UTILIZING BLOCKCHAIN CONSORTIUM'S POTENTIAL TO TRANSFORM FOOD PROVIDE CHAINS AND AGRICULTURE

PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF **BACHELOR OF TECHNOLOGY** IN **INFORMATION TECHNOLOGY** OF THE ANNA UNIVERSITY

PHASE: I

November 2023

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2020–2024

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ACKNOWLEDGEMENT

The success of a work depends on a team and cooperation. We take this opportunity to express our gratitude and thanks to everyone who helped us in our project. We would like to thank the management for the constant support provided by them to complete this project.

It is indeed our great honor bounded duty to thank our beloved **Chairman Mr. R. Mohanram**, for his academic interest towards the students. We are in debted to our **Director Mr. R. Rajaram**, for motivating and providing us with all facilities.

We wish to express our sincere regards and deep sense of gratitude to **Dr. Sudha Mohanram M.E, Ph.D. Principal**, for the excellent facilities and encouragement provided during the course of the study and project.

We are indebted to **Dr. John Augustine, M.E., Ph.D.** Head of Information Technology Department for having permitted us to carry out this project and giving the complete freedom to utilize the resources of the department.

We express our sincere thanks to our project Co-ordinator **Mr. U. Prakash, M.E.,** Assistant Professor, Department of Information Technology for providing us his support and guidance and encouragement given to us for this project.

We also extend our heartfelt thanks to our Project Guide **Mr. E.Balraj,M.E.,** Assistant Professor, Department of Information Technology for providing us his support and guidance which really helped us.

We solemnly express our thanks to all the teaching and non-teaching staff of the Information Technology Department, family and friends for their valuable support which inspired us to work on this project.

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UTILIZING BLOCKCHAIN CONSORTIUMS' POTENTIAL TO TRANSFORM FOOD PROVIDE CHAINS AND AGRICULTURE

ABSTRACT

Block chain technology is revolutionizing various industries, and the agricultural sector is no exception. Block chain-based agri-food traceability is a promising approach to enhance transparency, efficiency, and trust in the food supply chain. By leveraging block chain's immutable and distributed ledger, stakeholders across the food supply chain, from farmers to consumers, can access a secure and tamper-proof record of food origin, movement, and processing. This transparency enables traceability and accountability, empowering consumers to make informed choices and ensuring that food products meet safety and quality standards. We proposed Bitcoin SHA-256 hash algorithm using block chain-based agri-food traceability offers a secure and tamper-resistant solution for tracking agricultural products across the supply chain. This approach involves collecting and verifying data, hashing it with SHA-256, and recording it in a decentralized block chain network. The block chain's transparent and immutable nature ensures the integrity of data, allowing various stakeholders to trace a product's origin. Additionally, smart contracts and user-friendly interfaces enhance automation and accessibility for participants and consumers, thereby fostering trust and transparency in the agri-food industry.

The immutable and decentralized nature of blockchain ensures the integrity and confidentiality of patient records, reducing the risk of data breaches and unauthorized access. Through a blockchain-enabled healthcare ecosystem, patients gain control over their health data, granting permission for access and sharing. This not only enhances patient privacy but also facilitates seamless and secure sharing of medical records among healthcare providers. The utilization of blockchain in healthcare can streamline administrative processes, reduce fraud, and enhance the accuracy of medical records, ultimately contributing to more efficient and patient-focused healthcare systems. Our proposal advocates for the implementation of blockchain technology using a consensus algorithm such as Proof of Authority to establish a secure and transparent healthcare data infrastructure. Through the incorporation of decentralized and tamper-resistant blockchain networks, the healthcare industry can unlock new potentials in data management, fostering a paradigm shift towards patient empowerment and data integrity

CHAPTER 1

1. INTRODUCTION

Block chain-based agri-food traceability applications are at the forefront of a transformative revolution in the agricultural and food industries. In a world where consumers increasingly demand transparency, safety, and sustainability in their food supply chains, block chain technology offers an innovative solution. By leveraging the decentralized and immutable nature of block chain, these applications enable the tracking and tracing of agricultural products from farm to fork with unparalleled accuracy. With every step in the production and distribution process securely recorded on a block chain, consumers can gain real-time access to critical information about the origin, quality, and safety of the food they consume. Moreover, this technology holds the promise of reducing fraud, enhancing food safety, and promoting fair practices in the agri-food sector, ultimately fostering trust and reliability throughout the entire supply chain. As block chain continues to disrupt and reshape the industry, these applications are poised to drive a fundamental shift in how we source, verify, and consume agricultural products.

1.1 BLOCKCHAIN

Block chain is a revolutionary technology that has gained significant prominence in recent years. It is a decentralized and distributed digital ledger system that enables secure and transparent transactions across a network of computers. Unlike traditional centralized databases, where a single entity controls and manages the data, block chain operates on a peer-to-peer network, making it resistant to tampering and fraud. Each block in the chain contains a set of transactions, and once added, it becomes virtually immutable. This immutability, along with its transparency and security features, makes block chain a groundbreaking tool with applications ranging from cryptocurrency to supply chain management, healthcare, and beyond. Its potential to disrupt various industries and reshape how we trust, verify, and exchange information makes block chain an intriguing and transformative technology.

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1.2 FOOD

Food is an essential and universal aspect of human existence that goes beyond its primary function of nourishment. It is a cultural, social, and sensory experience that plays a central role in our lives. Food encompasses not only the sustenance our bodies require but also the flavors, traditions, and memories that define our culinary preferences. It connects people, transcending geographical and cultural boundaries, and serves as a means of expressing identity and heritage. The production, distribution, and consumption of food have far-reaching economic, environmental, and social implications, making it a subject of global significance. From farm to table, the journey of food is a complex and intricate web of processes, technologies, and traditions that continually evolve in response to changing tastes, dietary needs, and sustainability concerns. Understanding the profound impact of food on our lives and the world at large is essential in addressing the challenges and opportunities it presents in the 21st century.

1.3 SUPPLY CHAIN

The supply chain is the intricate and interconnected network of processes, people, organizations, information, and resources that collaborate to deliver products and services from their point of origin to the end consumer. It serves as the lifeblood of modern commerce, facilitating the movement of goods and the provision of services on a global scale. Every product we purchase, from a simple household item to the latest technological gadget, has undertaken a journey through the supply chain. It encompasses all the stages, from raw material extraction, manufacturing, transportation, warehousing, and distribution, to the final point of sale. In today's fast-paced and increasingly globalized world, the efficiency and resilience of supply chains are pivotal to meeting consumer demands, optimizing costs, and responding to unforeseen challenges. Understanding the dynamics and innovations within supply chains has become essential for businesses and industries seeking to adapt, thrive, and remain competitive in a constantly evolving marketplace.

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1.4 TRACEABILITY

Traceability is a crucial concept in various industries, encompassing the ability to track and trace the origin, journey, and transformation of products and information throughout their lifecycle. It plays a fundamental role in ensuring transparency, accountability, and quality assurance. In an era marked by growing consumer concerns about safety, authenticity, and sustainability, traceability mechanisms offer a powerful means of building trust and confidence in supply chains. Whether applied to food, pharmaceuticals, manufacturing, or other sectors, traceability enables stakeholders to pinpoint the source of products, identify potential issues, and swiftly respond to problems or recalls. This level of visibility not only enhances product safety but also empowers businesses and regulatory authorities to optimize processes, minimize waste, and make informed decisions. As technology and global connectivity advance, the importance of traceability continues to rise, shaping how we manage and monitor the flow of goods and information across various domains.

1.5 USER INTERFACE

The user interface, often abbreviated as UI, serves as the critical point of interaction between humans and digital systems, such as software applications, websites, and electronic devices. It plays a pivotal role in facilitating user experiences and determining how individuals engage with technology. A well-designed user interface is intuitive, user-friendly, and aesthetically pleasing, enhancing user efficiency and satisfaction. Whether it's a smartphone screen, a computer application, or a website layout, the quality of the user interface significantly influences a user's ability to navigate, access information, and complete tasks. As technology continues to advance, user interfaces are evolving to accommodate diverse needs and preferences, from touch screens and voice commands to virtual reality and beyond. The design and functionality of the user interface have become a central focus in the development of digital solutions, reflecting the ever-growing importance of providing seamless and engaging interactions between people and technology.

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1.6 OBJECTIVES

- By enabling precise tracking of food products throughout the supply chain, block chain can facilitate the swift identification and isolation of contaminated products, preventing widespread outbreaks of foodborne illnesses.

- Block chain's inherent transparency ensures that all stakeholders in the supply chain have access to verifiable and immutable data about the origin, production, and handling of food products. This fosters trust among consumers, producers, and distributors.

- It can streamline the flow of information and automate manual processes, reducing administrative burdens and expediting transactions. This leads to increased efficiency and reduced costs throughout the supply chain.

- Blockchain technology streamlines the flow of information, reducing delays and bottlenecks in the supply chain and automation of manual processes contributes to a more efficient system, minimizing administrative burdens for all parts involved

- By automating the manual process and reducing inefficiencies, blockchain implementation leads to cost reductions throughout the entire supply chain. Streamline transaction and information flow contribute to financial savings for producers, distributors and ultimately the consumers

- Blockchain enables real-time monitoring of food products as they move through the supply chain and this proactive approach allow for immediate response of any issues, preventing the escalation of problems and safeguarding the public health

- The traceability provided by blockchain ensures accountability at every stage of the supply chain and in case of a food safety issue, it becomes easier to identify the source, helping stakeholders take corrective actions promptly

- Blockchain's immutable ledger provide a reliable record of compliance with food safety regulations and this assurance is crucial for regulatory bodies, consumers, and business to maintain and enhance the overall integrity of the food supply chain

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CHAPTER-2

2. LITERATURE REVIEW

2.1 EMERGING OPPORTUNITIES FOR THE APPLICATION OF BLOCKCHAIN IN THE AGRI-FOOD INDUSTRY

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) or International Centre for Trade and Sustainable Development (ICTSD) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO or ICTSD in preference to others of a similar nature that are not mentioned. All around the globe, regardless of the level of economic development, humans are constantly transferring value. The transfer of value is a fundamental human activity enabling people to trade goods and services, and accumulate productive capital and savings for their wellbeing. In order to lower uncertainty during the exchange of value, institutions are used to ensure trust and mitigate risk between buyers and sellers. The institutions that intermediate the exchange of value use centralized electronic ledgers to track assets and store data. Since those intermediaries often rely on manual inputs and may be vulnerable to fraud, value transfers tend to impose a high cost on buyers and sellers, which drastically increases the burdens of doing business. High transaction costs are a major deterrent to economic development. In addition, cash transactions (in both the formal and informal economy) lack traceability, which ultimately hinders the ability of micro-, small- and medium-sized enterprises (MSMEs), particularly in developing countries, to access credit and new markets and to grow. Distributed ledger technologies are an evolving technology and transaction system that has many applications. It was first introduced as the cryptocurrency system for Bitcoin DLTs can be used to make all types of transactions and store any type of data and information of value. A DLT is a digital database that uses cryptography to link and secure transactions or data entries, and disintermediates data processing and data storage with a peer-to-peer distributed network of computers that are used to validate and store the transaction history and information.

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2.2 INTELLIGENT SUPPLY CHAIN MANAGEMENT SYSTEM

Internet of Things aims at integrating networked information systems to real world entities. It connects objects such as smart phones, sensors, Light Emitting Diodes (LED) displays, vehicles through the internet allowing them to interact and exchange information among themselves. In today's times IoT has found its application in practically every walk of life and supply chain management is no exception. At present, supply chains are becoming increasingly complex, where suppliers and customers stretch between various countries and continents. The biggest problem faced by manufacturers is to optimize supply chain performance and reduce operational costs over such large geographical stretches. IoT acts as a solution to this problem as it facilitates the use of Wireless Sensor Networks (WSN) in order to interconnect all the various actors in a supply chain. This humongous network of interconnected devices generates massive amounts of data which is difficult to store and process. Cloud computing here plays a role of a facilitator and provides great help in addressing challenges related to storage and processing capabilities. In this paper, we present an Intelligent Supply Chain Management System (ISCMS) that benefits from the amalgamation of IoT and Cloud and provides real time monitoring, tracking and managing of goods from the perspective of a supplier, customer and shipper. We also propose an algorithm that depicts the working of our system. The proposed Intelligent Supply Chain Management System along with the algorithm are simulated using the iFogSim simulator and significantly transformed supply chain management, where the increasing complexity of global supply chains necessitates innovative solutions. IoT seamlessly interconnects diverse entities, from smartphones to sensors and vehicles, fostering information exchange and interaction. In response to the challenge of optimizing supply chain performance over vast geographical expanses, a solution emerges through the amalgamation of IoT and Cloud computing. This paper introduces the Intelligent Supply Chain Management System (ISCMS), leveraging Wireless Sensor Networks (WSN) and Cloud capabilities. The ISCMS facilitates real-time monitoring, tracking, and management of goods, offering a holistic perspective for suppliers, customers, and shippers. A novel algorithm orchestrates the system's functionality, and simulations using the iFogSim simulator validate its effectiveness, positioning the proposed framework as a robust solution for enhancing the efficiency and responsiveness of contemporary supply chain ecosystems

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2.3 FUTURE CHALLENGES ON THE USE OF BLOCKCHAIN FOR FOOD TRACEABILITY ANALYSIS

A. M. Turri et.al says the steady increase in food falsification, which has caused large economic losses and eroded consumers' trust, has become a pressing issue for producers, researchers, governments, consumers and other stakeholders. Tracking and authenticating the food supply chain to understand provenance is critical with a view to identifying and addressing sources of contamination in the food supply chain worldwide. One way of solving traceability issues and ensuring transparency is by using block chain technology to store data from chemical analysis in chronological order so that they are impossible to manipulate afterwards. This review examines the potential of block chain technology for assuring traceability and authenticity in the food supply chain. It can be considered a true innovation and relevant approach to assure the quality of the third step of the analytical processes: data acquisition and management. Blockchain technology emerged in 2008 as a core component of the bitcoin cryptocurrency. Blockchains provide transactional, distributed ledger functionality that can operate without the need for a centralized, trusted authority. Ledger recorded updates are immutable and cryptographic time stamping affords serial recording. The robust, decentralized functionality of blockchains is very attractive for use with global financial systems but can easily be expanded to contracts or operations such as tracking of the global supply chain. Thus, described how to use crypto-signatures to timestamp documents; Ross Anderson proposed a decentralized storage system from which recorded updates could not be deleted; described how to encrypt sensitive information in order to protect log files on untrusted machines. Each transaction in the public ledger is verified by consensus of a majority of participants in the system. Once entered, information can never be erased. The block chain contains a certain, verifiable record of every single transaction ever made and its blocks can be used to coordinate an action or verify an event. This is accomplished without compromising the privacy of the digital assets or parties involved. Each hash is combined with previous ones into a single, new hash in order to make it very difficult to alter the previous hashes without knowing that something has gone wrong. Controlling changes in internal data is thus made much easier as well. e Digital fingerprints in an external hash tree. The solution can be made trustworthy by having an external institution control the hash tree. This makes it significantly more difficult for the organization possessing the original files to make changes without the other parties. In a public distributed ledger or block chain, anyone can be part of the validation process. None is in control of the system, but power to make changes is given to those running the system and providing most security to the solution. Public institutions cannot control the process, which is one of the benefits but also one of the problems. For example, there is no protection for those who lose their assets or their IDs. This risk can be mitigated by having custodians.

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2.4 PRIVACY ISSUES AND TECHNICAL CHALLENGES

Alexander Schaub et.al says In the future ubiquitous-computing environment, RFID tags will be attached to all kinds of products and other physical objects, even to people, and could become a fundamental technology for ubiquitous services where the tags are used to identify things and people automatically. However, despite this promise, the possible abuse (or just excessive use) by retailers and government agencies of RFID's tracking capability raises questions about potential violations of personal privacy. Here, we discuss two protest campaigns—one against apparel manufacturer Benetton in Italy, the other against Tesco in the U.K.—that reflect the growing concern among consumer-privacy advocates regarding how RFID might affect personal data. Consumers Against Supermarket Privacy Invasion and Numbering The normal-tag approach achieves privacy protection by preventing the unauthorized reading of the output from the tag, blocking electric waves with aluminum foil or jamming waves to interfere with a tag's ID being read by an adversary's unauthenticated reader. An example is the block-tag scheme developed by RSA Security. The blocker tag simulates all possible tag IDs to prevent malicious people from identifying the target tag's ID; it pretends that all possible tags exist there, thus preventing the reader from identifying the tags that are actually present. Although the blocker tag is implemented cheaply Tag cost, security level, and scalability are likely to be the key factors in any trade-off equation calculated by any organization thinking about implementing these schemes (see Figure 1). Illustrating the SmartTag approach are tags with rewritable memory and tags with lightweight circuits. When the tag incorporates rewritable memory, the reader rewrites the information in the tag to achieve privacy protection. A noteworthy example of this technology is the "anonymous-ID scheme" proposed in which an encrypted ID—E(ID)—is stored in the tag, where E denotes the encryption function. In response to a reader's request, the tag replies with the encrypted ID directly to the reader. The reader then sends the encrypted ID from the tag to the server, requesting the server decrypt the encrypted ID. The server does so to obtain the ID of the tag and sends the ID back to the reader. The scheme prevents the leaking of private consumer data by encrypting the ID. Addressing the problem of being able to track a consumer.

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2.5 A TRUSTLESS PRIVACY-PRESERVING REPUTATION SYSTEM

A. Schaub et.al Reputation systems are crucial for distributed applications in which users have to be made accountable for their actions, such as ecommerce websites. However, existing systems often disclose the identity of the ratters, which might deter honest users from posting reviews, out of fear of retaliation from the ratees. While many privacy-preserving reputation systems have been proposed, none of them was at the same time truly decentralized, trustless, and suitable for real world usage in, for example, e-commerce applications. After discussing the weaknesses and shortcoming of existing solutions, we will present our own blockchain based trustless reputation system, and analyze its correctness and the security guarantees it promises. These days, reputation systems are implemented in various websites, where they are crucial for the customer experience. One of the first and best-studied systems in the e-commerce domain is the reputation system. Its main objective is to help prospective customers to determine the trustworthiness of the sellers, and thus minimize the risk of fraud. Applications other than e-commerce also rely on reputation systems. For example, they are also used by online communities such as the Stack Exchange network in order to attest the trustworthiness of the members from those communities. Filesharing and other peer-to-peer applications also need reputation systems in order to incentivize users to participate in the network and avoid free-riding Given these considerations, we would like to achieve a trustless reputation system. one that does not require the participants to trust other users or entities to not disrupt the protocol or to breach their privacy. This privacy preserving reputation model should be suitable for e-commerce applications, and we will therefore suppose that the identity of the customer is revealed during the transactions that they can rate. Trust lessness seems hard to achieve without decentralization. One way to obtain decentralization is to use a distributed database in order to store the ratings submitted by the customers.

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2.6 HANDBOOK OF DIGITAL CURRENCY: BITCOIN, INNOVATION, FINANCIAL INSTRUMENTS, AND BIG DATA

There are various innovative money payment systems in the market today, many of which are built on platforms like the mobile phone, the Internet, and the digital storage card. These alternative payment systems have seen encouraging or even continued This chapter introduces the characteristics and features of Bitcoin and sets the stage for further discussion of cryptocurrencies in the rest of this book. Cryptocurrency in its purest form is a peer-to-peer version of electronic cash. It allows online payments to be sent directly from one party to another without going through a financial institution. The network time-stamps transactions using cryptographic proof of work. The proof-of-work Bitcoin protocol is basically a contest for decoding and an incentive to reward those who participate. For Bitcoin, first participant to crack the code will be rewarded with the newly created coins. This contest will form a record of the transactions that cannot be changed without redoing the proof of work. Cryptocurrency is a subset of digital currency. Examples of the many digital currencies are air miles issued by airlines, game tokens for computer games and online casinos, Brixton Pound to be spent only in the Brixton local community in the Greater, and many other forms that can be exchanged for virtual and physical objects in a closed system and, in the case of an open system, exchanged for fiat currency Despite sounding technical, what Szabo described was a simple protocol that requires participants to spend resources to mine the digital gold or bit gold, be rewarded, and in the process validate the public digital register. What differentiated his approach from failed digital currencies of the past were the timing of the financial crisis and the distributed nature of the protocol. The reward to the miners was one innovation and the free access to digital record for the users was another. One of the reasons is that the nature of the Internet makes collecting mandatory fees much harder, while voluntary subsidy is much easier. Therefore, there must be no barrier to access content or digital record, and there must be ease of use and voluntary payments.

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2.7 BLOCKCHAIN TECHNOLOGY IN THE ENERGY SECTOR: A SYSTEMATIC REVIEW OF CHALLENGES AND OPPORTUNITIES

Merlinda Andoni et.al Block chain or distributed ledgers are an emerging technology that has drawn considerable interest from energy supply firms, start-ups, technology developers, financial institutions, national governments and the academic community. Numerous sources coming from these backgrounds identify blockchains as having the potential to bring significant benefits and innovation. Blockchains promise transparent, tamper-proof and secure systems that can enable novel business solutions, especially when combined with smart contracts. This work provides a comprehensive overview of fundamental principles that underpin block chain technologies, such as system architectures and distributed consensus algorithms. Next, we focus on blockchain solutions for the energy industry and inform the state-of-the-art by thoroughly reviewing the literature and current business cases. To our knowledge, this is one of the first academic, peer-reviewed works to provide a systematic review of blockchain activities and initiatives in the energy sector. Our study reviews 140 blockchain research projects and start-ups from which we construct a map of the potential and relevance of blockchains for energy applications. These initiatives were systematically classified into different groups according to the field of activity, implementation platform and consensus strategy used.[1] Opportunities, potential challenges and limitations for a number of use cases are discussed, ranging from emerging peer-to-peer (P2P) energy trading and Internet of Things (IoT) applications, to decentralized marketplaces, electric vehicle charging and e-mobility. For each of these use cases, our contribution is twofold: first, in identifying the technical challenges that blockchain technology can solve for that application as well as its potential drawbacks, and second in briefly presenting the research and industrial projects and start-ups that are currently applying blockchain technology to that area. The paper ends with a discussion of challenges and market barriers the technology needs to overcome to get past the hype phase, prove its commercial viability and finally be adopted in the mainstream.

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2.8 ON BLOCKCHAIN AND ITS INTEGRATION WITH IOT. CHALLENGES AND OPPORTUNITIES

Ana Reyna et.al, conventional devices become smart and autonomous. This vision is turning into a reality thanks to advances in technology, but there are still challenges to address, particularly in the security domain e.g., data reliability. Taking into account the predicted evolution of the IoT in the coming years, it is necessary to provide confidence in this huge incoming information source. Blockchain has emerged as a key technology that will transform the way in which we share information. Building trust in distributed environments without the need for authorities is a technological advance that has the potential to change many industries, the IoT among them. Disruptive technologies such as big data and cloud computing have been leveraged by IoT to overcome its limitations since its conception, and we think blockchain will be one of the next ones. This paper focuses on this relationship, investigates challenges in blockchain IoT applications, and surveys the most relevant work in order to analyze how blockchain could potentially improve the IoT. The rapid evolution in miniaturization, electronics and wireless communication technologies have contributed to unprecedented advances in our society. This has resulted in an increase in the number of suitable electronic devices for many areas, a reduction in their production costs and a paradigm shift from the real world into the digital world. Therefore, the way in which we interact with each other and with the environment has changed, using current technology to gain a better understanding of the world. The Internet of Things (IoT) has emerged as a set of technologies from Wireless Sensors Networks (WSN) to Radio Frequency Identification (RFID), that provide the capabilities to sense, actuate with and communicate over the Internet. Nowadays, an IoT device can be an electronic device from a wearable to a hardware development platform and the range of applications where it can be used encompass many areas of the society. The IoT plays a central role in turning current cities into smart cities, electrical grids into smart grids and houses into smart homes, and this is only the beginning. According to various research reports, the number of connected devices is predicted to reach anywhere from 20 to 50 billion by 2020 mainly due to the vast number of devices that the IoT can place on the scene.

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2.9 BLOCKCHAIN-BASED SOYBEAN TRACEABILITY IN AGRICULTURAL SUPPLY CHAIN

Khaled Salah et.al says the globalized production and distribution of agricultural produce bring a renewed focus on the safety, quality and validation of several important criteria in agriculture and food supply chains. The growing number of issues related to food safety and contamination risks has established an immense need for effective traceability solution that act as an essential quality management tool ensuring adequate safety of products in the agricultural supply chain. Blockchain is a disruptive technology that can provide an innovative solution for product traceability in agriculture and food supply chains. Today's agricultural supply chains are complex ecosystem involving several stakeholders making it cumbersome to validate several important criteria such as country of origin, stages in crop development, conformance to quality standards and monitor yields. In this paper, we propose an approach that leverages the Ethereum blockchain and smart contracts efficiently perform business transactions for soybean tracking and traceability across the agricultural supply chain. Our proposed solution eliminates the need for a trusted centralized authority, intermediaries and provides transactions records, enhancing efficiency and safety with high integrity, reliability, and security. The proposed solution focuses on the utilization of smart contracts to govern and control all interactions and transactions among all the participants involved within the supply chain ecosystem. All transactions are recorded and stored in the blockchain's immutable ledger with links to a decentralized file system (IPFS), and thus providing to all a high level of transparency and traceability into the supply chain ecosystem in a secure, trusted, reliable, and efficient manner The adoption and implementation of blockchain technology can also ensure payment security to sellers while sharing important criteria about the origin, certification of organic ornon GMO, crop yields, and alert potential contamination risk among others. Ethereum is a programmable blockchain plat-form that has the ability to govern business logic including interactions, sequence of events, and access control to enforce the required workflow and execute agreed-on business logic among supply chain participants. The Ethereum Virtual Machine (EVM) is the runtime environment for Ethereum computations on which the user programs are executed.

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2.10 A SAFE AND EFFICIENT STORAGE SCHEME BASED ON BLOCKCHAIN AND IPFS FOR AGRICULTURAL PRODUCTS TRACKING

The adoption of agricultural products traceability management based on Internet of Things (IoT) technology provides excellent benefits for the current food safety issues. The provenance data can demonstrate agricultural products movement process from the countryside to the dining table. However, the massive provenance data incurs an inefficient query. Meanwhile, the provenance data can be tampered deliberately which affect food safety. There are seldom reported approaches that can solve the above problem effectively. In this paper, we propose a data storage model based on Inter-Planetary File System (IPFS) and blockchain. First, IPFS is used to store video, images, and real-time monitoring data reported from the sensors. Then, in order to avoid a malicious user in case of data faking attack, we exploit the blockchain to store the IPFS hash address of the provenance data. Based on that, we design an authentication mechanism based on blockchain. It can verify the data and ensures effective data security. The experimental results show that the proposed approach can outperforms the existing methods. For agricultural products movement process from the countryside to the dining table, it needs to go through the cultivation, processing, transportation and sales. Any one of the above-mentioned links can produce serious food safety hazards if there is artificial fraud. Therefore, with the development of IoT technology, many logistics management systems have emerged. Although these systems can automatically trace the entire process, they cannot avoid the food safety problem caused by modifying the data artificially. The reason is that some people deliberately tamper and destroy the data in the traditional data storage process. In order to solve mentioned-above problems, researchers began to try to use blockchain technology to store data and protect data security. The data encapsulation module mainly obtains uploaded video, picture and sensor data and then encapsulates them. Data management system module is to interact with IPFS, database and blockchain. After obtaining the encapsulated data, the data management system queries the transaction hash of the agricultural product in the blockchain from the database, and get the transaction content (IPFS hash address of the tracing data) from the blockchain. Then the previous provenance data packet is obtained. The new data will be stored in the provenance packet to generate a new provenance packet. When extracting data, the system uses the blockchain transaction hash to query transaction and obtains the IPFS hash address.

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CHAPTER 3
SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

Blockchain technology is a secure distributed ledger for lists of transactions, which has immense potential to solve traditional agri-food supply chain issues. An increasing number of research on blockchain-based traceability applications aims to improve food quality and safety. Still, relatively few works considered user interfaces when developing and reporting their applications, which could lead to usability issues. This paper aims to address this gap by reviewing existing works from user interface perspectives. We gathered 25 review papers on blockchain or agri-food supply chain and 39 research papers that presented screenshots of user interfaces of related applications. We first reviewed 7 review papers that focused on the blockchain-based agri-food supply chain to understand the benefits and challenges in the blockchain applications. We then analyzed 14 blockchain-based agri-food traceability applications and 10 non-blockchain-based agri-food traceability applications. The analysis resulted in categorizations of 5 target user groups, 3 main approaches for collecting data, 5 main approaches for visualizing data, and a discussion of other aspects of user interfaces. However, we found insufficient details and discussions on the user interfaces and design decisions of the applications for further usability assessment. Additionally, user involvement for evaluation is lower in blockchain-based researches than in non-blockchain-based researches. This trend could lead to usability problems of blockchain applications, causing blockchain technology to be underutilized. Finally, we discussed research gaps and future research directions related to user interface design, which should be addressed to ease future blockchain adoption.

3.1.1 DRAWBACKS

- Blockchain networks can become slow and congested as the number of users and transactions increases.
- The consensus mechanisms used by many blockchain, such as Proof of Work (PoW), require a lot of energy. This is because miners need to solve complex mathematical problems in order to verify transactions and add new blocks to the blockchain.
- While blockchain technology is generally considered to be secure, it is not without its vulnerabilities. Hackers have been able to exploit vulnerabilities in smart contracts, which are programs that run on the blockchain, to steal funds.
- While blockchain is renowned for its security, vulnerability exist, particularly in smart contracts. Exploitation of these vulnerabilities by hackers has, in some cases led to the unauthorized access and theft of funds, highlighting the need for continuous improvement in security measures

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- Existing blockchain systems often struggle with the interoperability, making it challenging for different blockchain networks to communicate and share information seamlessly. This lack of interoperability can impede the overall efficiency and effectiveness of blockchain application
- The regulatory landscape for blockchain is still evolving and uncertainties in legal frameworks can pose challenges for widespread adoption. Ambiguous regulations may create barriers to entry for businesses and inhibit the development of a more standardized and regulated environment
- Integrating blockchain technology into existing systems can be complex and time – consuming. The learning curve for understanding and implementing blockchain solutions may limit the speed at which organizations can adopt and benefit from this technology
- The decentralized nature of many blockchain networks poses challenges in terms of establishing effective governance frameworks. Decisions related to system upgrades, protocol changes and dispute resolution may lack clear structure, potentially leading to conflicts within the blockchain community

3.2 PROPOSED SYSTEM

The proposed system is a blockchain-based agri-food traceability solution designed to enhance transparency, efficiency, and trust within the food supply chain. Leveraging the immutable and distributed ledger properties of blockchain technology, it securely records and verifies data related to agricultural products, proposed the Bitcoin SHA-256 hash algorithm for data integrity. This tamper-resistant system ensures that all stakeholders, from farmers to consumers, can access a reliable record of food origin, movement, and processing. Smart contracts and user-friendly interfaces further automate and simplify interactions, fostering trust and transparency in the agri-food industry, empowering consumers to make informed choices and ensuring that food products meet safety and quality standards.

3.2.1 ADVANTAGES

- Blockchain provides an immutable and transparent ledger, allowing all stakeholders to track and verify the origin and journey of agricultural products, promoting transparency and accountability in the supply chain.

- The use of the SHA-256 hash algorithm ensures that data is secure and tamper-resistant, preventing unauthorized alterations to critical information, which is crucial for maintaining the authenticity of product details.

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- With blockchain, it becomes easier to trace the source of contamination or quality issues in case of recalls, helping to swiftly isolate affected products and minimize the impact on consumers and the industry.

- Smart contracts enable automated execution of predefined actions when specific conditions are met, reducing the need for intermediaries and streamlining processes throughout the supply chain.

3.3 FEASIBILITY STUDY

Preliminary investigation examines project feasibility; the likelihood the system will be useful to the organization. The main objective of the feasibility study is to test the Technical, Operational and Economical feasibility for adding new modules and debugging old running system. All system is feasible if they are unlimited resources and infinite time. There are aspects in the feasibility study portion of the preliminary investigation:

- Technical Feasibility
- Operation Feasibility
- Economic Feasibility

3.3.1 TECHNICAL FEASIBILITY

The technical issue usually raised during the feasibility stage of the investigation includes the following:

- Does the necessary technology exist to do what is suggested?
- Do the proposed equipment's have the technical capacity to hold the data required to use the new system?
- Will the proposed system provide adequate response to inquiries, regardless of the number or location of users?
- Can the system be upgraded if developed?
- Are there technical guarantees of accuracy, reliability, ease of access and data security?

Earlier no system existed to cater to the needs of 'Secure Infrastructure Implementation System'. The current system developed is technically feasible. It is a web-based user interface for audit workflow at DB2 Database. Thus, it provides an easy access to the users. The database's purpose is to create, establish and maintain a workflow among various entities in order to facilitate all concerned users in their various capacities or roles. Permission to the users would be granted based on the roles specified.

Therefore, it provides the technical guarantee of accuracy, reliability and security. The software and hard requirements for the development of this project are not many and are already available in-house at NIC or are available as free as open source. The work for the project is done with the current

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equipment and existing software technology. Necessary bandwidth exists for providing fast feedback to the users irrespective of the number of users using the system.

3.3.2 OPERATIONAL FEASIBILITY

Proposed projects are beneficial only if they can be turned out into information system. That will meet the organization's operating requirements. Operational feasibility aspects of the project are to be taken as an important part of the project implementation. Some of the important issues raised are to test the operational feasibility of a project includes the following:

- Is there sufficient support for the management from the users?
- Will the system be used and work properly if it is being developed and implemented?
- Will there be any resistance from the user that will undermine the possible application benefits?

This system is targeted to be in accordance with the above-mentioned issues. Beforehand, the management issues and user requirements have been taken into consideration. So there is no question of resistance from the users that can undermine the possible application benefits.

The well-planned design would ensure the optimal utilization of the computer resources and would help in the improvement of performance status.

3.3.3 ECONOMIC FEASIBILITY

A system can be developed technically and that will be used if installed must still be a good investment for the organization. In the economic feasibility, the development cost in creating the system is evaluated against the ultimate benefit derived from the new systems. Financial benefits must equal or exceed the costs.

The system is economically feasible. It does not require any addition hardware or software. Since the interface for this system is developed using the existing resources and technologies available at NIC, there is nominal expenditure and economic feasibility for certain.

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CHAPTER 4
SYSTEM SPECIFICATION

4.1 HARDWARE REQUIREMENTS

CPU type	:	Intel core i5 processor
Clock speed	:	3.0 GHz
RAM size	:	8 GB
Hard disk capacity	:	500 GB
Keyboard type	:	Internet Keyboard
CD -drive type	:	52xmax

4.2 SOFTWARE REQUIREMENTS

Operating System	:	Windows 10
Front End	:	JAVA

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CHAPTER 5
SOFTWARE DESCRIPTION

5.1 FRONT END: JAVA

The software requirement specification is created at the end of the analysis task. The function and performance allocated to software as part of system engineering are developed by establishing a complete information report as functional representation, a representation of system behavior, an indication of performance requirements and design constraints, appropriate validation criteria.

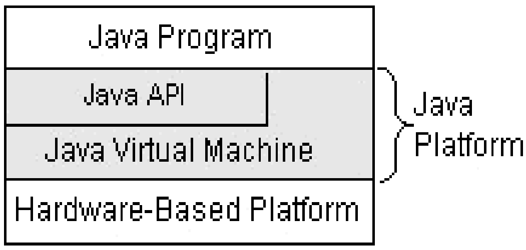
FEATURES OF JAVA

Java platform has two components:

- The *Java Virtual Machine* (Java VM)
- The *Java Application Programming Interface* (Java API)

The Java API is a large collection of ready-made software components that provide many useful capabilities, such as graphical user interface (GUI) widgets. The Java API is grouped into libraries (*packages*) of related components.

The following figure depicts a Java program, such as an application or applet, that's running on the Java platform. As the figure shows, the Java API and Virtual Machine insulates the Java program from hardware dependencies.



As a platform-independent environment, Java can be a bit slower than native code. However, smart compilers, well-tuned interpreters, and just-in-time byte code compilers can bring Java's performance close to that of native code without threatening portability.

SOCKET OVERVIEW:

A network socket is a lot like an electrical socket. Various plugs around the network have a standard way of delivering their payload. Anything that understands the standard protocol can “plug in” to the socket and communicate.

Internet protocol (IP) is a low-level routing protocol that breaks data into small packets and sends them to an address across a network, which does not guarantee to deliver said packets to the destination. Transmission Control Protocol (TCP) is a higher-level protocol that manages to reliably transmit data.

A third protocol, User Datagram Protocol (UDP), sits next to TCP and can be used directly to support fast, connectionless, unreliable transport of packets.

CLIENT/SERVER:

A server is anything that has some resource that can be shared. There are compute servers, which provide computing power; print servers, which manage a collection of printers; disk servers, which provide networked disk space; and web servers, which store web pages. A client is simply any other entity that wants to gain access to a particular server.

A server process is said to “listen” to a port until a client connects to it. A server is allowed to accept multiple clients connected to the same port number, although each session is unique. To manage multiple client connections, a server process must be multithreaded or have some other means of multiplexing the simultaneous I/O.

RESERVED SOCKETS:

Once connected, a higher-level protocol ensues, which is dependent on which port user are using. TCP/IP reserves the lower, 1,024 ports for specific protocols. Port number 21 is for FTP, 23 is for Telnet, 25 is for e-mail, 79 is for finger, 80 is for HTTP, 119 is for Netnews-and the list goes on. It is up to each protocol to determine how a client should interact with the port.

JAVA AND THE NET:

Java supports TCP/IP both by extending the already established stream I/O interface. Java supports both the TCP and UDP protocol families. TCP is used for reliable stream-based I/O across the network. UDP supports a simpler, hence faster, point-to-point datagram-oriented model.

INETADDRESS:

The InetAddress class is used to encapsulate both the numerical IP address and the domain name for that address. User interacts with this class by using the name of an IP host, which is more convenient and understandable than its IP address. The InetAddress class hides the number inside. As of Java 2, version 1.4, InetAddress can handle both IPv4 and IPv6 addresses.

FACTORY METHODS:

The InetAddress class has no visible constructors. To create an InetAddress object, user use one of the available factory methods. Factory methods are merely a convention whereby static methods in a class return an instance of that class. This is done in lieu of overloading a constructor with various parameter lists when having unique method names makes the results much clearer.

Three commonly used InetAddress factory methods are:

1. Static InetAddressgetLocalHost ( ) throws
   UnknownHostException
2. Static InetAddressgetByName (String hostName)

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throwsUnknowsHostException

3. Static InetAddress [ ] getAllByName (String hostName) throwsUnknownHostException

INSTANCE METHODS:

The InetAddress class also has several other methods, which can be used on the objects returned by the methods just discussed. Here are some of the most commonly used. Boolean equals (Object other) - Returns true if this object has the same Internet address as other.

- 1. byte [ ] get Address ( )- Returns a byte array that represents the object's Internet address in network byte order.
- String getHostAddress ( ) - Returns a string that represents the host address associated with the InetAddress object.
- String get Hostname ( ) - Returns a string that represents the host name associated with the InetAddress object.
- booleanisMulticastAddress ( )- Returns true if this Internet address is a multicast address. Otherwise, it returns false.
- String toString ( ) - Returns a string that lists the host name and the IP address for convenience.

TCP/IP CLIENT SOCKETS:

TCP/IP sockets are used to implement reliable, bidirectional, persistent, point-to-point and stream-based connections between hosts on the Internet. A socket can be used to connect Java's I/O system to other programs that may reside either on the local machine or on any other machine on the Internet.

There are two kinds of TCP sockets in Java. One is for servers, and the other is for clients. The Server Socket class is designed to be a "listener," which waits for clients to connect before doing anything. The Socket class is designed to connect to server sockets and initiate protocol exchanges.

The creation of a Socket object implicitly establishes a connection between the client and server. There are no methods or constructors that explicitly expose the details of establishing that connection. Here are two constructors used to create client sockets

Socket (String hostName, intport) - Creates a socket connecting the local host to the named host and port; can throw an UnknownHostException or anIOException.

Socket (InetAddressipAddress, intport) - Creates a socket using a preexistingInetAddressobject and a port; can throw an IOException.

A socket can be examined at any time for the address and port information associated with it, by use of the following methods:

- InetAddressgetInetAddress ( ) - Returns the InetAddress associated with the Socket object.
- IntgetPort ( ) - Returns the remote port to which this Socket object is connected.

- IntgetLocalPort ( ) - Returns the local port to which this Socket object is connected

Once the Socket object has been created, it can also be examined to gain access to the input and output streams associated with it. Each of these methods can throw an IO Exception if the sockets have been invalidated by a loss of connection on the Net.

- Input Streamget Input Stream ( ) - Returns the InputStream associated with the invoking socket.
- Output Streamget Output Stream ( ) - Returns the OutputStream associated with the invoking socket.

TCP/IP SERVER SOCKETS:

Java has a different socket class that must be used for creating server applications. The ServerSocket class is used to create servers that listen for either local or remote client programs to connect to them on published ports. ServerSockets are quite different form normal Sockets.

When the user create a ServerSocket, it will register itself with the system as having an interest in client connections.

- ServerSocket(int port) - Creates server socket on the specified port with a queue length of 50.
- Serversocket(int port, int maxQueue) - Creates a server socket on the specified portwith a maximum queue length of maxQueue.
- ServerSocket(int port, int maxQueue, InetAddress localAddress)-Creates a server socket on the specified port with a maximum queue length of maxQueue. On a multihomed host, localAddress specifies the IP address to which this socket binds.
- ServerSocket has a method called accept( ) - which is a blocking call that will wait for a client to initiate communications, and then return with a normal Socket that is then used for communication with the client.

URL:

The Web is a loose collection of higher-level protocols and file formats, all unified in a web browser. One of the most important aspects of the Web is that Tim Berners-Lee devised a saleable way to locate all of the resources of the Net. The Uniform Resource Locator (URL) is used to name anything and everything reliably.

The URL provides a reasonably intelligible form to uniquely identify or address information on the Internet. URLs are ubiquitous; every browser uses them to identify information on the Web.

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CHAPTER 6
PROJECT DESCRIPTION

6.1 PROBLEM DEFINITION

Blockchain technology, despite its promise to transform various industries, faces several drawbacks that hinder its widespread adoption. These limitations include scalability issues that lead to network congestion, excessive energy consumption due to consensus mechanisms, security vulnerabilities that expose smart contracts to exploits and 51% attacks, lack of privacy as transactions are pseudonymous but not fully private, and an uncertain regulatory landscape that creates ambiguity for businesses and investors. Addressing these challenges is crucial for realizing the full potential of blockchain technology.

6.2 MODULE DESCRIPTION

6.2.1 PROCESSING

In the processing menu the blockchain address will be shown and the private key generation with the block chain, buy crops and the distributed food with the deposit amount on the block chain will be represented. Removal of Noisy Data emphasized the importance of noise reduction by using the iterative process the key generation will be unique for every processing step.

6.2.2 PRODUCER

In the producer module the private key generation will be happen with the private key. in the deposit amount on blockchain tab the block chain address with the id and the available amount will be shown as the amount can be deposited A broad range of food production-distribution-consumption configurations can be characterized as short food supply chain (SFSCs).

6.2.3 DISTRIBUTION

Under the distribution login the block id can be choose the processing blockchain address will be generated with the price and the storage place id can be added to transfer the amount. the food name with the quantity of the price storage place id all the smart lock generation and upload with the blockchain food supply chain disruptions that result from climate change and increased geopolitical competition should also not be considered black swans.

6.2.4 RETAILER

Under the retailer menu choose block id with the distribution blockchain address with the price and the storage place is with the rise of immediate, customer facing food delivery companies. The modern consumer has access to and expects more immediate returns from food supply chains than ever before. retailers with agile, responsive supply chains are the ones Baum sees as thriving in this new economy of immediacy

6.2.5 PROVIDER

Crop seed name can be selected with the paddy seed with corn seed with the maze seed with the price and the storage place id can be selected. The purpose is to provide the food supply chain management

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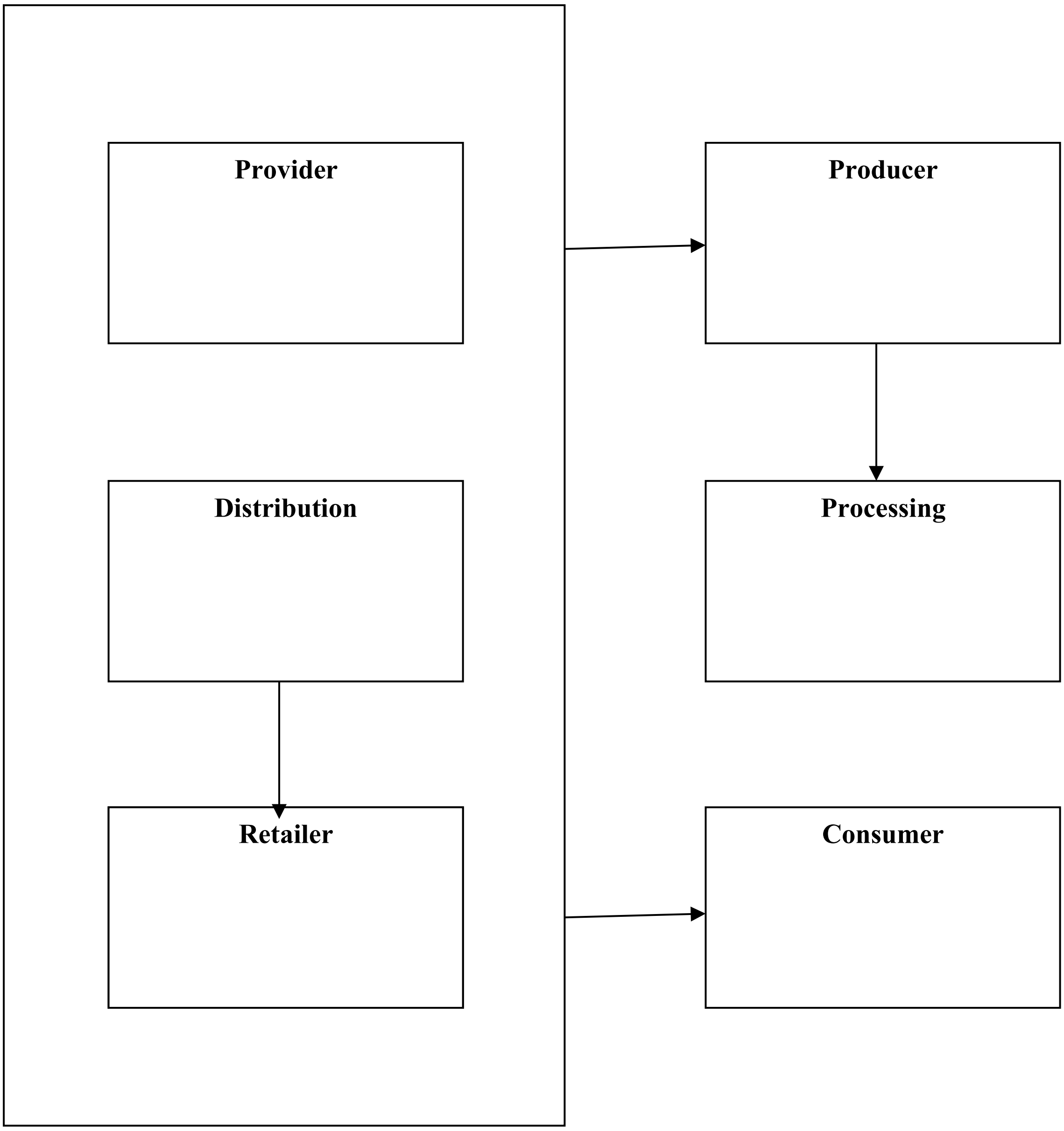
6.3 SYSTEM FLOW DIAGRAM



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6.4 INPUT DESIGN

- Product Identification: Each food product should be uniquely identified using a standardized identifier, such as a barcode, RFID tag, or QR code. This identifier should be linked to a digital record containing detailed information about the product.
- Sensor Data: Sensors can be deployed at various stages of the supply chain to collect real-time data about the product's condition, such as temperature, humidity, and pressure. This data can be used to monitor the product's quality and identify potential issues.
- Document Capture: Relevant documents, such as invoices, certificates of analysis, and shipping manifests, should be digitized and linked to the corresponding product record. This ensures that all relevant information is readily available for traceability purposes.

6.5 OUTPUT DESIGN

- Product Journey: The system should generate detailed traceability reports that provide a comprehensive overview of a product's journey from farm to fork.
- Timeline View: Reports should include a timeline view that chronologically presents the product's movement through the supply chain, including timestamps, locations, and associated events.
- Data Visualization: Traceability data should be visually represented using charts, graphs, and maps to provide a clear and easy-to-understand summary of the product's history.

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CHAPTER 7

7. SYSTEM TESTING AND IMPLEMENTATION

7.1. SYSTEM TESTING

- Unit Testing:
    - Test individual components and modules to ensure they function correctly in isolation.
    - Verify data integrity, input validation, and error handling.
- Integration Testing:
    - Test the integration of different components and modules to ensure they work together seamlessly.
    - Verify data flow, communication protocols, and error handling across interfaces.
- Functional Testing:
    - Test all system functionalities against defined requirements.
    - Verify data capture, data hashing, data storage, traceability queries, report generation, and user access control.
- Performance Testing:
    - Evaluate the system's performance under varying workloads and data volumes.
    - Assess response times, transaction throughput, and system scalability.

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7.2 SYSTEM IMPLEMENTATION

- Begin the implementation process by conducting an exhaustive assessment of the current IT infrastructure. Identify potential compatibility issues and integration challenges that may arise during the introduction of the new system.
- Develop a strategic plan to address compatibility and integration challenges identified during the assessment. This involves outlining specific measures and solutions to ensure seamless integration with existing systems, minimizing disruptions.
- Formulate a comprehensive implementation plan that provides a step-by-step guide for the entire process. This plan should include detailed timelines, resource allocation, risk mitigation strategies, and communication plans to keep all stakeholders informed and aligned.
- Clearly define the resources required for the implementation, including personnel, time, and budget. Ensure that the team responsible for the implementation is adequately trained on the new technology and processes.
- Identify potential risks associated with the implementation and develop mitigation strategies. This proactive approach helps in minimizing the impact of unforeseen challenges and ensures a smoother transition.
- Establish effective communication plans to keep all stakeholders informed about the progress of the implementation. Regular updates and transparent communication help manage expectations and address any concerns that may arise during the process.
- Procure the necessary hardware components, such as servers, network equipment, and storage devices, based on the requirements outlined in the implementation plan. Install and configure these components to ensure they align with the technical specifications of the blockchain system.
- Install the chosen blockchain platform, ensuring that it meets the specific needs of the organization. Configure the platform to align with the established goals and integrate it with existing systems to enable a cohesive IT environment

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CHAPTER 8

8.SYSTEM MAINTENANCE

The objectives of this maintenance work are to make sure that the system gets into work all time without any bug. Provision must be for environmental changes which may affect the computer or software system. This is called the maintenance of the system. Nowadays there is the rapid change in the software world. Due to this rapid change, the system should be capable of adapting these changes. In this project the process can be added without affecting other parts of the system. Maintenance plays a vital role. The system is liable to accept any modification after its implementation. This system has been designed to favor all new changes. Doing this will not affect the system's performance or its accuracy.

Maintenance is necessary to eliminate errors in the system during its working life and to tune the system to any variations in its working environment. It has been seen that there are always some errors found in the system that must be noted and corrected. It also means the review of the system from time to time.

The review of the system is done for:

- Knowing the full capabilities of the system.
- Knowing the required changes or the additional requirements.
- Studying the performance.

TYPES OF MAINTENANCE:

- Corrective maintenance
- Adaptive maintenance
- Perfective maintenance
- Preventive maintenance

8.1 CORRECTIVE MAINTENANCE

Changes made to a system to repair flows in its design coding or implementation. The design of the software will be changed. The corrective maintenance is applied to correct the errors that occur during that operation time. The user may enter invalid file type while submitting the information in the particular field, then the corrective maintenance will display the error message to the user in order to rectify the error.

Maintenance is a major income source. Nevertheless, even today many organizations assign maintenance to unsupervised beginners, and less competent programmers.

The user's problems are often caused by the individuals who developed the product, not the maintainer. The code itself may be badly written maintenance is despised by many software developers unless good maintenance service is provided, the client will take future development business elsewhere. Maintenance is the most important phase of software production, the most difficult and most thankless.

8.2 ADAPTIVE MAINTENANCE:

It means changes made to system to evolve its functionalities to change business needs or technologies. If any modification in the modules the software will adopt those modifications. If the user changes the server, then the project will adapt those changes. The modification server work as the existing is performed.

8.3 PERFECTIVE MAINTENANCE:

Perfective maintenance means made to a system to add new features or improve performance. The perfective maintenance is done to take some perfect measures to maintain the special features. It means enhancing the performance or modifying the programs to respond to the users need or changing needs. This proposed system could be added with additional functionalities easily. In this project, if the user wants to improve the performance further then this software can be easily upgraded.

8.4 PREVENTIVE MAINTENANCE:

Preventive maintenance involves changes made to a system to reduce the changes of features system failure. The possible occurrence of error that might occur are forecasted and prevented with suitable preventive problems. If the user wants to improve the performance of any process, then the new features can be added to the system for this project.

- Preventive maintenance focuses on proactively making changes to the system to reduce the likelihood of future failures. This involves identifying potential issues before they occur and implementing measures to address them, contributing to system stability.
- The process involves forecasting potential errors that might occur in the system. By analyzing historical data, user feedback, and performance metrics, the maintenance team can anticipate and address vulnerabilities, minimizing the risk of system failures.
- Suitable preventive measures are implemented to address identified potential issues. This proactive problem-solving approach aims to prevent the occurrence of errors rather than reacting to them after they have already impacted system performance.

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- If the user desires to enhance the performance of a specific process within the system, preventive maintenance allows for the addition of new features. This can involve updates, optimizations, or the integration of new technologies to improve overall system efficiency.
- Preventive maintenance involves ongoing monitoring of the system to detect any early signs of deterioration or potential issues. Regular checks and assessments ensure that the system remains robust and operates at optimal levels.
- Users can actively contribute to the improvement of the system by expressing their needs and preferences. Preventive maintenance, in response to user feedback, can involve the addition of features that enhance user experience or address specific performance concerns.
- Users can actively contribute to the improvement of the system by expressing their needs and preferences. Preventive maintenance, in response to user feedback, can involve the addition of features that enhance user experience or address specific performance concerns.
- Preventive maintenance allows the system to stay current with technological advancements. Integrating new features or updating existing ones ensures that the system remains competitive and can leverage the latest innovations in the field

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CHAPTER 9

9. CONCLUSION

In conclusion, Blockchain-based agri-food traceability systems hold immense potential to revolutionize the food industry by enhancing food safety, promoting transparency, improving efficiency, empowering consumers, and supporting sustainable practices. Through secure and transparent tracking of food products from farm to fork, these systems can address critical challenges in the global food supply chain, ensuring the safety, authenticity, and sustainability of the food we consume.

FUTURE WORK

In future work, Enhancement of data capture and sensor integration: Developing advanced sensor technologies and integrating them seamlessly into the traceability system will provide real-time insights into product conditions, environmental factors, and potential risks throughout the supply chain. Developing mobile applications and integrating traceability data into e-commerce platforms will empower consumers to make informed choices, track the origin and journey of their food, and interact with producers directly.

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CHAPTER 10

APPENDICES

10.1 SOURCE CODE

```
import javax.swing.UIManager;

public class Main {
    public static void main(String[] args)
    {
        try
        {
            UIManager.setLookAndFeel(className:"com.jtattoo.plaf.bernstein.BernsteinLookAndFeel");

            MainFrame mf=new MainFrame();
            mf.setTitle(title: "Main Frame");
            mf.setVisible(b: true);
            mf.setResizable(resizable:false);
        }
        catch (Exception ex)
        {

        }
    }
}
```

```
package blockchainsecurity;

import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.Statement;

public class DBConnection
{
    public Statement stt;
    public Connection con;
    public DBConnection()
    {
        try
        {
            Class.forName(className:"com.mysql.jdbc.Driver");
            con=DriverManager.getConnection(url:"jdbc:mysql://localhost:3306/blockchainsecurity",user: "root",password: "root");
            stt=con.createStatement();
        }
        catch(Exception e)
        {
            e.printStackTrace();
        }
    }
}
```


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```java
public class DistributionFrame extends javax.swing.JFrame {

    String blockchainaddress,distributionname;
    DBConnection dbn=new DBConnection();
    Statement st=dbn.stt;
    String privatekey="";
    int availableamount=0;

    public DistributionFrame(String name, String badrs) {
        initComponents();

        distributionname=name;
        blockchainaddress=badrs;
        viewDetails();
    }

    public final void viewDetails()
    {
        try
        {
            ResultSet rs=st.executeQuery("select * from depositedamount where BlockchainAddress='"+blockchainaddress+"'");
            if(rs.next())
            {

            }
            else
            {
                st.executeUpdate("insert into depositedamount values('"+blockchainaddress+"','"+"0"+"')");
            }
        }
        catch(Exception e)
        {
            e.printStackTrace();
        }

        try
        {
            ResultSet rs=st.executeQuery("select * from depositedamount where BlockchainAddress='"+blockchainaddress+"'");
```

```java
        {
            ResultSet rs=st.executeQuery("select * from depositedamount where BlockchainAddress='"+blockchainaddress+"'");
            if(rs.next())
            {
                availableamount=Integer.parseInt(s: rs.getString(columnIndex: 2));
            }

            DefaultTableModel dm=(DefaultTableModel)jTable3.getModel();
            Vector v=new Vector();
            v.add(e: blockchainaddress);
            v.add(e: availableamount);
            dm.addRow(rowData: v);
        }
        catch(Exception e)
        {
            e.printStackTrace();
        }

        try
        {
            ResultSet rs=st.executeQuery("select * from PrivateKeyGeneration where BlockchainAddress='"+blockchainaddress+"'");
            if(rs.next())
            {
                privatekey=rs.getString(columnIndex: 2);
                jTextField12.setText(t: privatekey.trim());
                jTextField12.setEditable(b: false);
                jButton2.setEnabled(b: false);
            }
        }
        catch(Exception e)
        {
            e.printStackTrace();
        }

        try
        {
            jTable1.setFillsViewportHeight(fillsViewportHeight:true);
            jTable1.getColumn(identifier: "Status").setCellRenderer(new CellRenderer());
```


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```
        String prodnam=rs.getString(columnIndex: 1);
        String blockchainadrs=rs.getString(columnIndex: 2);
        String foodnam=rs.getString(columnIndex: 3);
        String quantity=rs.getString(columnIndex: 4);
        String price=rs.getString(columnIndex: 5);
        String storageplaceid=rs.getString(columnIndex: 6);
        String hash=rs.getString(columnIndex: 7);
        String status=rs.getString(columnIndex: 9);

        if(status.trim().equals(anObject: "Pending"))
        {
            blockid++;

            JLabel imageLabel = new JLabel();
            ImageIcon imageicon = new ImageIcon(filename: "StoragePlace.png");
            Image img = imageicon.getImage().getScaledInstance(width: 60, height:60, hints: Image.SCALE_SMOOTH);
            imageLabel.setIcon(new ImageIcon(image: img));

            DefaultTableModel dm=(DefaultTableModel)jTable1.getModel();
            dm.addRow(new Object[]{blockid,prodnam,blockchainadrs, foodnam,quantity,price,storageplaceid,hash, imageLabel});

            jComboBox2.addItem(""+blockid);
        }
        else if(status.trim().equals(anObject: distributionname.trim()))
        {
            blockid++;

            JLabel imageLabel = new JLabel();
            ImageIcon imageicon = new ImageIcon(filename: "StoragePlaceOpen.png");
            Image img = imageicon.getImage().getScaledInstance(width: 60, height:60, hints: Image.SCALE_SMOOTH);
            imageLabel.setIcon(new ImageIcon(image: img));

            DefaultTableModel dm=(DefaultTableModel)jTable1.getModel();
            dm.addRow(new Object[]{blockid,prodnam,blockchainadrs, foodnam,quantity,price,storageplaceid,hash, imageLabel});

            jComboBox1.addItem(item: foodnam.trim());
        }
```

```
    private void jButton2ActionPerformed(java.awt.event.ActionEvent evt) {
        // TODO add your handling code here:

        String username=jTextField1.getText().trim();
        String password=jPasswordField1.getText().trim();
        String role=jComboBox1.getSelectedItem().toString().trim();

        try
        {
            ResultSet rs=st.executeQuery("select * from Register where Name='"+username+"' and Password='"+password+"' ar
            if(rs.next())
            {
                String name=rs.getString(columnIndex: 1);
                String pass=rs.getString(columnIndex: 2);
                String role1=rs.getString(columnIndex: 3);
                String blockchainaddress=rs.getString(columnIndex: 4);
                JOptionPane.showMessageDialog(parentComponent: this,message: "Login Successfully!");

                if(role1.trim().equals(anObject: "Provider"))
                {
                    ProviderFrame mf=new ProviderFrame(name,badrs: blockchainaddress);
                    mf.setTitle("Provider - "+name);
                    mf.setVisible(b: true);
                    mf.setResizable(resizable:false);

                    mf.jTextField1.setText(t: name.trim());
                    mf.jTextField2.setText(t: pass.trim());
                    mf.jTextField13.setText(t: blockchainaddress.trim());

                    mf.jTextField1.setEditable(b: false);
                    mf.jTextField2.setEditable(b: false);
                    mf.jTextField13.setEditable(b: false);
                }
                if(role1.trim().equals(anObject: "Producer"))
                {
                    ProducerFrame mf=new ProducerFrame(name,badrs: blockchainaddress);
                    mf.setTitle("Producer - "+name);
                    mf.setVisible(b: true);
```


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10.2 SCREEN SHOTS

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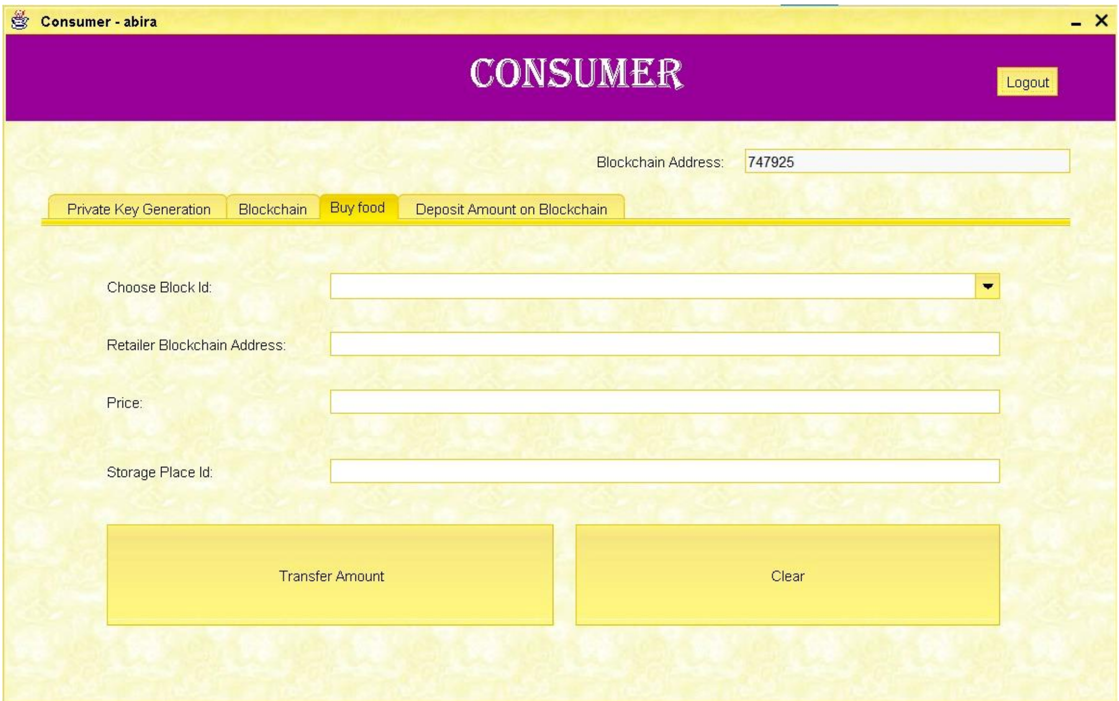
Provider - sam
Provider
Logout
Blockchain Address:
708856
Private Key generation
Own Blockchain
Sell Crop Seeds
Deposit Amount on Blockchain
Private Key Generation
Private Key:


Consumer - abira
CONSUMER
Logout
Blockchain Address:
747925
Private Key Generation
Blockchain
Buy food
Deposit Amount on Blockchain
Choose Block Id:
Retailer Blockchain Address:
Price:
Storage Place Id:
Transfer Amount
Clear

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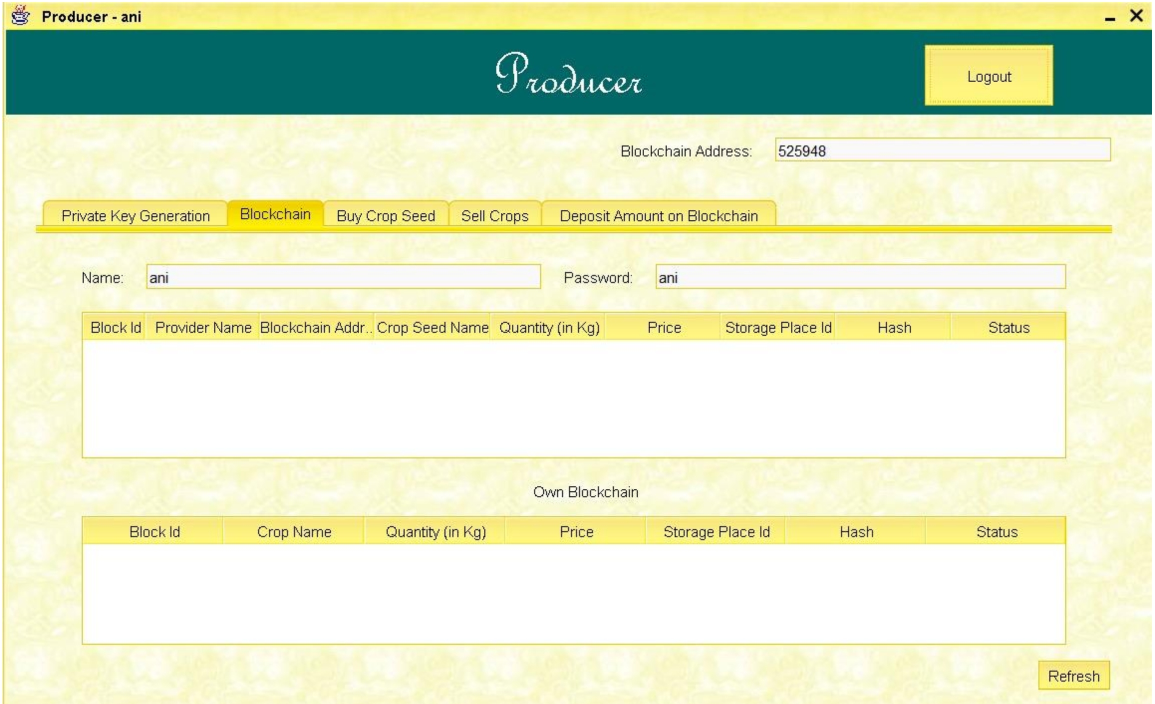
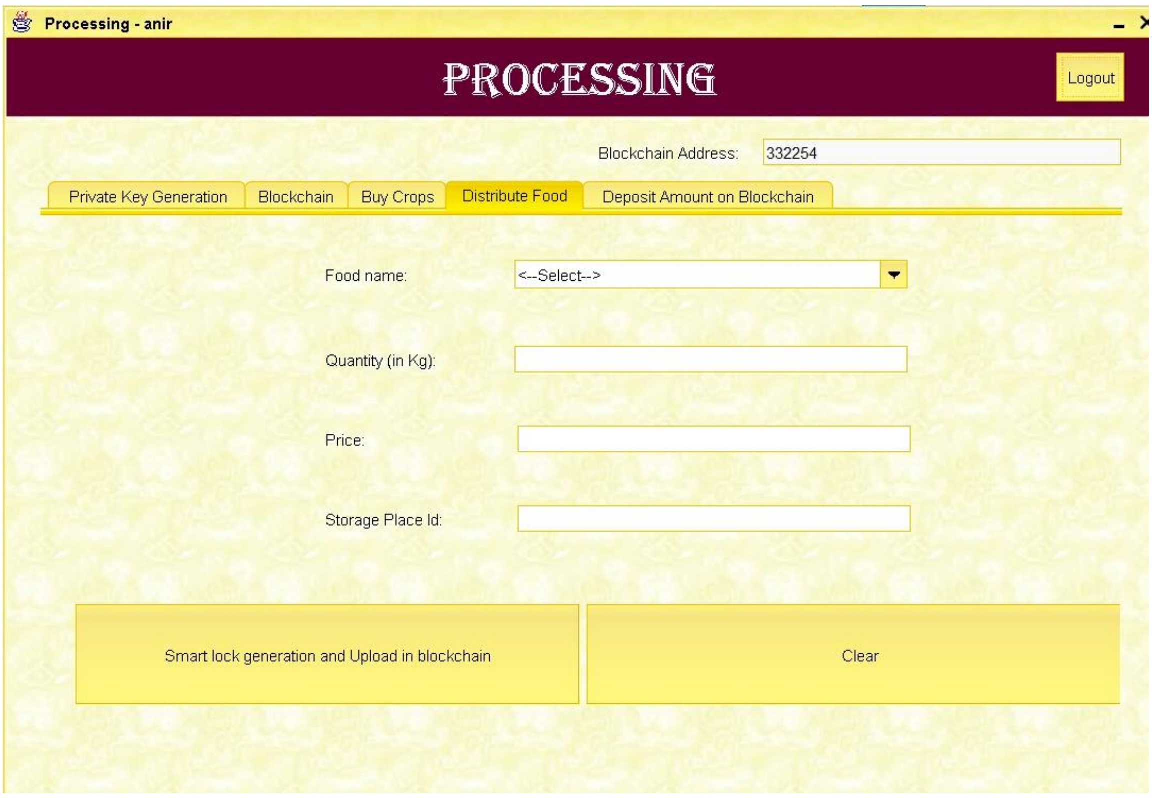

Producer - ani
Producer
Logout
Blockchain Address:
525948
Private Key Generation
Blockchain
Buy Crop Seed
Sell Crops
Deposit Amount on Blockchain
Name:
ani
Password:
ani
Block Id
Provider Name
Blockchain Addr..
Crop Seed Name
Quantity (in Kg)
Price
Storage Place Id
Hash
Status
Own Blockchain
Block Id
Crop Name
Quantity (in Kg)
Price
Storage Place Id
Hash
Status
Refresh


Processing - anir
PROCESSING
Logout
Blockchain Address:
332254
Private Key Generation
Blockchain
Buy Crops
Distribute Food
Deposit Amount on Blockchain
Food name:
<--Select-->
Quantity (in Kg):
Price:
Storage Place Id:
Smart lock generation and Upload in blockchain
Clear

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CHAPTER 11

11. REFERENCES

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