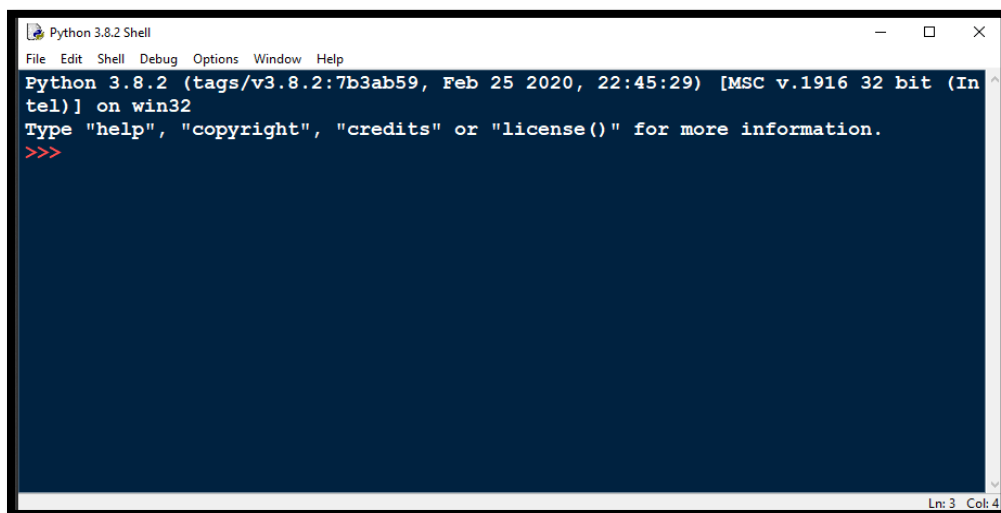


Figure 3.4 : Default Python interpreter

3.6.3 Database

While Django doesn't require a database for it to work, Django is capable to utilize SQLite, which is an inserted database engine, but it is not propose for preparation environments because that is not its aim. So in the last version of programming establishment, the project need to ensure that it has a database framework for handling the information. The project has some of the choices accessible with regards to databases. The most ordinarily utilized ones are both open-source: PostgreSQL and MySQL [93].

3.6.4 PyCharm

PyCharm is an Integrated Development Environment (IDE), it was created by Jet Brains software organization. It is strong and devices arrive at program which makes Python programming fast and productive. PyCharm is also a strong tool for creating Django applications [95]. It gives number of features, for example,

- Navigation Project
- Assistance Coding
- Analysis Coding
- Debugger Graphical
- Refactoring Python
- Integration version Control

A default IDE of PyCharm can see in figure3.6.

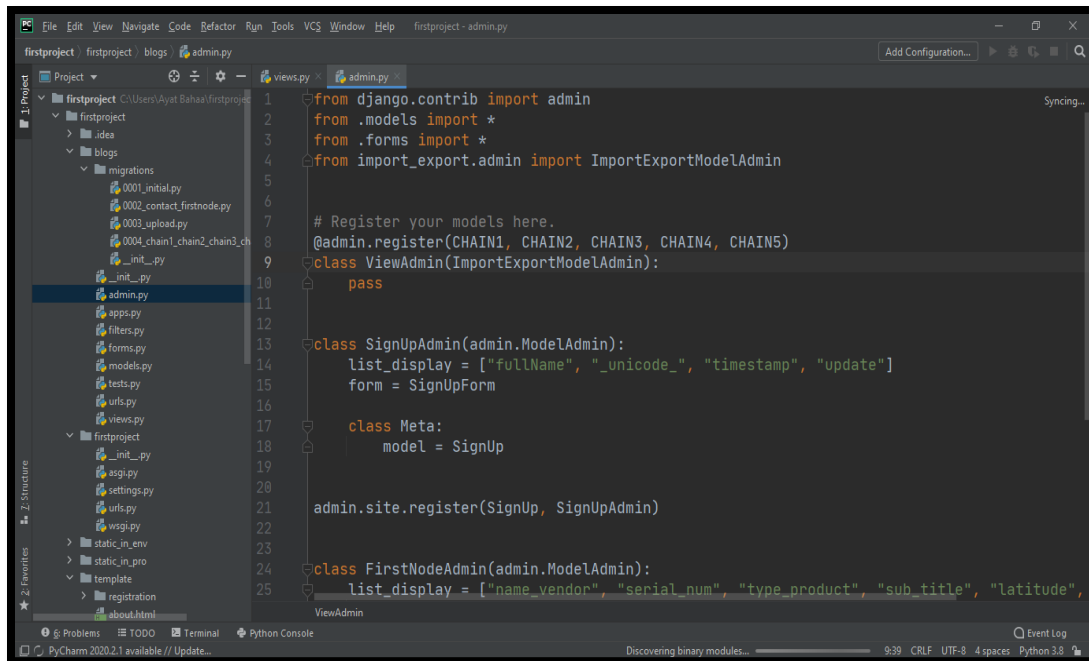


Figure 3.5 : IDE PyCharm

3.6.5 SERVER

In this project Window PowerShell is use in order to run application with some command of PYTHON as see in figure3.7.

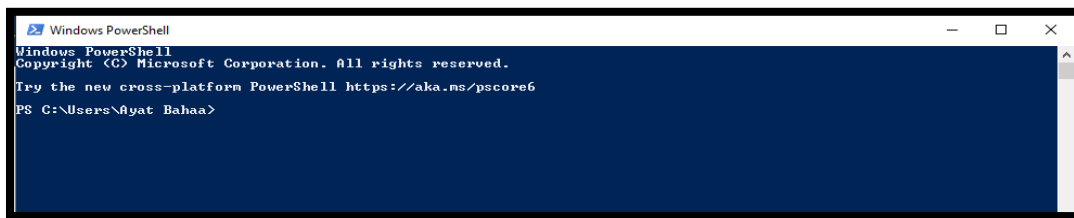


Figure 3.6 : window for PowerShell

3.7 BUILD APPLICATION

In this part the building of the seed web application will be explained along with its features. The primary layout of the application is shown in figure3.8.

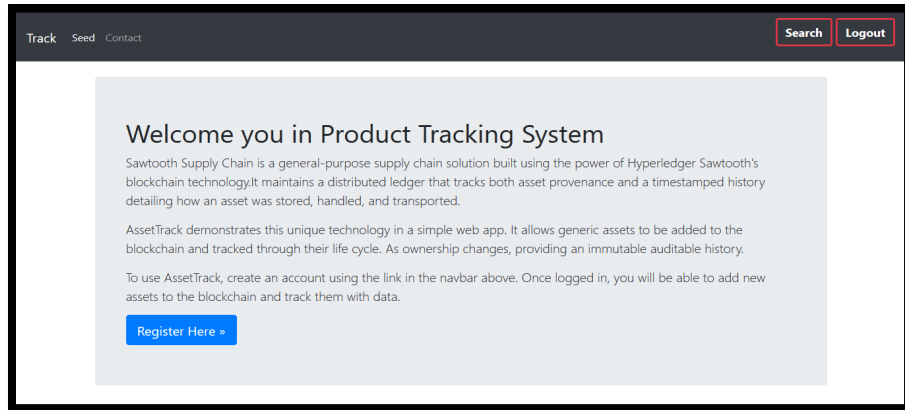


Figure 3.7 : The main interface of seed application

3.7.1 Getting Permission

Firstly of all, user (end user) must take a permission to add a transaction or information for the system. Django framework provide some permission that user can using it as see in figure3.9.

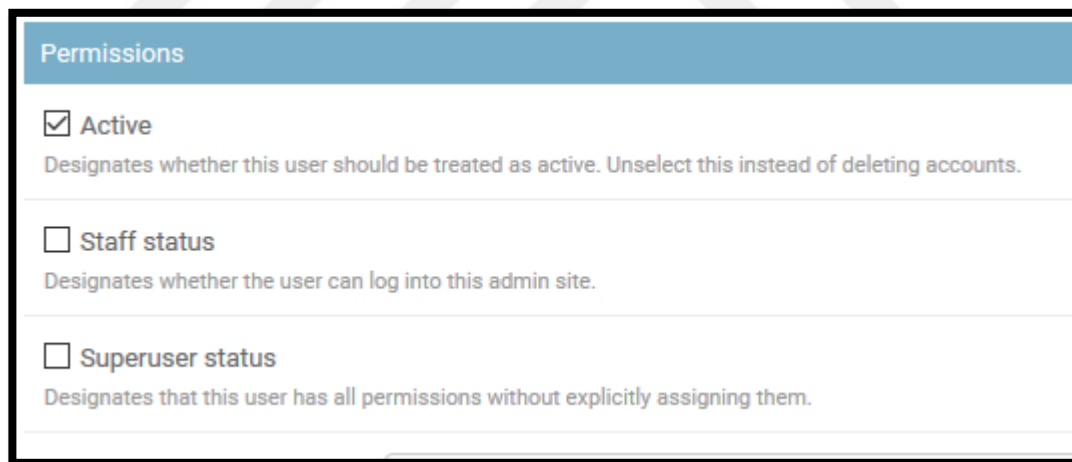


Figure 3.8 : Permission provided by Django Framework

- 1) Active: This mean that the user is registered in the system and waiting the manager to accept after confirm from his information. This user can just see the data the display in the system. That's mean the user can't add any information or data or add any new product to the system.
- 2) Staff status: This type of users can add and view products information which can't control the admin page such as accept new users or edit permission of users.

- 3) Superuser status: This permission makes the users as a manager. Users can control everything at both client side and server side of the system. Furthermore, in this type can add a specific permission for users which can be done by Superuser only and Django framework provides some of these permissions for any users as shown in figure.3.10.

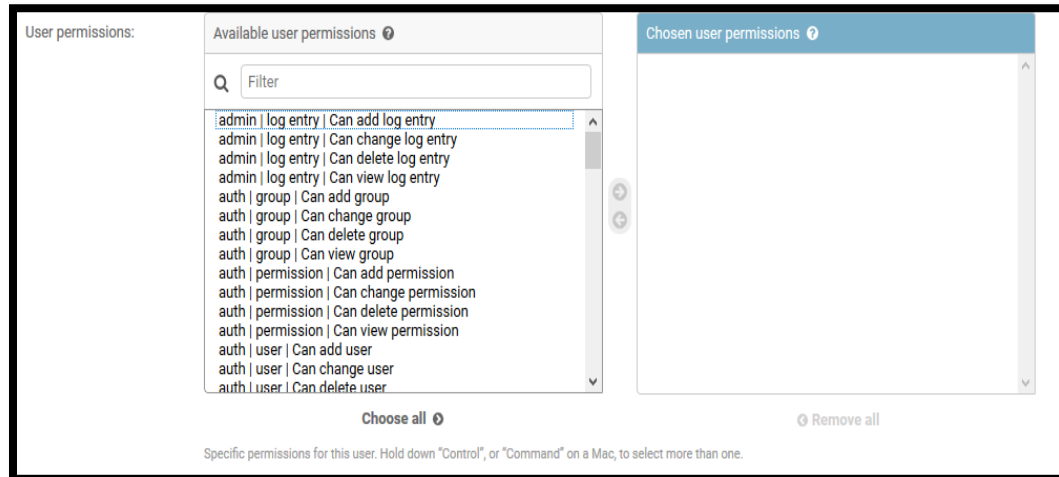


Figure 3.9 : Specific permission that provided by Django framework for users

Django prepares a client system authentication. It treats client accounts, groups, and authorizations and treats session's cookie-based user.

In order to explain the implementation works of authentication system, it is necessary to know what extend suitable for customers and the project's requirements. The system authentication of Django treads both authentication and authorization. The authentication checks a clients is which they right to be, and authorization set whatever an authentication user is permitted to do. The authentication system is a common method of executing labels and permissions to one or more than one user as shown in figure3.11.



Figure 3.10 : Authentication and authorization system in Django

It contains the following features:

- Permissions: flags determine whether a user may execute a specific task.
- A password depend on hashing system.
- Apparatuses for logging in users, or restricting content.
- A pluggable backend system.

In Django the authentication of the system intends to be extremely nonexclusive and does not give a few highlights generally found in web authentication frameworks like:

- The strength checking of Secret key (password)
- login attempts choking
- third-parties authentication for instance (OAuth)
- a permissions of object- level

Django accompanies a built-in permissions system. It gives an approach to appoint authorizations to explicit clients and group of clients. It's utilized by the Django administrator site. For users that accepted in the system, every user will have a generated activation key.

3.7.2 Store transactions into Ledger

The public term “Data” is switched at the blockchain applications by the term "transaction." So, just to bypass the confusion and maintain consistency, the system will be utilizing the expression "transaction" to point an information in the system model. In the conventional client-server design, the system store transactions records in a database, in a centralized area. The keeping the system information in a central area has the following disadvantages:

- Possibility for losing this information.
- Threats for information integrity.

There are number of features for the transitions that have been kept in the blockchain ledger. The first point can mitigate and explains the duplicating of information in various areas (known as

backup). The second point is guarantee the integrity of the information that have put on the server. The unified way to deal with information storage is not generally ideal. The decentralization of data storage, commonly known as a distributed ledger. Since the transaction are reproduced on various PCs, Putting the same transaction on numerous PCs guarantees that no single PC can do any modifying process without any permission in ledger. If a user would like to edit a transaction, it need to make the modifying on all PCs. The more PCs taking an interest in the system, the more PCs needs to edit as seen in figure 3.12.

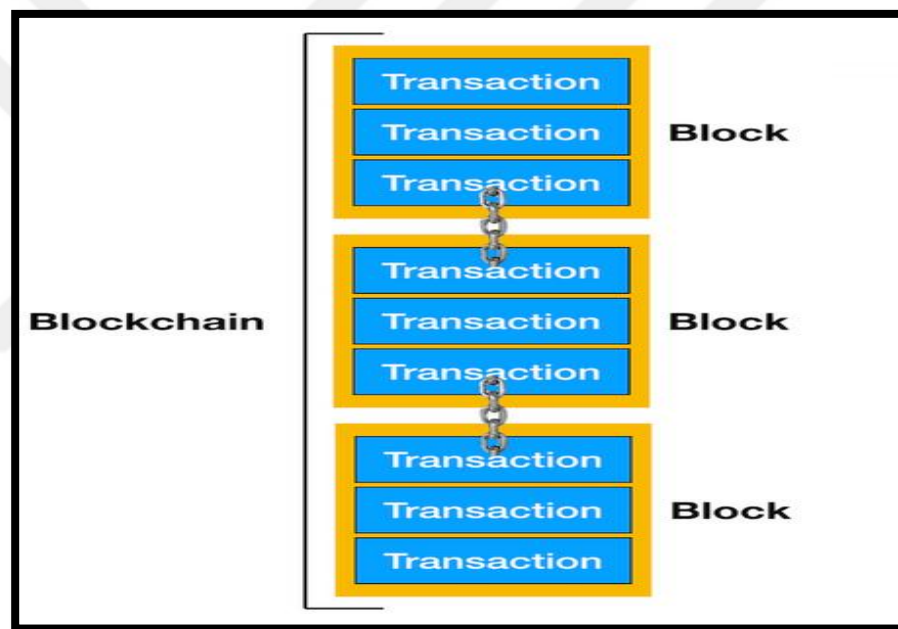


Figure 3.11 : Blocks that saved

The transactions are placed into blocks. A block can include one or numerous transaction. The blocks will consist of the transaction that are generated and added to the blockchain. Since there can be different blocks, each square ought to have a remarkable ID.

3.7.3 Add digital fingerprints

The system prefers to deny any type of altering in the information inside a blocks, and make a discovery from the initial steps. To recognize if the information in the block has been altered, the user can utilize cryptographic has function.

A hash function is a function that takes an information of any size and makes them a fixed size, it is commonly utilizing to recognize the information. The attributes of hash function are:

- Easy to compute.
- Deterministic (similar information will bring a similar hash consistently).
- Irregular consistent (randomly), which means a small change in an information is essential to change the hash.

In Django when user register it take a activation key this is based on the base64 function that consider type of hash. Base64 is an algorithm that utilizing an idea of recent encryption algorithm [98]. At the point when a client signs up, the activation work process makes a new user instance to the account and sets the `is_active` field to `False`. It then managers (Superuser staff) can accept this client by make field `is_active` is `true` as seen in figure.3.14.

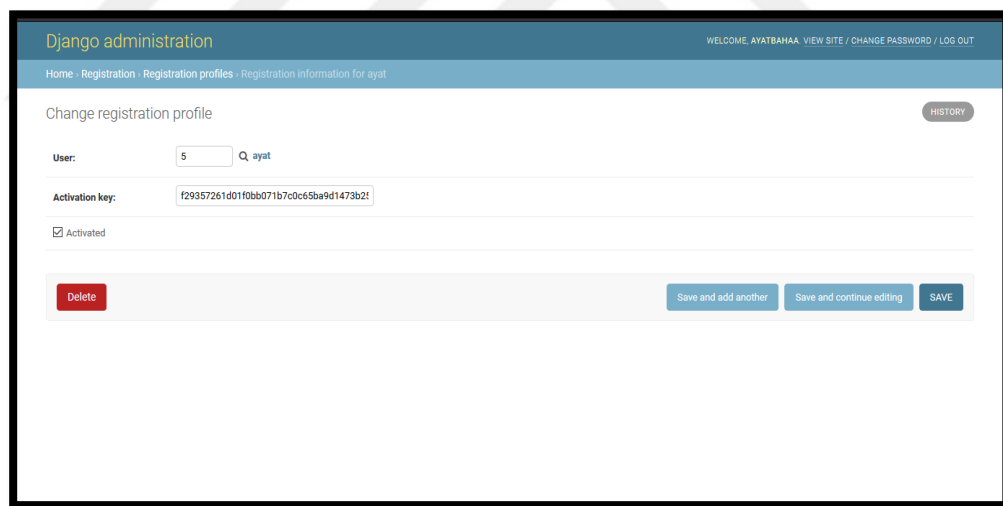


Figure 3.12 : Activation Key process

3.7.4 Server and client in progress

a) From the client side: In first step after turn on the system, users must enter data to system. This step can explain in number of stages:

1. Input supply chain process stage.

- It contain five stage (chain) every chain need to insert information about product.
- Only users that registers in the system and take permissions as Superuser or staff status can add information to this chain and only this users can see this stage. As can see in figure.3.14, figure.3.15.

ID	Serial Number	Vendor Name	Type Product	TimeStamp	Update
1	1457963452	ayat	seed	fasolya	April 25, 2020, 10:48 a.m.
2	15879624	ammer	seed	bakla	April 25, 2020, 12:50 p.m.
3	15879624	ammer	seed	bakla	April 25, 2020, 12:52 p.m.
4	17853	zain	seed	v	April 25, 2020, 12:52 p.m.
5	1487596533	ayat bahaa	seed	lentil	April 25, 2020, 1:21 p.m.
6	1475952487	tarek	seed	vegtibal	April 29, 2020, 1:34 p.m.

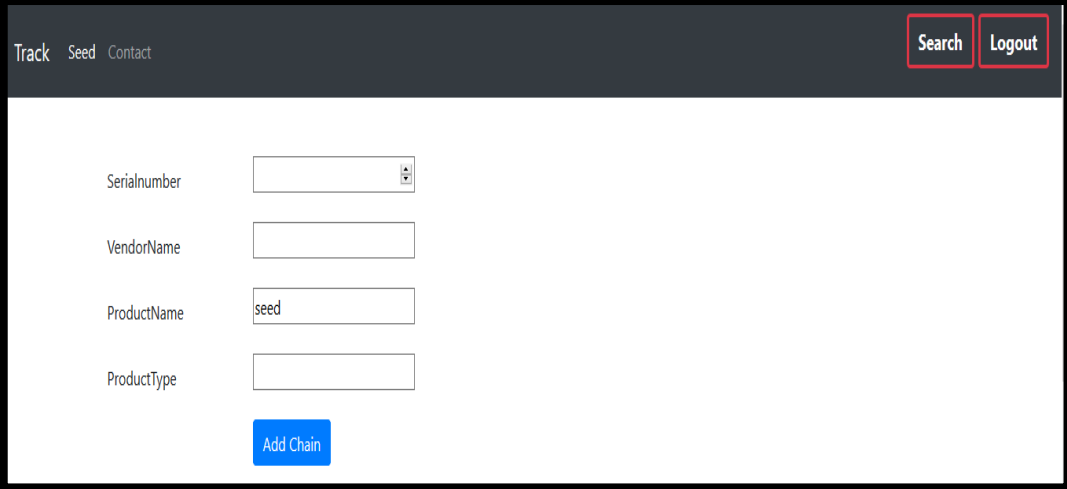
Figure 3.13 : Chains for product before register users

ID	Serial Number	Vendor Name	Type Product	TimeStamp	Update
1	1457963452	ayat	seed	fasolya	April 25, 2020, 10:48 a.m.
2	15879624	ammer	seed	bakla	April 25, 2020, 12:50 p.m.
3	15879624	ammer	seed	bakla	April 25, 2020, 12:52 p.m.
4	17853	zain	seed	v	April 25, 2020, 12:52 p.m.
5	1487596533	ayat bahaa	seed	lentil	April 25, 2020, 1:21 p.m.
6	1475952487	tarek	seed	vegtibal	April 29, 2020, 1:34 p.m.

Figure 3.14 : Chains for product after register users

2. Save information in blockchain

- After write information in the previous step, it necessary to save data in ledger to enable all world to see it.
- Each chain in the system contain some information about product need to filled by users, as presented in figures (3.16 – 3.20). The system consist of five chain, every chain contain some information, this can consider as stages for seed.



Track Seed Contact Search Logout

SerialNumber

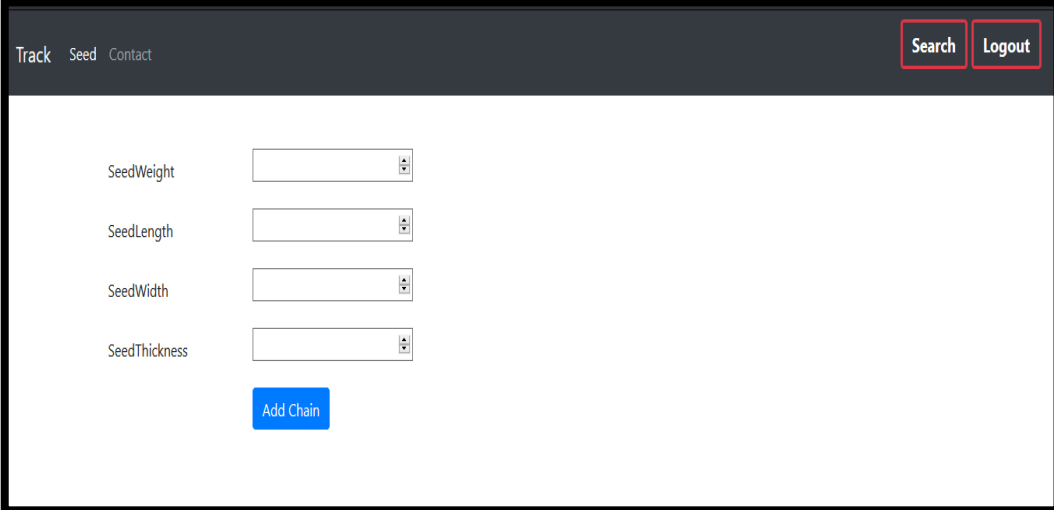
VendorName

ProductName seed

ProductType

Add Chain

Figure 3.15 : Information that needed product in chain1



Track Seed Contact Search Logout

SeedWeight

SeedLength

SeedWidth

SeedThickness

Add Chain

Figure 3.16 : Information the needed product in chain 2

Track Seed Contact Search Logout

SeedWeight

SeedLength

SeedWidth

SeedThickness

NumberofHarvest

Add Chain

Figure 3.17 : Information that needed product in chain3

Track Seed Contact Search Logout

PhysicalSize

UniformSize

FreeFormInsectdamage

FreeFormseedBorndiesase

GeneticPurity

Seedviability

SeedVigour

Add Chain

Figure 3.18 : Information that needed product in chain 4

Figure 3.19 : Information that needed product in chain 5

3. Searching a product depends on two methods:

- Enter serial number that inserted to the blockchain as seen in figure.3.21.
- After entered the serial number and click on search button, it will display information about product.
- Using the QR that can be found on the product label as seen in figure.3.21.
- When click on QR Search, the camera will turn on and read the QR sticker of a product.

ID	Vendor Name	Product Name	Type Product	TimeStamp	Update
1	ayat	seed	fasolya	April 25, 2020, 10:48 a.m.	April 25, 2020, 7:34 p.m.
2	ammer	seed	bakla	April 25, 2020, 12:50 p.m.	April 25, 2020, 7:34 p.m.
3	ammer	seed	bakla	April 25, 2020, 12:52 p.m.	April 25, 2020, 7:34 p.m.
4	zain	seed	v	April 25, 2020, 12:52 p.m.	April 25, 2020, 7:34 p.m.
5	ayat bahaa	seed	lentil	April 25, 2020, 1:21 p.m.	April 25, 2020, 7:34 p.m.
6	tarek	seed	vegtibal	April 29, 2020, 1:34 p.m.	April 29, 2020, 1:34 p.m.

Figure 3.20 : Ways for search

After select the way to search, if the product is registered, the basic information about this product will display if not it will display empty.

a) In server side :

1. Register users :

- To register user will click on the button on the home page as shown in figure.3.22

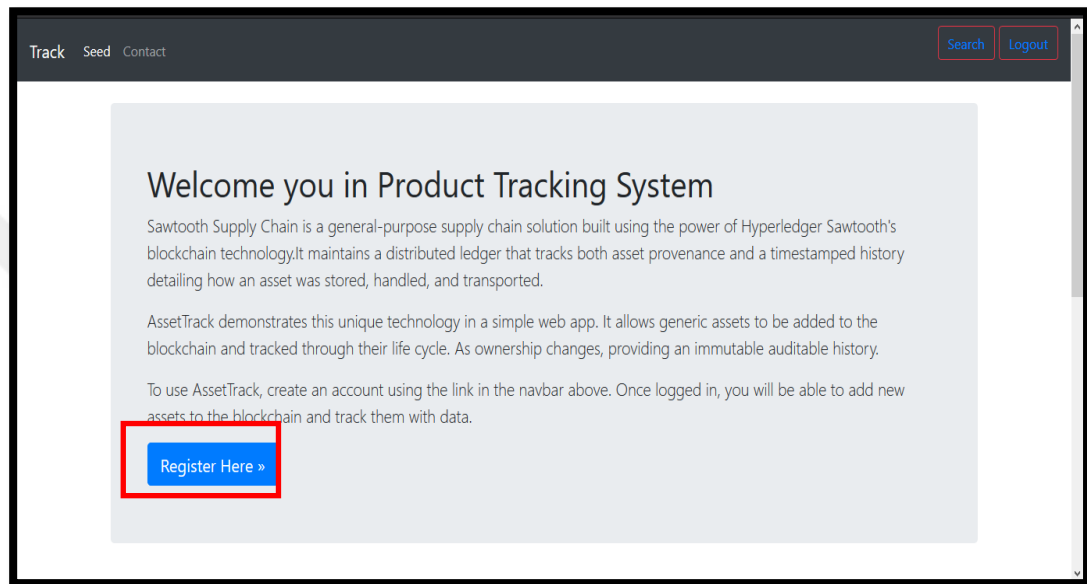


Figure 3.21 : Home page with Register Button

- When click on **Register Here**, This mean register a new user that the system will accepted by the manager to become a trusted user.
- The information that the system requested as shown in Figure.3.23.

Figure 3.22 : Register page

2. Django depends on a MVC (model-view-controller) pattern. So it is essential to create data models (or tables) along with view and controller. The advantage of MVC are:

- Numerous developers can work instantaneously on the model, controller and views.
- Logically MVC gathers the related actions on a controller as well as the views for a certain model which are grouped together.
- Models can have numerous views.
- After creating the data models, the changes need to be reflected in the database to do this run the following command:

```
python manage.py makemigrations
```

- If it didn't find any errors then, it creates a file in the migration folder. Later run the command given below to finally reflect the changes saved onto the migration file onto the database.

```
python manage.py migrate
```

- The user need to take consideration the validation process such as strong password, email, valid user name which will help to make system strongly and secretly.

3. When a user enters the data, the data will entered to server and needed to get permission from the managers to be accepted.

4. The data models and the Form class are created. In order to run the web application, it is essential to run the server as the follow :

- First, run on localhost through this command:

```
python manage.py runserver
```

- In the server, as mentioned previously Django framework is used as a server and as ledger. So every user when registered, the system will generate an activation key. Django framework contain algorithm to generate activation key for each user added to system as shown in figure.3.24

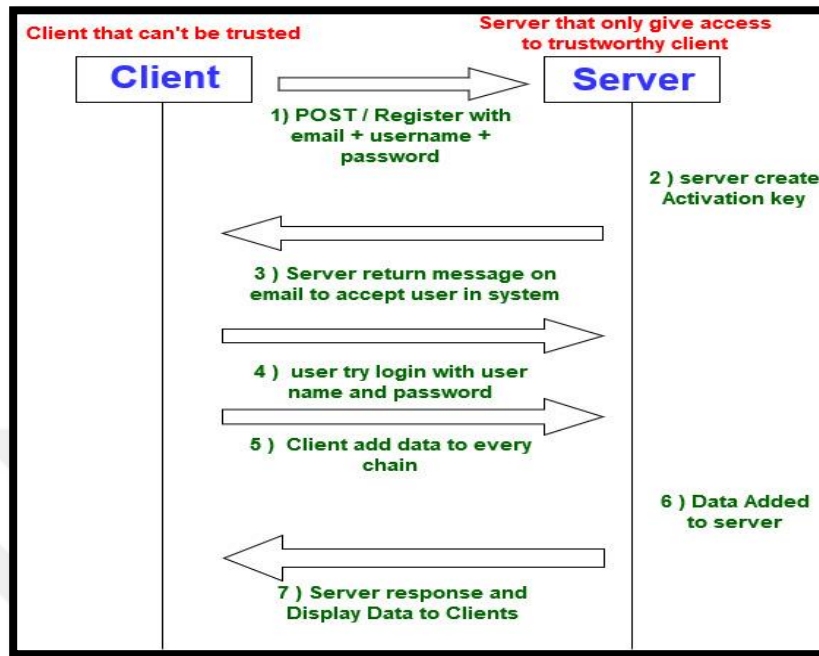


Figure 3.23 : client and server mechanism

3.7.5 Contact page

This page used when someone have a problem and want to contact a manager. The user can write what is the problem as a message along with the email and the user name to the manger email as shown in figure.3.25.

The screenshot shows a web interface for a "Contact Us" page. At the top, there is a navigation bar with links for "Track", "Seed", and "Contact". On the right side of the navigation bar, there are "Search" and "Logout" buttons. The main content area is titled "Contact Us" and contains a form with the following fields:

- Full Name: Enter Your name
- Email: Enter Your email
- Message: leave your message

A blue "Submit" button is located below the message field.

Figure 3.24 : Contact interface

Figure.3.26 explain how the message arrive to manager when a client click on the submit button.

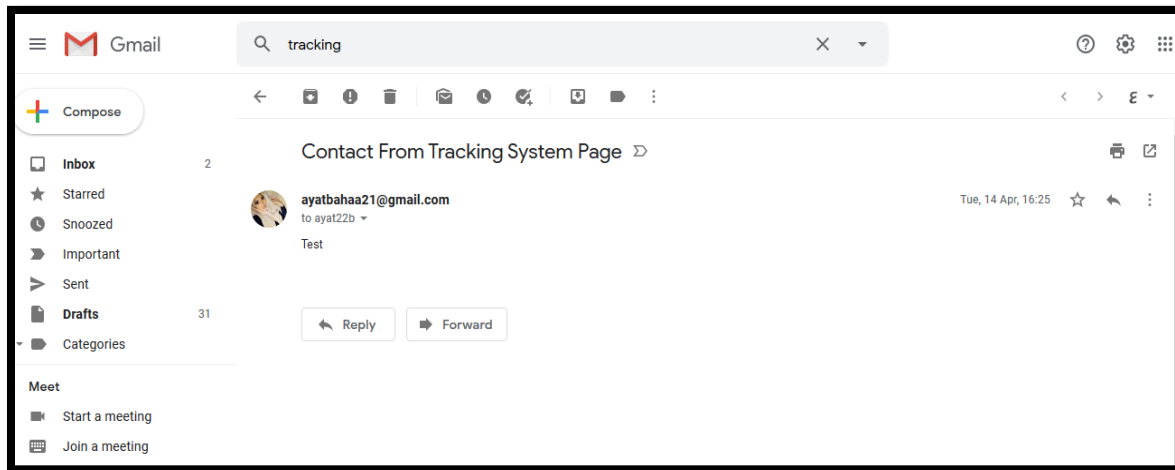


Figure 3.25 : Message from web page for contact form

3.7.6 Login

When the Login activity is called, it is checked that the client name and password are valid and the client can be signed in. After the client is signed in, the function adding chain is called, and the function logout will be called as shown in figure.3.27 and 3.28.

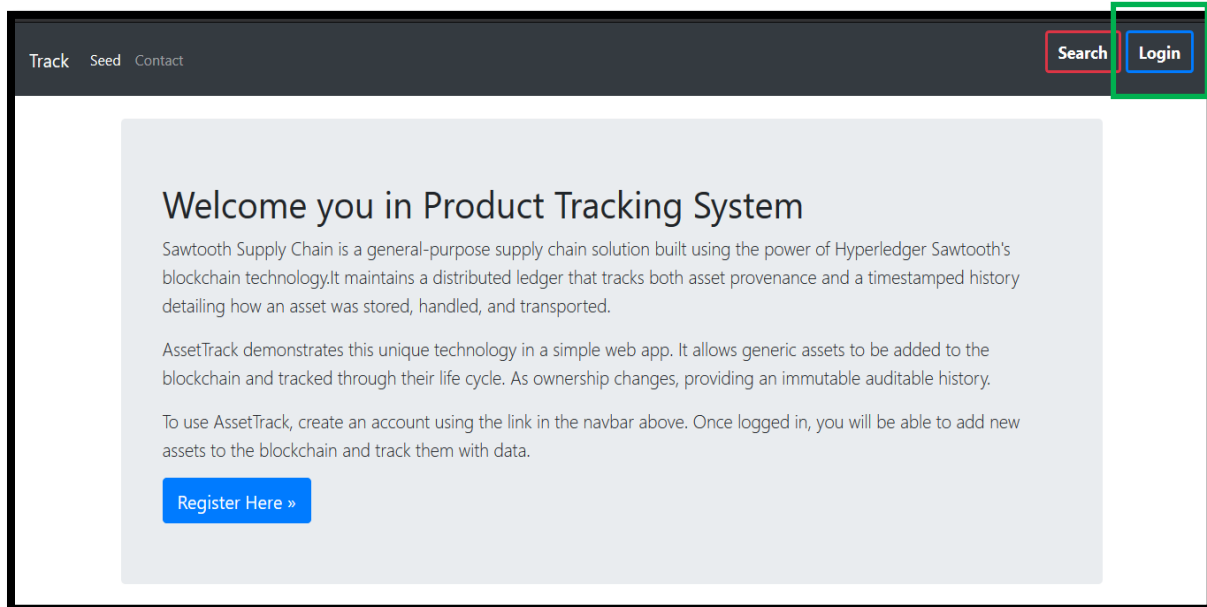


Figure 3.26 : login Button

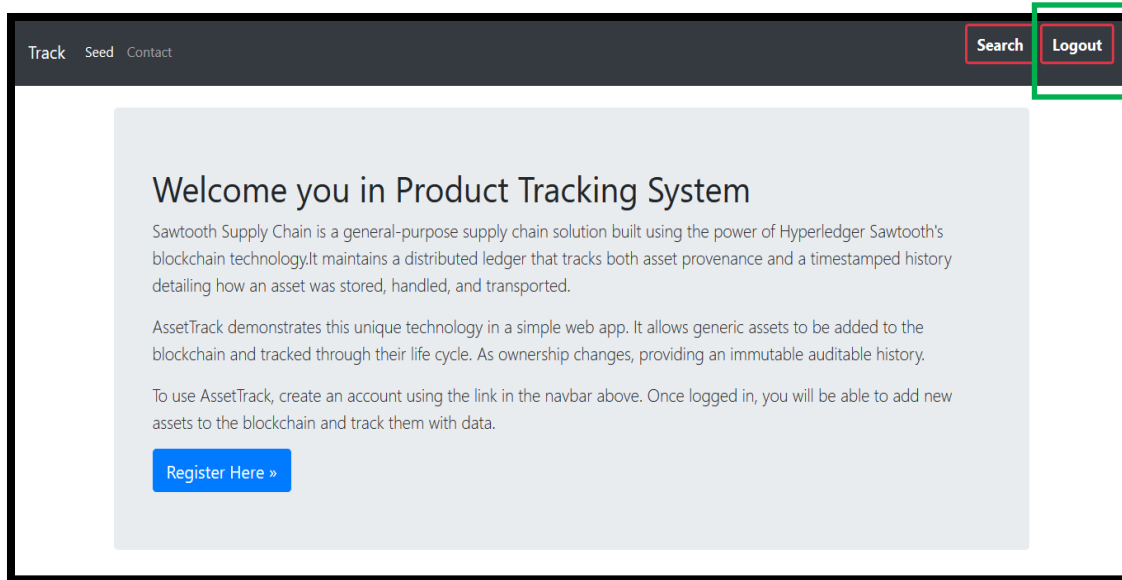


Figure 3.27 : Logout button

If it does not exist it will be directed through return function.

3.7.7 Restore page

If client forget password or user name the function reset is called, this done by click on reset as shown in figure.3.29.

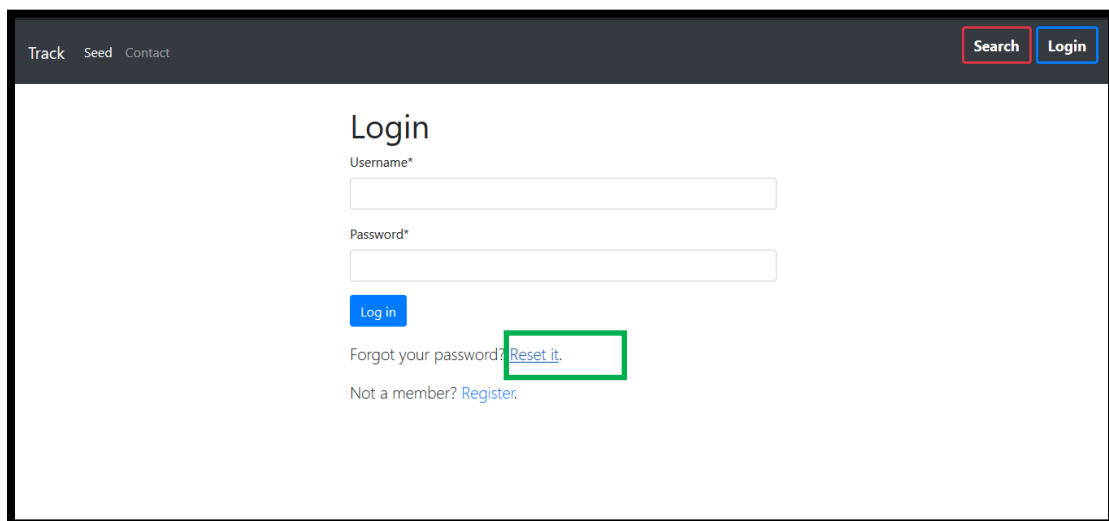
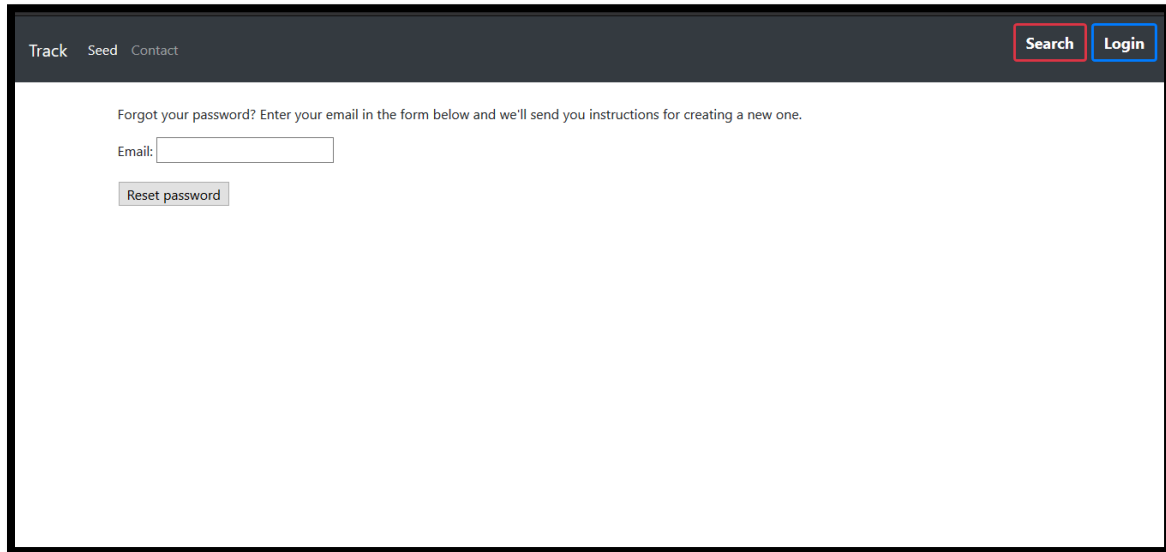


Figure 3.28 : Reset Button

By clicking on reset it, the redirection will be to the reset page as shown in figure.3.30. By entering email and hit the button “reset password”, it will send information for creating a new password.



Track Seed Contact

Search Login

Forgot your password? Enter your email in the form below and we'll send you instructions for creating a new one.

Email:

Reset password

Figure 3.29 : Reset page

4. TESTING & DISCUSSION

4.1 TESTING

The Test is a fundamental piece of programming improvement – it intends to discover imperfections of the application, watch that the application meets business prerequisites and can even in as a to discover new necessities. Whenever directed effectively, it is an integral asset which can be utilized to improve the application gigantically. In this part, testing of the application usefulness is depicted.

4.2 USABILITY TESTING

As the name recommends, the essential objective of ease of use testing is to improve the usability of the application. The premise is clear and direct – members who represent to expected clients of the product are picked and are allocated a series of the tasks which would be ordinarily executed in the application. Members are noticed while finishing the tasks and are gotten some information about their choices all through the process, recording everything any of them says. Next, the entirety of the notes are analyzed and utilized for making a list of issues which should be fixed and a list of necessities which may serve for actualizing new highlights later on.

4.2.1 Chosen tasks

The tasks are isolated into groups which relate with client jobs accessible in the application. The groups are rearranged from the least confined activities to the most limited – implying that the tasks recorded for the basic client are first and task for directors are recorded last. The explanation for this is direct – while the administration will be entrusted with all tasks clients and directors will be entrusted with (in light of the fact that executives will need to utilize the application for getting messages about their inclinations too), that isn't correct the opposite way around.

4.2.1.1 User

- Account management – registration.
- Interest area – showing the data for every chain for product.

- Contact message – leave a message for manager.

4.2.1.2 User Staff

- Account management – signing in, logging off, etc.
- Interest area – showing and adding data for every chain for product.
- Contact message – leave a message for manager.

4.2.1.3 Manager staff

- Account manager - grant permission for every user and control in the admin page, setting up user staff.
- General interest area management – listing, creating, deactivating, editing.
- Interest area – showing, adding, editing and delete data for every chain for product.
- Contact message - leave a message for manager.

Table 4-1: Permission of staff in system

Permission	Guest (user)	User staff	Manager staff
View Data	available	available	available
Add chain	unavailable	available	available
contact	available	available	available

Register	available	available	available
-----------------	-----------	-----------	-----------

4.3 EVALUATION

In this section, the final result of the development process in a type of screen captures appear, downsides of the application are referenced and comparing answers for them inspected and new technique proposed. The application is currently deployed to company testing server and accessible from the internet on <http://seedchain.com> and is already fully functional with all the functional requirements (as described in the Analysis chapter) met. Figures 4.1, 4.2 and 4.3 on next pages show screenshots of the currently deployed application.



Figure 4.1 : Home page

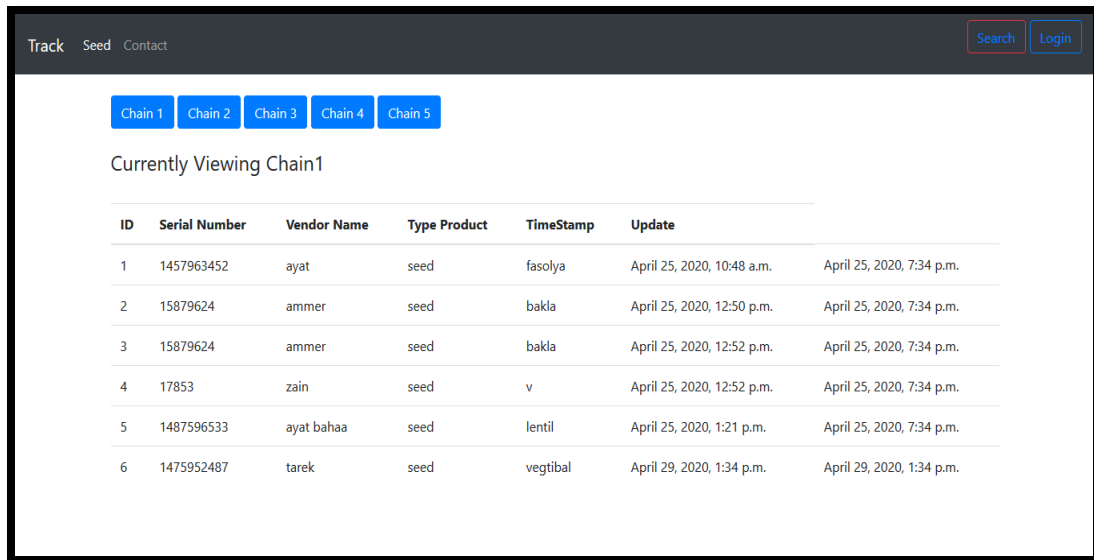


Figure 4.2 : Showing Data

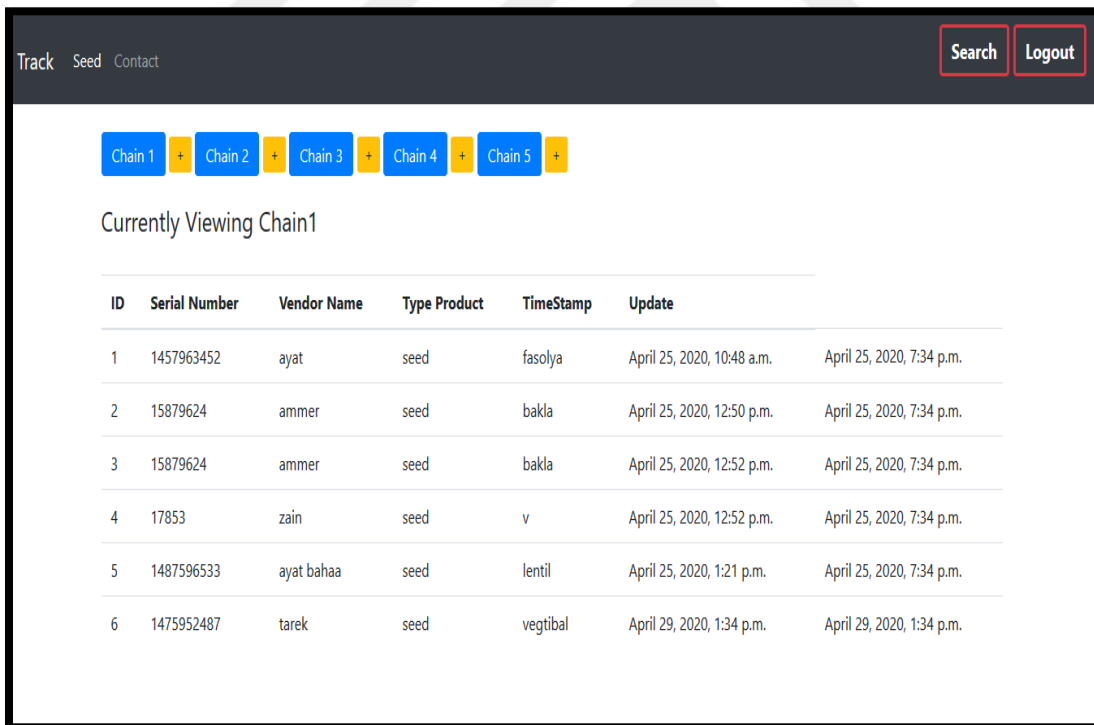


Figure 4.3 : Adding Data for every chain

Track
Seed
Contact
Search
Logout

Searching About Product

QR
Search
Search

ID	Vendor Name	Product Name	Type Product	TimeStamp	Update
1	ayat	seed	fasolya	April 25, 2020, 10:48 a.m.	April 25, 2020, 7:34 p.m.
2	ammer	seed	bakla	April 25, 2020, 12:50 p.m.	April 25, 2020, 7:34 p.m.
3	ammer	seed	bakla	April 25, 2020, 12:52 p.m.	April 25, 2020, 7:34 p.m.
4	zain	seed	v	April 25, 2020, 12:52 p.m.	April 25, 2020, 7:34 p.m.
5	ayat bahaa	seed	lentil	April 25, 2020, 1:21 p.m.	April 25, 2020, 7:34 p.m.
6	tarek	seed	vegtibal	April 29, 2020, 1:34 p.m.	April 29, 2020, 1:34 p.m.

Figure 4.4: SearchPage

Register Now

Username*

Required. 150 characters or fewer. Letters, digits and @/./+/-/_ only.

E-mail*

Password*

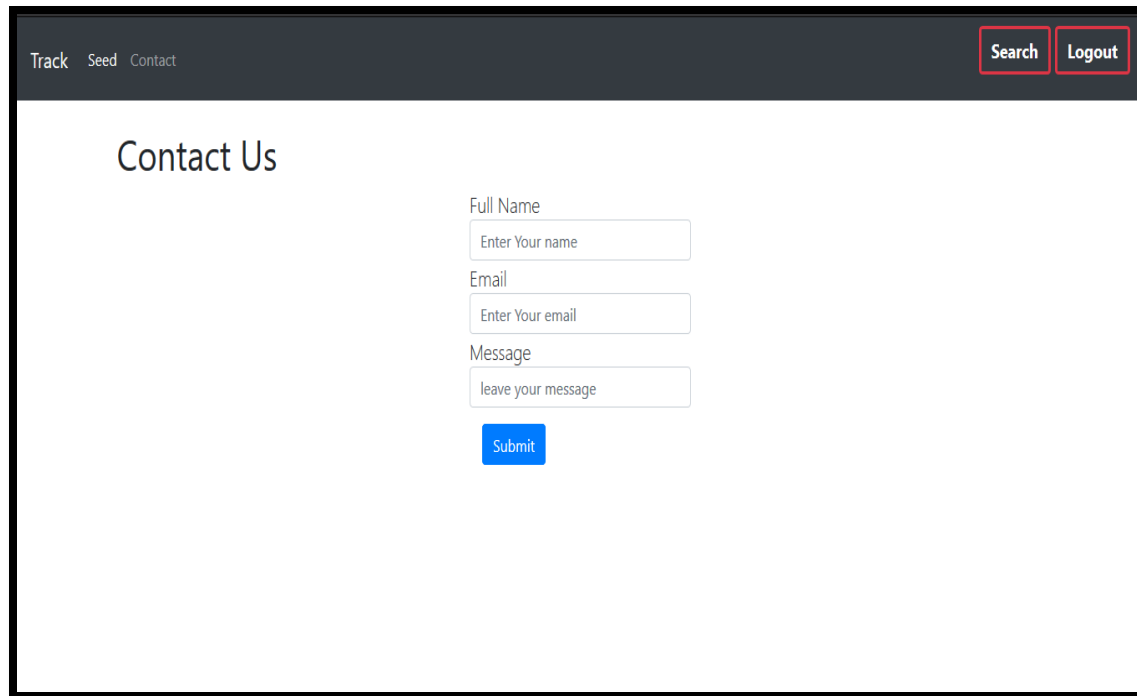
- Your password can't be too similar to your other personal information.
- Your password must contain at least 8 characters.
- Your password can't be a commonly used password.
- Your password can't be entirely numeric.

Password confirmation*

Enter the same password as before, for verification.

Submit

Figure 4.5 : RegisterPage



Track Seed Contact

Search Logout

Contact Us

Full Name
Enter Your name

Email
Enter Your email

Message
leave your message

Submit

Figure 4.6 : Contact Page

Despite of the application being already deployed and completely utilitarian, there is still a ton of work to be finished. This comprises of fixing the issues found while directing client testing, discovering solution downsides of the application and proposing new usefulness.

Figure 4.1 illustrates the web application, starting at the Home page, users immediately facing button for registering in the web application which can interact and discover pages. After clicking on a Register here a Register page pops up with fields that must be filled by users and after filling the field must click on the button called Submit to send data to save in register ledger.

After the user took permission from manger web, he can log.in to the application , If client has already logged to the application, then a click to log out will appear. If the logged-in user by clicks the button he or she will be taken to a page that can add information form to add real data about seed just from a trusted user.

Based on the login status of the ckient , the seed page in the application will change from having button adding information or not found. The Home page, and the Login page, the seed page and

search page, the contact page, the and the Logout page. The Contact page (Figure 2:8) has fielded that if the user wants to leave command about the project or leave command to the managers to ask about something.

As mention previous, the web application has been based on a reacting format, thus it very well may be seen on both conventional and portable screens with the same use. Therefore, the site is comparatively directly, simple utilizing similar colour and Times New Roman font is used so as to supply design continuity anywhere the site. Arial is utilized for the content and other littler estimated text. Each page depends on a comparative layout which has at its base top route bar and a basic footer. The substance between those two components changes relying upon the page.

4.4 DISCUSSION

This section is shown the pros and cons of the web application. This discussion will demonstrate the whole stages that lead to find the strengths and shortcomings points by assessment the web application.

4.4.1 Application Strengths

The evaluation offer that the application satisfied the base prerequisites that were resolved. This part will additionally plot the web application strengths, and furthermore, talk about the strengths of the subsequent web application model.

In this manner, the web application's strengths are:

- (1) Adding real data about the seeds by only a trusted person which have got a permission from the ministry and has a knowledge about them.
- (2) Inviting people across the world to add their real data which they have the accepting letter signed from the ministry of their country in order to get involved and contribute in the system.
- (3) The application is easy to use and friendly which can be accessed using any computer or device that has an internet access.
- (4) The system can be access all over the world

As mention, part of the purpose of this thesis is to build up the web application in such a way that it can be served as a web application model for other people. Considering, the web application model's qualities are:

- (1) It doesn't need advanced information base administration setup and maintenance abilities;
- (2) The code is open source and can see it by using PyCharm, the code can be modified and stretched out to all the more likely suit a venture's prerequisites;
- (3) The application's apparatuses are free and reasonable compared to setting up similar services hosted on one's own servers.

4.4.2 Application Weaknesses

The web application shortcomings originate from the execution of a portion of its advantages. For instance, theoretically, anybody access the application, one significant obstacle to overcome is the local language. The official language in Iraq is Arabic, and keeping in mind that English is getting more mainstream as a second language for the more youthful age, most of the public communities in Arabic. Therefore, the web application is adequately unavailable to a large portion of the local network, a considerable lot of whom may have pertinent data to contribute. Thus, translation of the web application into Arabic is included for the applications for future recommendation.

The application currently limits the ability of adding profile photo, which would facilitate the authorization of user. In this manner the gather data will be limited.

Likewise, with respect to recording extra data, the application doesn't have an approach to record a user's area on the guide utilizing versatile tracking or geolocation. The application is not responsive and thusly, is streamlined to be perceptible on a tablet or cell phone.

On the Superuser staff side, the application interface exists to manage, vet, and control commitments to the fundamental record. At present, the head should play out that examination through a correlation of the record. This doesn't consider the veracity or precision of the commitments, and maybe an open reviewing process is.

Concerning utilizing the web application as an advancement model for comparative undertakings, aside from the as of now referenced shortcoming of the application itself, execution will involve some specialized aptitude and programming experience, regardless of whole try to make the application as simple to actualize as could reasonably be expected, with the utilization of a few diverse easy to use web administrations. So as to balance this, the storehouse won't be made open until great documentation for the establishment and use is incorporated.

During the development process, it turned out to be evident that there were a few highlights that would enhance the web application in spite of they aren't being inside the extent of the underlying prerequisites or maybe being excessively troublesome at this phase to program or actualize. These, alongside different activities, have been remembered for the web application's guide for future development, which has been arranged by level of significance as see in Table 1

Table 4-2 : Roadmap of Web Application

Feature or Activity of the future web application	Importance	Notes
Translating into Arabic	High	This would extend the conceivable patron pool for the project zone.
The ability of adding new records	High	This would permit contributors the capacity to include records from outside the pilot overview region.
Refine navigation	Low	When the site has more records and data, this would assist clients with finding what they are searching for.
Integrated interface to manage	Medium	This would give the application administrator and/or users the ability to monitor the contributions and push changes to the main

		record.
Ability to upload images for users register	High	This would enable clients to incorporate a picture with a commitment without facilitating the picture on the web.
Add geo tracking ability to map	High	This would enable clients to see and record their genuine area corresponding to the structure records while seeing as well as a commitment to the application.

The significance of every item on the roadmap is dictated by taking the thing's capacity to enhance the project as the simplicity of execution and amount of exertion. For instance, the capacity to include new records is an element that doesn't as of now exist for contributors and would extend the measure of information gathered Whereas, refining the route just hardly improves the client's understanding and may require a considerable amount of programming to execute.

4.5 CHALLENGE WITH AWS

We try to using the AWS service to execute this project but we have some problem that will explain it now.

Amazon site and shortcut to Amazon Web Services provides many services, including service for blockchain managed that it managed blockchain, which is a fully managed through the amazon site in order to create and manage blockchain networks using its open source frameworks. Currently, the framework supported on the Amazon platform is of the type Hyperledger Fabric open-source framework. Blockchain allows building applications where multiple parties can operate transactions safely and transparently and share data without the need for a reliable central authority. Anyone can use this service to create a fast and efficient blockchain network in three ways:

1- Via AWS Managed console

2- Via AWS CLI

3- Via AWS Managed Blockchain SDK

Blockchain works to meet the requirements of millions of transactions that belongs to thousands of applications.

After turning on the blockchain network, it also works managed blockchain to simplify network management task.

Role managed blockchain: Manages your certificates, allows you to easily create a proposal and vote on it through network members and tracks operating metrics such as computing, storage and memory resources. The problem with hyperledger fabric is so expensive , the time for free is 720 hours just and need to make this service working along time and the billing it shock !! 1340 \$ as see in figure4.7.

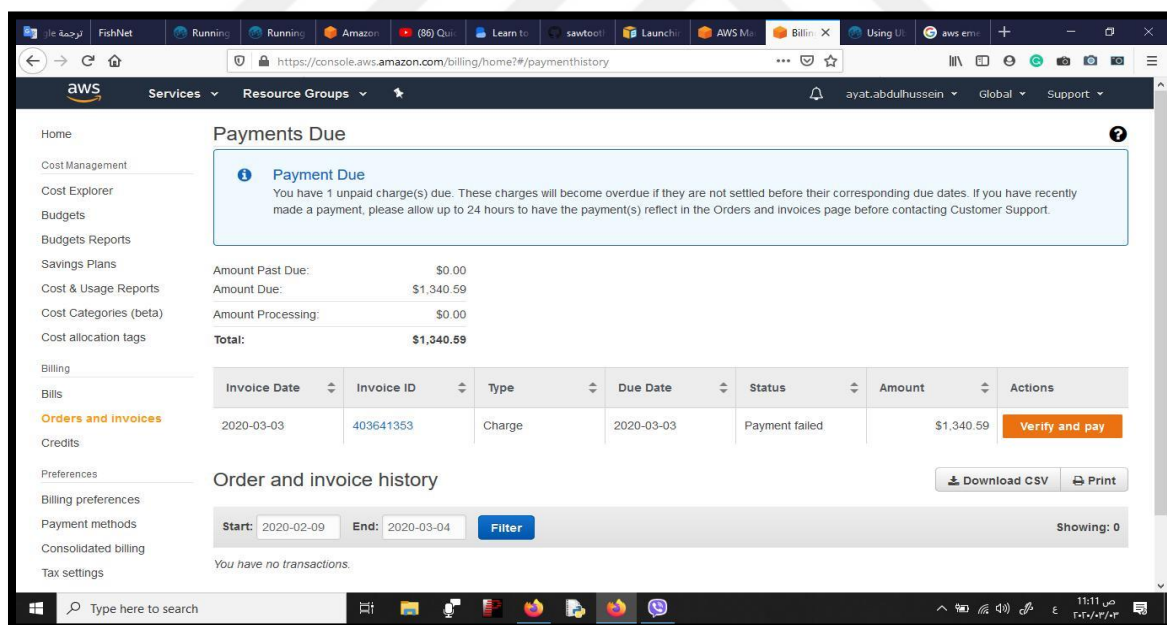


Figure 4.7 : First bill from AWS

and every month I recived bill with 300\$ fee And I meet many problem with command that I follow it from AWS documantation. For that I go to use sawtooth hyperledger and I used same steps but I found also it expensive and not free for that I building this project by using programming language.some screenshot from AWS blockchain.

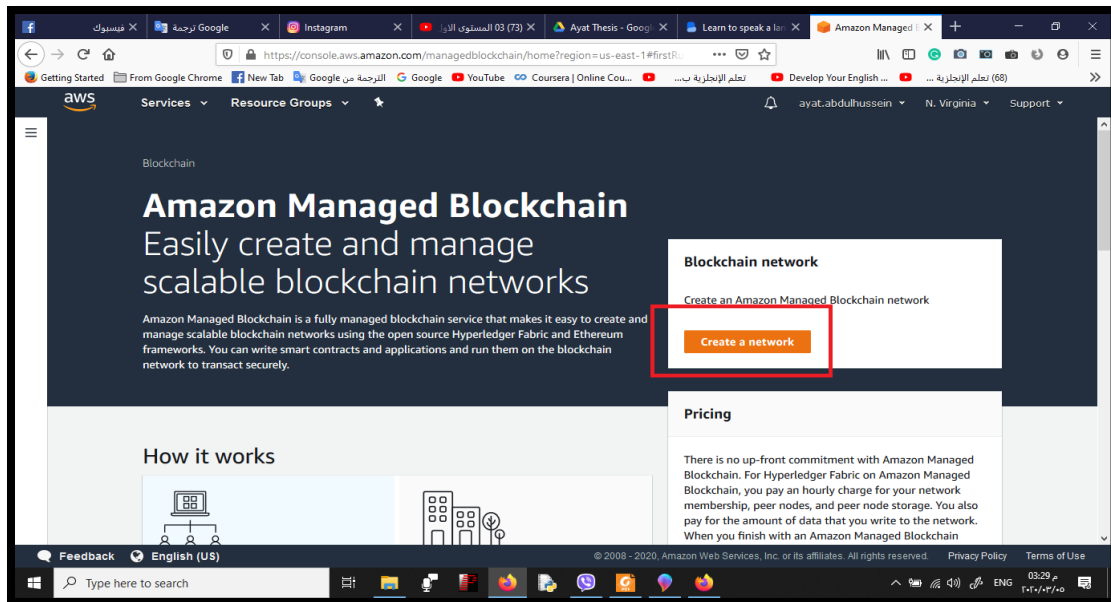


Figure 4.8 : Home page for AWS Blockchain

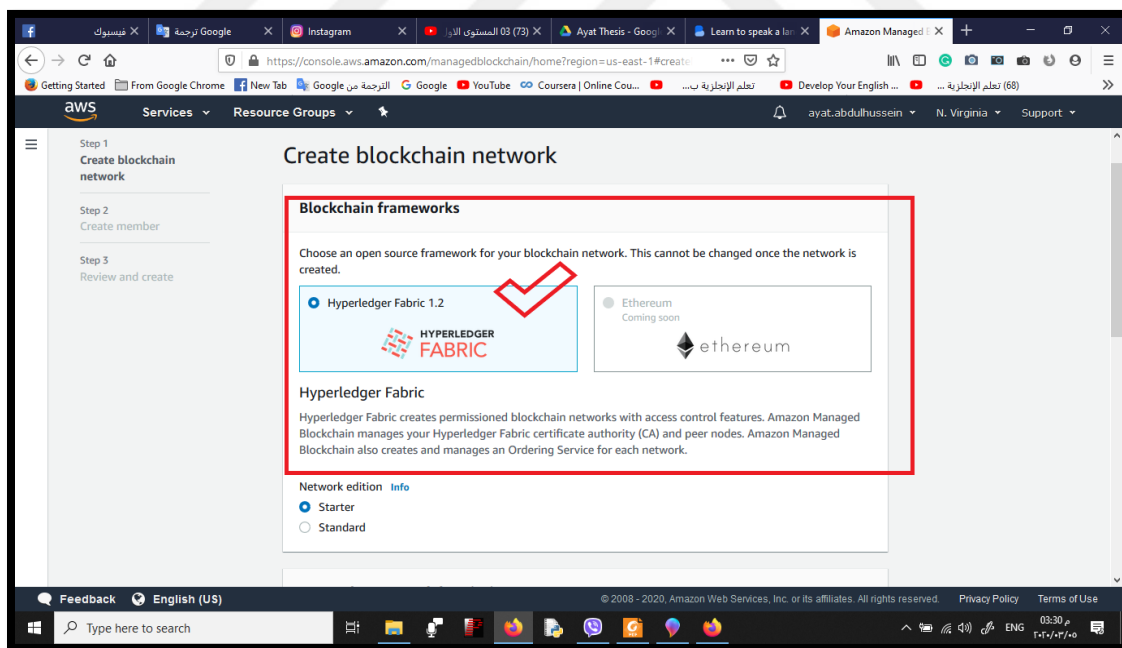


Figure 4.9 : Selecting Fabric Hyperledger

The screenshot shows a web browser window with the URL `ec2-3-95-200-106.compute-1.amazonaws.com/asset/#/assets`. The page title is "AssetTrack" and it includes navigation links for "Add Asset", "View Assets", and "View Agents". A "Profile" dropdown menu is visible in the top right corner, containing a "Logout" button.

Below the navigation bar, there are tabs for "All", "Owned", "Custodian", and "Reporting". The "All" tab is selected. The main content area displays a table with the following columns: "Serial Number", "Type", "Added", "Updated", and "Updates".

Serial Number	Type	Added	Updated	Updates
1410110009	seed	03/11/2020, 11:41:39 pm	03/11/2020, 11:41:39 pm	4
1410110285	seed	03/11/2020, 11:40:46 pm	03/11/2020, 11:40:46 pm	4
1410110371	seed	03/11/2020, 11:40:03 pm	03/11/2020, 11:40:03 pm	4
1410110047	seed	03/11/2020, 11:39:11 pm	03/11/2020, 11:39:11 pm	4
1410110105	seed	03/11/2020, 11:38:27 pm	03/11/2020, 11:38:27 pm	4
1310110107	seed	03/11/2020, 11:37:09 pm	03/11/2020, 11:37:09 pm	4
1310110301	seed	03/11/2020, 11:36:22 pm	03/11/2020, 11:36:22 pm	4
1410110359	seed	03/11/2020, 11:35:26 pm	03/11/2020, 11:35:26 pm	4
1310110129	seed	03/11/2020, 11:34:32 pm	03/11/2020, 11:34:32 pm	4
1410110089	seed	03/11/2020, 11:33:47 pm	03/11/2020, 11:33:47 pm	4
1310110316	seed	03/11/2020, 11:31:36 pm	03/11/2020, 11:31:36 pm	4
1410110369	seed	03/11/2020, 11:30:14 pm	03/11/2020, 11:30:14 pm	4
1410110452	seed	03/11/2020, 11:29:21 pm	03/11/2020, 11:29:21 pm	4

An "Activate Windows" watermark is visible in the bottom right corner of the application area, with the text "Go to Settings to activate Windows."

The Windows taskbar at the bottom shows the search bar, task view button, and several pinned application icons (Edge, File Explorer, Mail, Store, Chrome, etc.). The system clock indicates the time is 2:07 PM on 3/12/2020.

Figure 4.10 : Sawtooth Hyperledger home page

5. CONCLUSION AND FUTURE WORK

5.1 CONCLUSION

In this work, a blockchain and supply chain technologies introduced that integrated with web application, which is used to solve some of the problems that appear in a management system of product that can illustrate in a first problem is lack of knowledge around a source of products, especially seed item in this research. In this problem it is inability to track the item to save health safety. It leads to damage the item fully in the case of injury part of it. Also, minimize or eliminate of fraud where an only trusted person from the ministry will use this application and all information will be checked from truth that entered to the system. Data save using blockchain technology this is helping to protect data from hacking, as well as the data in blockchain save on all computers that participated in the system, so if any hacker wants to crash the system, the hacker must hacking all the computers in the series of blockchain computers. Whenever the serious hacker and longer make it harder to crash. Blockchain technology able to adapt to build advanced economy using in digital trade. The system proposed with technologies that utilizing (blockchain and supply chain) provide solution to issue of food quality and safety which are take a highly place by consumers and government.

5.2 FUTURE WORK

As a future work, the researchers can using sensor in the stage of cultivation, when cultivation the seed can put sensor to calculate the size of the seed in this stage, this **information** will saved as data sending to blockchain but not publishing for each participate before take permission from member of ministry in the system.

REFERENCES

- [1] Jedsada Tipmontian , Jaime Castellanos Alcover and M. Rajmohan, "Impact of Blockchain Adoption for Safe Food Supply Chain Management through System Dynamics Approach from Management Perspectives in Thailand," *MDPI*, p. 5, 2020.
- [2] Stanley Lutts, Paolo Benincasa, Lukasz Wojtyla, Szymon Kubala S, Roberta Pace, Katzarina Lechowska, Muriel Quinet and Garnzczarska, "Seed Priming: New Comprehensive Approaches for an Old Empirical Technique," *INTECH*, p. 47, 2016.
- [3] Hang Xiong , Tobias Dalhaus , Puqing Wang , Jiajin Huang, "Blockchain Technology for Agriculture: Application and Rational," *Frontiers in Blockchain*, p. 7, 2020.
- [4] Guoqing Zhaoa, Shaofeng Liu ,Carmen Lopez ,Haiyan Lu, Sebastian Elgueta ,Huilan Chena , Biljana Mileva Boshkoska, "Blockchain technology in agri food value chain management A synthesis of applications challenges and future research directions," *Elsevier*, p. 17, 2019.
- [5] Riham AlTawy and Guang Gong, "A Supply Chain Solution with Locally Private Blockchain Transactions," in *Proceedings on Privacy Enhancing Technologies*, sciendo, 2019, p. 21.
- [6] K.Stevens, Shawn, "Tracing the Food Safety Laws and Regulations Governing Traceability: A Brief History of Food Safety and Traceability Regulation," *Food Traceability, Food Microbiology and Food Safety*, p. 14, 2019.
- [7] Elise Golan, Barry Krissoff, Fred Kuchler, Linda Calvin, Kenneth Nelson, and Gregory Price, "Traceability in the U.S. Food Supply: Economic Theory and Industry Studies," *USDA/Economic Research Service*, p. 56, 2018.
- [8] Jennifer McEntire and Andrew W. Kennedy, *Food Traceability From Binders to Blockchain*, Griffin, GA, USA: Food Microbiology and Food Safety Springer Nature Switzerland, 2019.

- [9] Petter Olsena and Melania Borit, "How to define traceability," *Trends in Food Science & Technology*, p. 9, 2013.
- [10] John Guzewich and Benjamin Miller, "Public Health," *Springer Nature Switzerland*, p. 23, 2019.
- [11] Rome, "CODEX ALIMENTARIUS COMMISSION," Joint FAO/WHO Food Standards Programme, US, 2013.
- [12] Philip G.Crandall, Corliss A. O'Bryan, "GLOBAL FOOD SAFETY INITIATIVE: IMPLEMENTATION AND PERSPECTIVES," *Elsevier*, p. 6, 2015.
- [13] Philip Boucher, Susana Nascimento and Mihalis Kritikos, "How blockchain technology could change our lives," *STOA -Science and Technology Options Assessment. Brussels:European Parliamentary Search Service*, p. 28, 2017.
- [14] Jennifer McEntire and Tejas Bhatt, "Pilot Projects for Improving Product Tracing along the Food Supply System Final Report," Institute of Food Technologists, Chicago, 2012.
- [15] M. Southall, "Industry Benefits," *Springer Nature Switzerland*, p. 12, 2019.
- [16] Orzechowski and Edward, "The Traceability of Bulk Food Products," *Springer Nature Switzerland*, p. 7, 2019.
- [17] Marie-Alice Fraiture, Philippe Herman, MarcDeLoose, Frédéric Debode and Nancy H.Roosens, "How Can We Better Detect Unauthorized GMOs in Food and Feed Chains?," *trends in Biotechnology*, p. 10, 2017.
- [18] Barbara Blakistone and Steven Mavity, "Seafood," *Springer Nature Switzerland AG*, p. 15, 2019.
- [19] J. McEntire, "Pilot Projects for Improving Product Tracing along the Food Supply System – Final Report," Institute of Food Technologists, Chicago, 2012.

- [20] Reshma Kamath, "Food Traceability on Blockchain: Walmart's Pork and Mango Pilots with IBM," *The Journal of The British Blockchain Association*, p. 12, 2018.
- [21] Dole, Driscoll's, Golden State Foods, Kroger, McCormick and Company, McLane Company, Nestlé, Tyson Foods, Unilever and Walmart , "CISION," IBM, 22 Aug 2017. [Online]. Available: <https://www.prnewswire.com/news-releases/ibm-announces-major-blockchain-collaboration-with-dole-driscolls-golden-state-foods-kroger-mccormick-and-company-mclane-company-nestle-tyson-foods-unilever-and-walmart-to-address-food-safety-worldwide-300507604.htm>.
- [22] J. Cuomo, Interviewee, *IBM's Vice President of Blockchain Technologies*. [Interview]. 7 jan 2018.
- [23] J. Andrews, Interviewee, *Frank Yiannas, Vice President of Food Safety for Walmart*. [Interview]. 4 Aug 2015.
- [24] Hodge Stuart, "Can blockchain technology transform safety standards in the global food supply chain?," 25 Aug 2017. [Online]. Available: <https://www.supplychaindigital.com/technology/can-blockchain-technology-transform-safety-standards-global-food-supply-chain>.
- [25] Steve Clemons, "China's Latest Food Scandal: Fox-Tainted Donkey Meat," *The Atlantic*, 2014.
- [26] C. Hatton, "BBC News," 30 September 2015. [Online]. Available: <https://www.bbc.com/news/blogs-china-blog-34398412>.
- [27] F. Gale, "China's Pork Imports Rise Along with Production Costs," *Economic Research Services*, US, 2017.
- [28] T. Tiwari, "Profit alert: Walmart is adopting the blockchain right now," *Palm Beach Research Group*, 6 Dec 2016. [Online]. Available: <https://www.palmbeachgroup.com/palm-beach-daily/profit-alert-walmart-is-adopting-the-blockchain-right-now/>.

- [29] E. Lai, "Hyperledger–open source blockchain for business – IBM Blockchain," IBM, [Online]. Available: <https://www.ibm.com/blockchain/hyperledger>.
- [30] Yan Yuan, Xinliang Liu, Kunming Hong, Shaoyi Song and Wanlin Gao, "Trustworthy Traceability of Quality and Safety for Pig Supply Chain Based on blockchain," *springer Nature Switzerland AG*, p. 13, 2020.
- [31] D. Galvin, "IBM and Walmart: Blockchain for Food Safety," IBM Corporation, 2017.
- [32] Alfonso Panarello , Nachiket Tapas, Giovanni Merlino, Francesco Longo and Antonio Puliafito, "Blockchain and IoT Integration: A Systematic Survey," *MDPI*, p. 37, 2018.
- [33] ABEYRATNE, S.A. and MONFARED, R.P, "Blockchain ready manufacturing supply chain using distributed ledger," *SAT*, p. 11, 2016.
- [34] F. Tian, "An agri-food supply chain traceability system for China based on RFID & blockchain technology," *IEEE*, p. 6, 2016.
- [35] Daniel Conte de Leon, Antonius Q. Stalick and Ananth A. Jillepalli, "Blockchain: properties and misconceptions," *Asia Pacific Journal of Innovation and Entrepreneurship*, vol. 11, p. 15, 2017.
- [36] S. Norton, "CIO explainer: what is blockchain?," The Wall Street Journal Blog, 2 feb 2016. [Online]. Available: <https://blogs.wsj.com/cio/2016/02/02/cio-explainer-what-is-blockchain/>.
- [37] Norul Suhaliana bt Abd Halim, Md Arafatur Rahman ,Saiful Azad and Muhammad Nomani Kabir, "Blockchain Security Hole: Issues and Solutions," *Springer International Publishing AG*, p. 8, 2018.
- [38] S. Ø. a. A. Jansen, "Blockchain Technology as s Support Infrastructurein e-Government," *IFIP International Federation for Information Processing*, p. 13, 2017.
- [39] Luciano Garcíia-Banuelos , Alexander Ponomarev, Marlon Dumas and Ingo Weber,

- "Optimized Execution of Business Processes on Blockchain," *Springer International Publishing AG*, p. 17, 2017.
- [40] Laurent Probst, Laurent Frideres, Benoît Cambier, Christian Martinez-Diaz, PwC Luxembourg, "Blockchain applications & services," European Union, 2016.
- [41] M. Gupta, *Blockchain For Dummies 3rd IBM Limited Edition*, America: John Wiley & Sons, Inc., 2020.
- [42] Marco Iansiti and Karim R. Lakhani, "The truth about blockchain," *HARVARD BUSINESS REVIEW*, p. 11, 2017.
- [43] Hang Xiong , Tobias Dalhaus , Puqing Wang , Jiajin Huang, "Blockchain Technology for Agriculture: Application and Rational," *Frontiers in Blockchain*, p. 7, 2020.
- [44] Sylvester, Gerard, *E-agriculture in Action: Blockchain for Agriculture*, Bangkok: the food and agriculture organization of the united nations and the international telecommunication union, 2019.
- [45] Lan Ge, Christopher Brewster, Jacco Spek, Anton Smeenk, and Jan Top, "Blockchain for Agriculture and Food Findings from the pilot study," *Wageningen Economic Research and TNO*, p. 40, 2017.
- [46] Jennifer McEntire , Andrew W. Kennedy, "Food traceability from binders to blockchain," *Springer Nature Switzerland*, p. 203, 2019.
- [47] Kamath and Reshma, "Food Traceability on Blockchain:Walmart's Pork and Mango Pilots with IBM," *The JBBA*, vol. 1, no. 1, p. 7, 2018.
- [48] Matteo Montecchi , Kirk Plangger, Michael Etter, "It's real, trust me! Establishing supply chain provenance using blockchain," *Elsevier Inc*, p. 11, 2019.
- [49] Michael Crosby, Nachiappan , Pradan Pattanayak , Sanjeev Verma and Vignesh Kalyanaraman , "blockchain technology : beyond bitcoin," *Applied Innovation Review*, no.

2, p. 16, 2016.

- [50] S. Kansal, "Develop a blockchain application from scratch in Python," IBM Develop, 29 January 2020. [Online]. Available: <https://developer.ibm.com/technologies/blockchain/tutorials/develop-a-blockchain-application-from-scratch-in-python/>.
- [51] Hany F. Atlam, Ahmed Alenezi, Madini O. Alassafi, Gary B. Wills, "Blockchain with Internet of Things: Benefits, Challenges, and Future Directions," *International Journal of Intelligent Systems and Applications*, p. 10, 2018.
- [52] W. Fauvel, blockchain Advantage and Disadvantages, 11 Aug 2017. [Online]. Available: <https://medium.com/nudjed/blockchain-advantage-and-disadvantages-e76dfde3bbc0>.
- [53] Arshdeep Bahga, Vijay Madisetti, Internet of Things: A Hands-On Approach, Atlanta: Arshdeep Bahga, Vijay Madisetti, 2014.
- [54] Ankit Songara and Lokesh Chouhan, "Blockchain: A Decentralized Technique for Securing Internet of Things," *Conference on Emerging Trends*, p. 4, 2017.
- [55] Julija Golosova and Andrejs Romanovs, "The Advantages and Disadvantages of the Blockchain Technology," *IEEE*, p. 6, 2018.
- [56] D. Team, "Advantages and Disadvantages Of Blockchain Technology," Data flair, 14 sep 2018. [Online]. Available: <https://data-flair.training/blogs/advantages-and-disadvantages-of-blockchain/>.
- [57] John Light, "The differences between a hard fork, a soft fork, and a chain split, and what they mean for the future of bitcoin," 25, Sep 2017. [Online]. Available: <https://medium.com/@lightcoin/the-differences-between-a-hard-fork-a-soft-fork-and-a-chain-split-and-what-they-mean-for-the-769273f358c9>.
- [58] N. Reiff, "Blockchain explained," Investopedia, 1 feb 2020. [Online]. Available: <https://www.investopedia.com/terms/b/blockchain.asp#how-blockchain-works>.

- [59] Zibin Zheng, Shaoan Xie, Hongning Dai, Xiangping Chen, and Huaimin Wang, "An Overview of Blockchain Technology:Architecture, Consensus, and Future Trends," *IEEE 6th International Congress on Big Data*, p. 8, 2017.
- [60] "Litecoin," Litecoin—Open Source P2P Digital Currency, 2013. [Online]. Available: <https://litecoin.org/>. [Accessed 2018].
- [61] Elli Androulaki , Christian Cachin ,Christopher Ferris ,Srinivasan Muralidharan , Chet Murthy , Binh Nguyen , Manish Sethi , Chrysoula Stathakopoulou, "Hyperledger Fabric: A Distributed Operating System forPermissioned Blockchains," *ACM* , p. 15, 2018.
- [62] N. Kshetri, "Blockchain's roles in strengthening cybersecurity andprotecting privacy," *Elsevier Ltd.*, p. 12, 2017.
- [63] George C. Polyzos and Nikos Fotiou , "Blockchain-assisted Information Distribution for the Internet of Things," *IEEE International Conference on Information Reuse and Integration*, p. 4, 2017.
- [64] Masooda Bashir , Beth Strickland, and Jeremiah Bohr, "What Motivates People to Use Bitcoin," *Springer International Publishing AG*, p. 21, 2016.
- [65] David Vandervort , Dale Gaucas, and Robert St Jacques, "Issues in Designing a Bitcoin-likeCommunity Currency," *International Financial Cryptography Association*, p. 14, 2015.
- [66] Thomas Bocek , Bruno B. Rodrigues, Tim Strasser and Burkhard Stiller, "Blockchains Everywhere - A Use-case ofBlockchains in the Pharma Supply-Chain," *IFIP/IEEE Symposium on Integrated Network and Service Management (IM)*, p. 6, 2017.
- [67] H. Hou, "The Application of Blockchain Technology in E-government in China," *26th International Conference on Computer Communication and Networks (ICCCN)*, p. 4, 2017.
- [68] Daniel Augot,Hervé Chabanne, Thomas Chenevier,William George, and Laurent Lambert, "A User-Centric System for Verified Identitieson the Bitcoin Blockchain," *Springer International Publishing AG*, p. 18, 2017.

- [69] Dimaz Ankaa Wijaya, Joseph K. Liu, Dony Ariadi Suwarsono and Peng Zhang, "A New Blockchain-Based Value-Added Tax System," *Springer International Publishing AG*, p. 16, 2017.
- [70] Hissu Hyvärinen, Marten Risius and Gustav Friis, "A Blockchain-Based Approach Towards Overcoming Financial Fraud in Public Sector Services," *Springer Fachmedien Wiesbaden GmbH*, p. 16, 2017.
- [71] S. Ølne, "Beyond Bitcoin Enabling Smart Government Using Blockchain Technology," *IFIP International Federation for Information Processing*, p. 12, 2016.
- [72] Sinică Alboai and Doina Cosovan, "Private Data System Enabling Self-Sovereign Storage Managed by Executable Choreographies," *IFIP International Federation for Information Processing*, p. 16, 2017.
- [73] Valentina Gatteschi, Fabrizio Lamberti, Claudio Demartini, Chiara Pranteda, Víctor Santamaría, "Blockchain or not blockchain, that is the question of the insurance and other sectors," *IT Professional*, p. 13, 2017.
- [74] M. Mettler, "Blockchain Technology in Healthcare The Revolution Starts Here," *IEEE 18th International Conference on e-Health Networking, Applications and Services (Healthcom)*, p. 3, 2016.
- [75] Alevtina Dubovitskaya, Zhigang Xu, Samuel Ryu, Michael Schumacher, and Fusheng Wang, "How Blockchain Could Empower eHealth: An Application for Radiation Oncology," *Springer International Publishing AG*, p. 4, 2017.
- [76] Eric Munsing, Jonathan Mather, and Scott Moura, "Blockchains for Decentralized Optimization of Energy Resources in Microgrid Networks," *IEEE Conference on Control Technology and Applications (CCTA)*, p. 8, 2017.
- [77] Nurzhan Zhumabekuly Aitzhan and Davor Svetinovic, "Security and Privacy in Decentralized Energy Trading through Multi-Signatures, Blockchain and Anonymous Messaging Streams," *IEEE Transactions on Dependable and Secure Computing*, p. 14,

2016.

- [78] Kentaroh Toyoda, P. Takis Mathiopoulos, Iwao Sasase and Tomoaki Ohtsuki, "A Novel Blockchain-Based Product Ownership Management System (POMS) for Anti-Counterfeits in The Post Supply Chain," *IEEE. Translations and content mining are permitted for academic research only*, p. 13, 2017.
- [79] Tong Wu and Xiubo Liang , "Exploration and Practice of Inter-bank Application Based on Blockchain," *The 12th International Conference on Computer Science & Education (ICCSE 2017)*, p. 6, 2017.
- [80] Ye Guo and Chen Liang, "Blockchain application and outlook in the banking industry," *Financial Innovation*, p. 12, 2016.
- [81] Wei-Tek Tsai & Robert Blower, "A System View of Financial Blockchains," *IEEE Symposium on Service-Oriented System Engineering*, p. 8, 2016.
- [82] Hoang Tam Vo, Lenin Mehedy, Mukesh Mohania, Ermyas Abebe, "Blockchain-based Data Management and Analytics for Micro-insurance Applications," *In: Proceedings of the 2017 ACM on Conference on Information and Knowledge Management - CIKM 2017*, p. 4, 2017.
- [83] Žiga Turka, and Robert Klinc, "Potentials of Blockchain Technology for Construction Management," *Elsevier Ltd*, p. 8, 2017.
- [84] Ricardo Zimmermann Luís Miguel Domingues Fernandes Ferreira Antonio Carrizo Moreira, "The influence of supply chain on the innovation process: a systematic literature review," *Supply Chain Management: An International Journal*, p. 35, 2016.
- [85] B. O. L. College, "Supply chain management," Brentwood Open Learning College, 2020.
- [86] Riham AlTawy and Guang Gong, "Mesh: A Supply Chain Solution with Locally Private Blockchain Transactions," *sciendo*, p. 21, 2019.
- [87] K. Sadouskaya, "Adoption of Blockchain Technology in Supply Chain," 2017.

- [88] S. Sarpong, "Traceability and supply chain complexity: confronting the issues and concerns," *European Business Review*, p. 16, 2014.
- [89] James E. Morehouse and Lola Cardoso, "Consumer product fraud – how to stop the fraud now," *Supply chain Quarterly*, 27 June 2011. [Online]. Available: <https://www.supplychainquarterly.com/articles/509-consumer-product-fraud-how-to-stop-it-now>.
- [90] F. S. Agency, "Food standards manual wales," 2017. [Online]. Available: <https://signin.riams.org/connect/revision/wjtuc/Environmental-Health/Food-Standards-Manual-Wales>.
- [91] E. Earls, "Track and trace security to stamp out a food scandal," 17 July 2013. [Online]. Available: <https://www.foodprocessing-technology.com/features/feature-track-trace-security-food-scandal/>.
- [92] Abubaker Haddud and Anshuman Khare, "Digitalizing supply chains potential benefits and impact on lean operations," *International Journal of Lean Six Sigma*, vol. 11, no. 4, pp. 731-765, 2020.
- [93] A. Hourieh, *Learning Website Development with Django*, BIRMINGHAM - MUMBAI: Packt Publishing, 2008.
- [94] F. Marani, *Practical Django 2 and Channels 2: Building Projects and Applications*, London, UK, 2019.
- [95] "Powerful Python and Django IDE," 20 August 2013. [Online]. Available: <https://www.jetbrains.com/pycharm/>.
- [96] M. Lutz, *Learning Python*, fifth edition, Gravenstein Highway North, Sebastopol, CA: O'Reilly Media, 2013.
- [97] "About Python," 28 June 2013. [Online]. Available: <http://python.org/about/>.

- [98] Isnar Sumartono, Andysah Putera Utama Siahaan and Arpan Arpan, "Base64 Character Encoding and Decoding Modeling," *Internation journal of recent trends in engineer & research*, 2017.

