Agricultural Supply Chain using Blockchain Technology

[1]Bharti Sahu, [2] Apurva Lokare, [3]Pragati Bedse, [4]Anjali Kondle, [5]Swapnil Borase

[1]Assistant Professor, Department of Computer Engineering, Dr. D.Y. Patil Institute of Technology Pimpri, Pune, India
[2]UG Student, Department of Computer Engineering, Dr. D.Y. Patil Institute of Technology Pimpri, Pune, India
[3]UG Student, Department of Computer Engineering, Dr. D.Y. Patil Institute of Technology Pimpri, Pune, India
[4]UG Student, Department of Computer Engineering, Dr. D.Y. Patil Institute of Technology Pimpri, Pune, India
[5]UG Student, Department of Computer Engineering, Dr. D.Y. Patil Institute of Technology Pimpri, Pune, India

E-Mail- sahubharti1430@gmail.com

Abstract: In order to verify, execute, and record transactions between parties, block chains have become well-established as a digital system that integrates cryptography, data management, networking, and incentive mechanisms. Despite the fact that blockchain technology was first developed to underpin novel digital currencies for more convenient and secure payments, it currently shows enormous potential as a new basis for all types of trade. In particular, the agribusiness industry stands to gain a great deal from this technology as a platform to carry out'smart contracts' for transactions involving high-value crops. There has to be a clear delineation between private digital currencies and the underlying distributed ledger and block chain technology. The decentralised and global character of cryptocurrencies like Bitcoin makes it unlikely that central banks will be able to effectively regulate the underlying protocols of these systems. Instead of being able to monitor and manage the money itself, monetary authorities are concentrating on understanding the 'on-ramps' and 'off-ramps' that comprise the linkages to the old payments system. While the digital money aspect of block chain has little practical use, the distributed ledger feature may find significant application in farming and trade finance.

Keywords— Supplychain, Blockchain, Agricultural, crypto currencies.

1. Introduction

Academics have shown a great deal of interest in blockchain technology, which is a kind of distributed ledger. The word "blockchain" is used to describe a distributed ledger system in which a group of computers cannot be trusted to reliably record and share data about financial transactions. It is the job of each block in the chain to record a sequence of transactions, the length of which might vary. Satoshi Nakamoto, the person responsible for the invention of the Bitcoin cryptocurrency, introduced the notion of a blockchain in 2008. The application of blockchain technology in the financial industry is widely known for its capacity to offer direct trade of digital money inside an untrustworthy network of anonymous nodes, removing the need to depend on a trusted third party such as a central bank [2]. Several sectors are now using blockchain technology, including healthcare [3, 4], smart cities [5, 6], smart contracts [6, 7], the energy market [8, 9], and governance [10]. The properties of dependability, transparency, and immutability are critical for the success of this technology. This article focuses on the application of blockchain technology to track agricultural items and ensure the safety of our food supply. The term "from field to table" [10] refers to the many persons and organisations engaged in the various phases of agricultural and horticultural commodity production, transportation, processing, and marketing. Several theoretical frameworks have been proposed in recent academic debate with the goal of improving food traceability and limiting the possibility of recurrent food crises similar to their historical antecedents. The relationship between blockchain technology and food traceability, although promising, is still underutilised. The legal necessity for food traceability is mandated by law [11], although the specifics of this obligation may vary among jurisdictions. Due to the prevalence of harmful practices and challenges in the agriculture industry, the construction of a traceability system is required. One major concern is the extensive use of pesticides and fertilisers in agricultural practices, which results in the presence of harmful residues within edible food crops. Hormones and other pharmacological compounds used throughout the growing process are known to accelerate maturity and boost agricultural yield. Mineral oil is sometimes used to improve the aesthetic appeal of rice and biscuits. Numerous agricultural practices have been demonstrated to not only reduce the nutritional content of the generated items but also pose a considerable danger to consumer health [12]. The primary goal of this study is to perform a thorough analysis of the current literature on the application of blockchain technology in agricultural supply chains, with a particular emphasis on the issues involved with maintaining traceability in the context of food production and distribution. To the best of our knowledge, this is the first effort to properly study the relationship between blockchain technology and food traceability in a rural environment. The inclusion of the second evaluation [13] on blockchain and agriculture is justified by the requirement for thoroughness. It should be emphasised, however, that this study takes a broader viewpoint and does not specifically address the issue of food traceability.

2. Related work

This chapter undertakes an analysis of previously documented blockchain-based solutions for food and agricultural supply chains, with a particular focus on highlighting their notable advantages.

[14] In the scholarly article titled "Blockchain and traceability in agricultural supply chains: an examination of advancements and forthcoming challenges," authored by Giovanni Mirabelli et al. The present research undertook a comprehensive compilation and evaluation of the primary scholarly works pertaining to the possible agricultural uses of blockchain technology, with a particular focus on addressing issues related to food safety and traceability. Hormones and other compounds often used in agricultural practises serve to expedite the growth process, hence enhancing crop productivity. In a similar vein, mineral oil is sometimes utilised to enhance the overall quality of wafers and rice. Collectively, these approaches diminish the economic value of agricultural commodities while also presenting a potential risk to the well-being of nearby communities. The primary purpose of this study is to do a literature review on the assertions surrounding blockchain technology in agricultural supply chains, with a specific focus on issues pertaining to nutritional traceability. During this presentation, we will examine the potential applications of blockchain technology in the tracking of food origins and nutritional content.

In their work titled "AgriBlockIoT- A blockchain-based traceability solution integrating data from IoT devices along the value chain," Caro et al. [15] elucidate the methodology for achieving this objective. Following the formulation of a use case aimed at enhancing productivity within the ranch division, the integration of Ethereum and Hyperledger protocols was undertaken.

The publication titled "Secured Data Storage Scheme based on Blockchain for Agricultural Products Tracking" authored by Xie C et al [16] has just been released. Ensuring the security of data storage has become a primary concern in its nascent phase. Instead of prioritising the restoration of mechanisation, the primary concern about the use of blockchain technology for monitoring the feelings of agricultural commodities pertains to data storage. Hence, the authors propose a technique for dual restraint storage, whereby the blockchain transaction hash and the corresponding constraint are stored together in a correlated data structure. Every organisation is typically comprised of three primary layers: the Sensing Layer, the Data Storage Layer, and the Application Layer. The Sensing Layer offers an Internet of Things (IoT) module that comprises several components, such as a humidity instrument, a weight instrument, a temperature instrument, an acceleration sensor, a GPS component, and a GPRS component. The primary objective is to minimise the risk of unauthorised access to confidential agricultural data. The proposed data-storage structure is assessed and examined in various scenarios via the use of a representative software sample.

The innovative nutrition monitoring strategy described by Jun Lin et al. [17] incorporates all members within the smart agricultural network, using blockchain and IoT technologies. The tool has been designed with trustworthiness, user-friendliness, self-coordination, and sociability in mind. The Internet of Things (IoT) is being used to mitigate individuals' inherent tendency towards intrusive behaviour.

The paper titled "Bitcoin: A Peer-to-Peer Electronic Cash System" [18] was authored by Satoshi Nakamoto. The issue of inconsistency is addressed by the implementation of a data loading mechanism that divides the data into segments. Each segment is accompanied with the hash value of the previous segment. The issue of centralised authority is addressed by the establishment of a decentralised network consisting of interconnected peers. The blockchain-based governance system known as Bitcoin was created by an individual or group operating under the pseudonym Satoshi Nakamoto. All other individuals involved in this network possess the ability to retrieve the disclosed information on the financial transaction. In addition to the aforementioned agreement strategy, it is worth noting that block excavation principles were also included. The blockchain technology refers to a decentralised ledger system that operates inside a peer-to-peer network. In this network, every participating node has a replica of the ledger. The data stored within the blockchain is securely translated to ensure its integrity. Furthermore, the addition of new information or blocks to the blockchain follows a preset order.

In the study titled "A Supply Chain Traceability System for Food Safety Based on HACCP, Blockchain, and the Internet of Things" authored by Feng Tian [19], a novel decentralised traceability system is proposed. This system utilises internet-of-things and blockchain technologies to address concerns related to overall grading. The supply of real-time evidence on nutrition produce fortification to all stream restraint applicants by centralised evidence bodies mitigates related risks and ensures the delivery of more precise, dispersed, usable, and coordinated information. Nevertheless, the majority of these establishments exhibit characteristics of hierarchy, authoritarianism, inequality, and impermeability, potentially giving rise to issues such as academic dishonesty, exploitation, biassed data, and external meddling.

The work titled "Supply Chain Management Centred on Blockchain: A Systematic Mapping Study" by Youness Tribis et al. [20] provides a comprehensive examination of research planning in the field of supply chain management (SCM) based on blockchain technology (BCT). Furthermore, alongside the farming stream shackles, the improvement of engineering safeguards, the administration of proprietorship in the production sector, the management of common-pool supply, the procurement and stock administration, the administration of stream restrain superiority, and the assessment of stream restrain presentation dimensions are identified as additional blockchain applications within the realm of supply chain management that warrant further investigation. Nevertheless, empirical studies conducted in real-world settings have shown that the use of context-based keys may effectively reduce instances of failure.

In the article titled "The Arrival of Blockchain Technology in Agriculture and Food Supply Chains" by Andreas Kamilaris et al. [21], the authors examine the effects of blockchain technology on the agricultural industry and the management of food supply chains. They present current initiatives and programmes, analyse the global implications, risks, and opportunities associated with blockchain adoption, and express a confident attitude towards the development of strategies. The use of blockchain technology has the potential to effectively manage a transparent nutrition supply chain. However, the findings indicate that several challenges continue to hinder its widespread adoption among farmers and other entities. Valid concerns include a range of issues pertaining to procedural aspects, planning processes, legislative activities, and supervision frameworks.

The authors, Shangping Wang et al. [22], present a blockchain-based architecture for implementing granular access control in distributed storage networks. The Ethereum blockchain is now being used for the development of a decentralised logistics company. The objective of this study is to identify strategies for enhancing the security of decentralised storage systems, hence mitigating concerns related to data breaches and possible vulnerabilities in disaster-prone areas. The InterPlanetary File System (IPFS), a fully decentralised file system, is used for the purpose of data loading. A file encoding technique is used to encrypt the file on the target system prior to its upload into the InterPlanetary File System (IPFS). then, the cypher transcript has been encoded and then posted to the InterPlanetary File System (IPFS). The hash of the saved folder is generated by IPFS and then appended to the Ethereum blockchain. However, within the context of the Internet of Things (IoT), the suggested technique is deemed unfeasible owing to the additional issue of handling.

The user's text "Y.P." does not provide any information or context. Therefore, The research conducted by Lin et al. [23], titled "Blockchain: The Evolutionary Next Step for ICT E-agriculture," was published in the esteemed journal Science. This article provides an overview of fundamental concepts related to data, announcement, and blockchain comprehension. They developed both an electrical farming technique and a robust tool. This conference has the potential to develop fundamental principles for agricultural organisations that use blockchain technology. The proposed methodology, however, fails to consider the true behaviour and disposition of the system being investigated.

[24] The paper titled "Emerging Opportunities for the Application of Blockchain in the Agri-Food Industry" by Mischa Tripoli et al. explores the concepts of distributed ledger technology (DLT) and smart contracts. Dramatists assert that distributed ledger technologies (DLTs) with significant potential for achieving long-term evolution objectives encounter comparable challenges in terms of practicality and implementation.

The problem was examined in a work authored by Dianhui Mao et al., titled "Credit Evaluation System Based on Blockchain for Multiple Stakeholders in the Food Supply Chain" [25]. A blockchain-enabled, smart-contract-driven evaluation system was developed to effectively handle operational limits in the field of nutrition stream management.

[26] In the scholarly article titled "Blockchain-Based Soybean Traceability in the Agricultural Supply Chain," authored by Salah K et al., The monitoring and tracing of soybean stream shackles are facilitated with the use of the Ethereum blockchain and smart contracts in this assertion. The use of this method enables businesses to operate without reliance on intermediaries or centralised administrative entities. The primary objective of the writers was to provide a comprehensive description of the organisational methodology, entity-relationship diagram, sequence diagram, and algorithms used in the blockchain-based system. The proposed framework encompasses a multitude of generic structures that have the potential to be relevant to a wide range of constraints in agricultural streams, extending beyond the specific context of soybeans. Several benefits may be identified, such as truthfulness, stability, and trustworthiness.

In their scholarly article titled "Traceability System of Agricultural Product Based on Blockchain and Application in Tea Quality Safety Management," Liao et al. (27) provide a proposal for a traceability system that utilises blockchain technology to ensure the quality and safety of tea products. The three components of the trajectory include informational content, professional discernment, and expository elements. In the documentary, both the Ethereum Blockchain and a MySQL-based relational database are shown as secondary resources. The last individual engaging with the tea product proceeds to make a purchase and afterwards employs a QR code scanning mechanism to get comprehensive details pertaining to the said product. The blockchain is used for the purpose of validating the integrity and genuineness of the information being accessed. The integration of blockchain technology with a web-based service discussion platform has significantly enhanced the organization's dependability and security.

[28] In the study conducted by Kim et al. (2018), titled "Integrating Blockchain, Smart Contract-Tokens, and IoT to Design a Food Traceability Solution," the authors introduce Harvest Network as a hypothetical food traceability system. This system incorporates various technologies, including the Ethereum Blockchain, the Internet of Things (IoT), the GS1 approach, and smart contracts. The playwrights further highlight the constraints of the agriculture sector with the introduction of "food bytes," a data format that enables customers to trace the provenance of their food from the field to the dining table.

In their publication, Hua J. et al. introduce a research paper titled "Blockchain-Based Provenance for Agricultural Products: A Distributed Platform with Duplicated and Shared Bookkeeping" [29]. The two most crucial attributes of agricultural traceability organisations are the reliability of data and the incorporation of data across several actor data structures. Discussions pertaining to these subjects are occurring extensively inside the peer-to-peer web. The authors provide a foundational framework and a hierarchical structure for the agricultural traceability system. Comprehensive fixing records encompass various details, including the date, time, location, profession, individual involved, action type, ideas (such as the specific pesticide name and quantity utilised), memo (i.e., supplementary ink), and farmer's tag. Similarly, attribution records comprise comparable information, such as the date, time, location, profession, individual involved, action type, ideas (such as the specific pesticide name and quantity utilised), memo (i.e., additional ink), and farmer's tag.

Yadav et al. [30] propose the use of blockchain technology as a solution for addressing the special challenges faced by Indian farmers. In line with this, a mobile application based on blockchain is now being development to cater to the distinct needs of Indian farmers. The efficacy of this solution is being proved via a comprehensive evaluation process using the Delphi approach. The application will include three primary functionalities, including data traceability, monitoring facilitated by smart contracts, and data organisation.

The authors, Filippo Gandino et al. [31], propose an agenda in their 2009 research paper titled "On Improving Automation by Integrating RFID in the Traceability Management of the Agri-Food Sector." This agenda involves the use of RFID tags to establish a connection between commodities and their corresponding information inside a fruit warehouse. In order to evaluate the effectiveness of traceability and explore the possibilities for technological advancements, it is proposed to implement a self-loading traceability stage based on RFID technology. This study presents a novel self-loading stage for traceability, which use RFID technology to evaluate the existing levels of traceability proficiency and forecast potential advancements in computerised systems. This case study posits that the use of RFID technology in enhancing agricultural traceability may provide many benefits and advantages, such as expedited information management and inquiry processes.

[32] In a study conducted by Baralla et al. (2019), titled "A Blockchain-Based System to Ensure Transparency and Reliability in the Food Supply Chain," the authors propose a method to achieve this objective. In Sardinia, a comprehensive nutrition stream constraint assembly was developed, using an Ethereum-based blockchain and smart contracts. Baralla et al. underscore the significance of this approach in promoting sustainable tourism and safeguarding the unique products of Sardinia.

A. Introduction to Blockchain Technology:

Blockchain technology has emerged as a transformative force in the digital landscape, reshaping the way we manage data, conduct transactions, and establish trust in the digital age. At its core, a blockchain is a decentralized and immutable ledger system that operates on a network of computers, each known as a node, working collaboratively to validate, record, and secure transactions. Unlike traditional centralized systems, where a single entity holds control and trust, blockchain leverages cryptographic techniques to ensure the integrity and transparency of data, enabling a trustless environment where participants can interact with confidence.

The most renowned application of blockchain technology is in the realm of cryptocurrencies, with Bitcoin being the pioneering example. Bitcoin introduced the concept of a peer-to-peer digital currency, allowing individuals to transact directly without the need for intermediaries like banks. However, the potential of blockchain extends well beyond cryptocurrencies. It finds utility in supply chain management, where it enhances transparency and traceability, in finance through the creation of decentralized financial systems (DeFi), in healthcare for securely managing patient records, and in various other sectors seeking to streamline processes, reduce fraud, and empower users with greater control over their digital assets and information.

In this era of rapid digital transformation, understanding the foundational principles of blockchain is not only relevant but essential. This introduction serves as a gateway to explore the multifaceted world of blockchain technology, offering insights into its decentralized nature, cryptographic security, and the diverse applications that are poised to reshape industries and the way we interact in the digital realm.

B. Agricultural Supply Chain Using Blockchain Technology:

1. **Introduction to Agricultural Supply Chain and Its Challenges**: The agricultural supply chain is a complex network involving farmers, suppliers, distributors, and consumers. Historically, this system has faced challenges related to traceability, transparency, and efficiency. These issues can result in food safety concerns, delays, and waste within the supply chain.
2. **Blockchain's Role in Transforming Agriculture**: Blockchain technology has emerged as a transformative force in agriculture by addressing these challenges. Its decentralized and immutable ledger system provides a secure and transparent platform for recording and verifying transactions at each stage of the supply chain.
3. **Traceability and Transparency**: Blockchain enables end-to-end traceability, allowing consumers to track the journey of agricultural products from the farm to their table. Each transaction, from planting to harvesting, packaging, and distribution, is recorded on the blockchain. This transparency instills trust and ensures the authenticity of products.
4. **Food Safety and Recall Management**: In cases of foodborne illnesses or contamination, blockchain technology facilitates rapid and precise recalls. By pinpointing the exact source of the issue, it minimizes the impact on public health and reduces financial losses for producers and retailers.

5. **Smart Contracts for Payments**: Smart contracts, a key feature of blockchain, automate payment processes. Farmers can receive immediate payments once their produce meets predefined quality and quantity criteria, addressing financial inclusion challenges for small-scale farmers and reducing delays and disputes.
6. **Reducing Fraud and Counterfeits**: Blockchain's cryptographic security and transparency make it difficult for fraudulent activities and counterfeit products to infiltrate the supply chain. This protects consumers and maintains the reputation of agricultural products.
7. **Supply Chain Efficiency**: Blockchain technology streamlines supply chain operations by providing real-time visibility into inventory levels, demand, and logistics. This optimization reduces waste, lowers costs, and enhances overall efficiency.
8. **Market Access and Fair Trade**: Blockchain can empower small-scale farmers by providing them with verifiable records of their products' quality and origins. This documentation helps them access larger markets and ensures fair trade practices.
9. **Sustainability and Certification**: Blockchain can verify sustainability practices, such as organic farming or fair trade certification. This information is invaluable to consumers who prioritize environmentally friendly and ethical products.
10. **Global Collaboration**: Blockchain's decentralized nature promotes collaboration between stakeholders across borders. International trade in agricultural products benefits from enhanced trust, reduced paperwork, and more efficient customs procedures.

In conclusion, blockchain technology is fundamentally reshaping the agricultural supply chain by enhancing traceability, transparency, and efficiency. Its ability to address food safety concerns, streamline payment processes, reduce fraud, and promote sustainability makes it a transformative tool in ensuring a resilient and sustainable food system for the future. As blockchain adoption continues to grow, we can expect even more innovation and positive impact in the agricultural industry.

C. Advantages of Agricultural Supply Chain Using Blockchain Technology:

The advantages of using blockchain technology in agricultural supply chains are numerous and have the potential to greatly improve the efficiency, transparency, and sustainability of the entire system. Here are some key advantages:

1. **Transparency and Traceability**: Blockchain provides a tamper-proof ledger of all transactions and activities within the supply chain. This transparency allows all stakeholders, from farmers to consumers, to track the journey of agricultural products from production to distribution. It ensures that information about the origin, quality, and handling of products is readily available, reducing the risk of fraud and counterfeits.
2. **Enhanced Food Safety**: Rapid and accurate traceability enabled by blockchain technology is essential for food safety. In the event of a contamination or foodborne illness outbreak, the source of the issue can be identified quickly, allowing for targeted recalls and reducing the impact on public health and the reputation of the agricultural industry.
3. **Efficient Recall Management**: Blockchain enables more efficient and precise recalls by pinpointing the exact products and batches affected by safety concerns. This minimizes the cost and waste associated with broad-scale recalls and helps maintain consumer trust.
4. **Smart Contracts for Fair Payments**: Smart contracts automate payment processes based on predefined criteria, such as product quality and quantity. This ensures that farmers receive fair compensation for their produce without delays or disputes, contributing to financial inclusion and economic stability for small-scale farmers.
5. **Reduction in Fraud and Counterfeiting**: Blockchain's cryptographic security and immutability make it challenging for bad actors to introduce fraudulent products into the supply chain. This protects consumers, maintains the reputation of agricultural products, and reduces economic losses.
6. **Streamlined Supply Chain Operations**: Real-time data and visibility provided by blockchain technology enable better decision-making and inventory management. This optimization of supply chain operations reduces waste, lowers costs, and improves overall efficiency.

7. **Market Access and Fair Trade**: Small-scale farmers and producers can benefit from blockchain technology by providing verifiable records of their products' quality, origin, and adherence to fair trade or sustainability standards. This empowers them to access larger markets and receive fair compensation for their efforts.
8. **Sustainability Verification**: Blockchain can verify and record sustainable practices, such as organic farming or responsible sourcing, ensuring that consumers have access to products that align with their ethical and environmental preferences.
9. **Global Collaboration**: Blockchain's decentralized nature promotes collaboration among stakeholders, even across international borders. This collaboration enhances trust, reduces paperwork, and streamlines customs and regulatory processes for international trade.
10. **Data Security and Privacy**: Blockchain's security features protect sensitive information, such as proprietary data and trade secrets, from unauthorized access or manipulation, ensuring data integrity and privacy for all participants.

In conclusion, blockchain technology offers a range of advantages that can transform agricultural supply chains into more transparent, efficient, and sustainable systems. These advantages benefit not only farmers and producers but also consumers, regulators, and the entire industry by enhancing trust, reducing risks, and promoting fair and ethical practices.

D. Challenges of Agricultural Supply Chain Using Blockchain Technology:

While blockchain technology offers numerous advantages for agricultural supply chains, its adoption also presents several challenges and obstacles that need to be addressed:

1. **Integration Complexity**: Implementing blockchain technology requires significant changes to existing systems and processes. Integrating blockchain into agricultural supply chains can be complex, especially for traditional systems that rely heavily on paper-based records or outdated digital systems.
2. **Technical Expertise**: Ensuring the proper development, deployment, and maintenance of blockchain systems requires specialized technical expertise. Many stakeholders in the agricultural industry may lack the necessary knowledge and resources to manage blockchain technology effectively.
3. **Costs and Infrastructure**: Developing and maintaining a blockchain network can be costly, particularly for small-scale farmers or less economically developed regions. The infrastructure needed to support blockchain, including reliable internet connectivity and computing resources, may not be readily available in some areas.
4. **Interoperability**: Different blockchain platforms and solutions may not be compatible with each other. This lack of interoperability can hinder collaboration and data sharing among various participants in the supply chain.
5. **Scalability**: As the number of participants and transactions on a blockchain network increases, scalability becomes a concern. Ensuring that the blockchain can handle the growing volume of data and transactions is crucial for its long-term viability.
6. **Data Privacy and Security**: While blockchain is known for its security features, it's essential to protect sensitive data, such as proprietary agricultural practices or intellectual property. Privacy concerns and data breaches can still occur if proper security measures are not in place.
7. **Regulatory and Legal Challenges**: The regulatory environment for blockchain in agriculture is still evolving. Different regions and countries may have varying regulations regarding data ownership, smart contracts, and digital identities, leading to legal complexities.
8. **Education and Adoption**: Farmers and other stakeholders need education and training on blockchain technology. Widespread adoption can only occur when individuals and organizations understand the benefits and how to use blockchain effectively.
9. **Resistance to Change**: Resistance to change is a common challenge in any industry. Some stakeholders may be hesitant to embrace blockchain due to a fear of disruptions, uncertainties, or the need to learn new processes.

10. **Environmental Concerns**: Some blockchain networks, especially those using energy-intensive consensus mechanisms like Proof of Work (PoW), have raised environmental concerns due to their energy consumption. Developing more sustainable blockchain solutions is a pressing issue.

Addressing these challenges requires collaborative efforts among stakeholders, government support, and ongoing research and development. Overcoming these obstacles is essential for realizing the full potential of blockchain technology in agricultural supply chains, with benefits such as improved transparency, food safety, and fair compensation for farmers.

3. Result and Dicussion

A. Analysis Models: Sdlc Model To Be Applied- SDLC model to be applied Waterfall Model:

The Waterfall Model is considered to be one of the oldest and most well-established methodologies for software development. The phrase "life cycle model" may also be used to denote this kind of study. Due to its inherent simplicity, this concept is easily comprehensible and user-friendly. Given the interdependence of each step within this process, progression to subsequent stages is contingent upon the completion of the preceding level. This practise is often used for activities with limited levels of participation. This paradigm requires a consistent or unchanging need. In fig 1, 2, 3 the Waterfall Model, System Architecture and System Flow given.

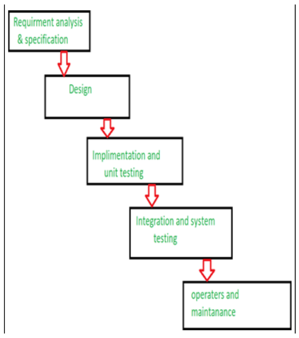

Fig 1: Waterfall Model

B. System Design

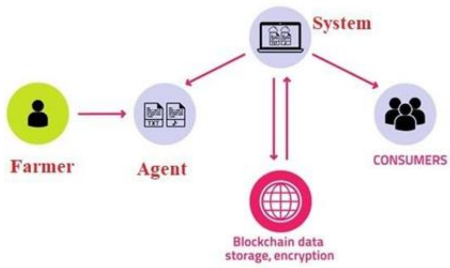

Fig 2: System Architecture

The block in the system has a record of each transaction, represented by a hash value. The virtual block chain is formed by linking each successive block to the preceding one. The hash of a new block is computed by merging its contents with the hash of the preceding block. This guarantees that in the event of any modification to a single block, the subsequent hash of the whole block will inevitably be modified as well. To ensure the security and confidentiality of the data, it is replicated across many servers. The use of a mobile application to oversee the whole agricultural supply chain ensures transparency and ease of access throughout the process.

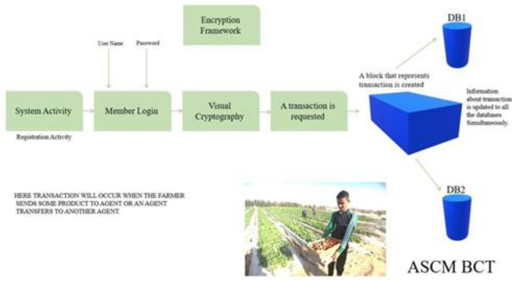

Fig 3: System Flow

C. DATA FLOW DIAGRAMS

DFDs are graphical representations of the processes inside an information system, showing how data is transferred from one part of the system to another. As an initial step towards providing a full description of the system, a Data Flow Diagram (DFD) is typically employed. When it comes to representing and visualising data processing operations, data flow diagrams (DFDs) may also be useful. In fig. 4, 5, 6 the Level 0 Data Flow Diagram, Level 1 Data Flow Diagram an Entity Relationship Diagrams given.

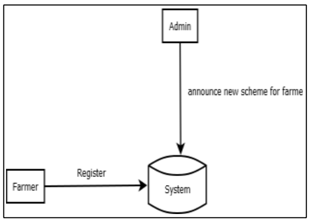

Fig 4: Level 0 Data Flow Diagram

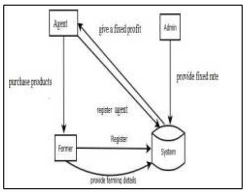

Fig 5: Level 1 Data Flow Diagram

D. Entity Relationship Diagrams

The relationships between entities in a database may be visualised with the use of an entity relationship diagram (ERD). An entity is a thing or a piece of data in this situation. A collection of entities with shared properties is called a "entity set." These items have traits that serve as indicators of their nature. By outlining the entities, their characteristics, and the links between them, an ER diagram may show the logical structure of a database.

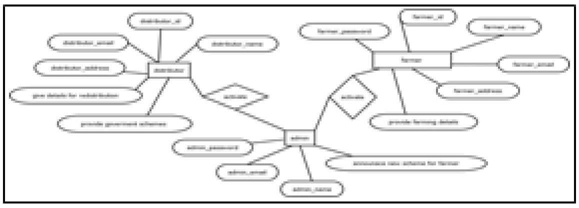

Fig 6: Entity Relationship Diagrams

4. UML DIAGRAMS

A. Class Diagram

A class diagram is a kind of static structural diagram within the domain of Unified Modelling Language (UML) that mainly delineates the system's design. The representation of classes, traits, activities, methods, and the relationships among objects are all shown.

B. Activity Diagram

An activity diagram is a graphical representation, similar to a flowchart, that illustrates the sequence and flow of activities from one to another. These actions may be characterised as a function of the system. The control flow often entails the progression from one action of an application to another. This phenomenon may manifest as either branching, sequential, or concurrent. Activity diagrams have the capability to handle many types of flow control and include diverse features, such as join or fork, in their structure. Activity diagram shown in fig 7.

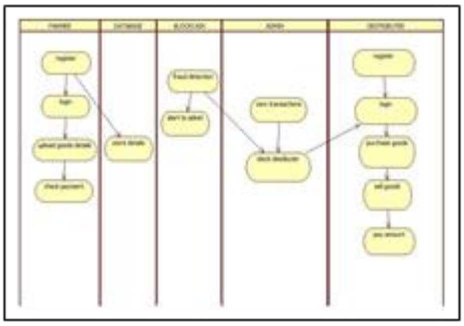

Fig 7: Activity Diagram

C. COCOMO Model

The Cocomo (Constructive Cost Model) framework is based on the Lines of Code (LOC) regression technique. It is a technique that, by following a set of rules, may reliably estimate the size, effort, cost, duration, and quality of software development projects. It was initially established by Barry Boehm in 1970, and because it is based on the examination of 63 different projects, it is considered to be one of the models with the greatest documentation. The Cocomo is responsible for the results of both the effort and the schedule, which are the two primary elements that are used to determine the quality of software.

- Effort refers to the amount of physical labour that will be necessary to finish a job. The units of measurement for it are person-months.
- Timetable: This term refers to the total length of time necessary to do the task, which is, of course, directly related to the amount of effort that is expended. The length of time is determined by the units of measurement used, such as weeks and months.
- Various models of Cocomo have been suggested in order to anticipate the cost estimate at various levels. These models are differentiated by the degree of precision and correctness that is necessary. Every one of these models is adaptable to a wide range of endeavours, the particulars of which will dictate the value of the constant that will be included into the future computations. The following list describes some of the properties that are unique to the various kinds of systems.

According to Boehm, organic, semidetached, and embedded systems are defined as follows:

- An organic software project has a small team, a well-known problem, and team members with little prior experience in the field. All of these prerequisites have to be satisfied.
- The important features of a software project are said to be of the semi-detached type if they fall somewhere in the middle ground between those of the organic type and those of the embedded type. Some examples of these necessary qualities include the size of the team, experience, and comprehension of the various programming environments. When compared to organic projects, those that are classified as semi-detached are far less common and considerably more challenging to construct. Organic projects are more straightforward. As a consequence of this, they need a much higher level of competence in addition to an enhanced sense of direction and inventiveness. Compilers and other kinds of embedded systems, for example, might be considered to be of the Semi-Detached form of system.
- Embedded is the category of software projects that requires the highest degrees of complexity, inventiveness, and expertise. These kinds of projects are called "embedded." The aforementioned

sorts of initiatives are included in the scope of this specific classification. This kind of software demands a larger team size than the other two models require, and the developers also need to possess a degree of knowledge and creativity that is appropriate with the product's level of complexity. Additionally, the team size must be greater than what is required for the other two models.

Each of the aforementioned types of systems use a distinct set of values for the constants that are included into the Effort Calculations. Different Types of Models: The COCOMO system is structured in a hierarchical manner, consisting of three levels, with each level being progressively more detailed and precise than the preceding one. The parameters included in our study provide sufficient flexibility to accept any one of the three potential configurations. The following examples illustrate several COCOMO models.

The COCOMO Core Model The simplest level of COCOMO, known as Basic COCOMO, may be used to rapidly and roughly estimate software expenses. Because of the limited number of variables considered, its accuracy suffers slightly.

D. Reconciled Estimates

The part of the project will be hardware, which need to implement in our system on besides, also need to estimates the cost of the application which are designing keeping in mind the following factor:

- Its market demand, what it has got to offer to the customer
- Its relevance in the current world.
- The extent to which it can adhere to its objective of secured data transmission.

E. Reconciled Estimates

The part of the project will be hardware, which need to implement in our system on besides, also need to estimates the cost of the application which are designing keeping in mind the following factor:

- Its market demand, what it has got to offer to the customer
- Its relevance in the current world.
- The extent to which it can adhere to its objective of secured data transmission.

5. OVERVIEW OF MODULES

Blockchain technology (BCT) may be described as an unalterable digital ledger that records transactions in a sequential manner, with each transaction being assigned a timestamp and linked to the preceding one. The present system operates on a peer-to-peer (P2P) network architecture and is accessible for unrestricted sharing among users from diverse backgrounds. A fresh "block" of data is appended to the chain each time a new set of transactions is included, thus the nomenclature. Once data has been put to a blockchain, it becomes immutable and cannot be erased. Furthermore, any alterations to the data need unanimous approval from all users involved. Due to its "write-once, append-many" nature, each transaction inside the system may be validated and audited in an independent manner. All transfers of products between agents will only take place via the application interface, facilitating the movement of products from the farmer to the agent, as well as from the agent to any other agent. The database is secured by the implementation of the Advanced Encryption Standard (AES), and comprehensive measures are taken to maintain transparency by storing transaction records across many sites. Visual cryptography is used as a means of safeguarding user login credentials inside a system.

A. Tools And Technologies Used:

Java Development Kit 1.8 Setup Please double-click the "jdk-8-ea-bin-b32-windows-i586" file to begin the installation. The user is presented with the Java Development Kit (JDK) Licence dialogue. The installation of JDK cannot continue unless the related licencing agreement is accepted.

The user may provide a different location for the JRE Files in the JRE Custom setup window. The thorough conversation suggests a smooth setup.

IDE NetBeans 7.3.1 Setup After the download has finished, you can begin the installation process by running the installer. The Windows installer executable file is always labelled with the.exe extension. Please double-click the installer file to begin the installation procedure. Users who have obtained the "All" bundle have the flexibility to tailor the setup to their own needs. Follow the prompts on the installation's Welcome page to get started. a. Choose the "Customise" menu item.

- Make your preferred adjustments in the next Customise Installation dialogue box.
- Select "Next" when prompted to continue the installation on the Welcome screen. The terms and conditions of the licencing agreement may be found on the licencing Agreement page and should be read thoroughly. When the review is finished, the user should click the "Next" button after checking the acceptance box. Users must consent to the installation of JUnit by clicking through to the JUnit Licence Agreement page. They need to give some serious thought to what they want and make an informed decision. Users may then click the "Next" button to continue after making their selection. It is requested that the following be done on the NetBeans IDE installation page: Accepting the default installation path for the NetBeans IDE is an option, although the user is free to change it if they so want. In order for the installation to succeed, it is essential that the directory be completely empty. In addition, you must have read/write access to this directory in the user profile you're using to run the installation.
- Users may pick a different JDK installation from the drop-down menu or stick with the default setup for use with the NetBeans IDE. If the NetBeans IDE installation wizard can't find a JDK that's compatible with your system, it's probably because you didn't put it there. In this case, you'll need to provide the path to an existing Java Development Kit (JDK) installation before clicking "Next" or cancelling the installation altogether. The installation procedure may be resumed when the required version of the Java Development Kit (JDK) has been installed.
- The installation page for Apache Tomcat gives customers the choice to change the default installation directory or keep it. To proceed, click the "Next" button below.
- When you reach the Summary page, double check the listed components to ensure they are what you plan to install, and make sure you have enough free space on your machine to do so.
- If you haven't already, click the "Install" button to begin setting up.

Users may choose to provide anonymous usage statistics at the "Setup Complete" page by clicking the "Finish" button.

B. MySQL Database

The ease of database administration is enhanced with the use of Microsoft's proprietary SQL Server, which serves as a relational database management system. A database server is a software application primarily designed to facilitate the storage and retrieval of data upon request from other software programmes. These applications have the potential to operate either on a local system or via a network, with the possibility of the network including or excluding the Internet. Microsoft SQL Server is available in many versions that cater to different use scenarios, ranging from individual machine utilisation to supporting a large number of simultaneous users on the Internet.

C. Algorithm Details:

An algorithm is a step-by-step procedure or set of rules for solving a problem or completing. The Advanced Encryption Standard (AES) is used for the encryption of the database. The encryption procedure employs a collection of specifically developed keys known as round keys. These procedures are implemented in conjunction with other operations, on an array of data that exclusively contains a single block of data, which is the data intended for encryption. The aforementioned collection is often referred to as the state array.

STEPS:

- The process of obtaining the set of round keys from the cypher key is known as key derivation.
- The state array is initialised by assigning the block data (plaintext) to it.
- The first round key is added to the beginning state array.
- Conduct a series of nine iterations of state modification.
- Execute the tenth and ultimate iteration of state manipulation.

- The final state array should be copied as the encrypted data, also known as ciphertext.

The Secure Hash Algorithm-256 (SHA-256) is a cryptographic hash function that generates a 256-bit digest and is compliant with Federal Information Processing Standard 182-2. In this case, the function in issue is a keyless cryptographic hash function. It has features that suggest it is an MDC, or a Manipulation Detection Code. The processing of a message requires partitioning it into 512-bit blocks, which may then be subdivided into 16-bit blocks if necessary. There are 64 iterations of each of these blocks. A cryptographic hash, also known as a digest, acts as a digital signature for files of text or data. The 256-bit (32-byte) cryptographic hash value generated by the SHA-256 algorithm is very unlikely to be duplicated for any given input text.When compared to encryption, a hash function cannot be unmasked to reveal its original data. It functions as a one-way cryptographic function, with a fixed size independent of the input text length. This is helpful in cases when comparing "hashed" versions of communications is preferred than decrypting the content to acquire the original.

6. Conclusion

In conclusion, having an in-depth knowledge of blockchain technology has the potential to make it easier to implement a smart farming system that is reliable, self-regulating, transparent, and sustainable. This kind of system would include all players within the ecological domain, regardless of whether or not they trust one another. In order to actively participate in the Internet of Things (IoT) market, AgriBlockIoT capitalises on its prior expertise working with Blockchain technology. Its major goal is to deliver data that is transparent, robust, immutable, and verifiable with the aim of making agri-food traceability easier to accomplish. The whole strategy uses the Ethereum blockchain and smart contracts to remove middlemen and centralised processing centres, as well as to make it easier to monitor, trace, and carry out transactions that are possible across the agricultural supply chain. This investigation will, in the near future, focus on repairing the broken traceability system that is housed inside the blockchain-based farming stream chain.

The application of Internet of Things (IoT) expertise makes the structuring and transfer of data easier, which in turn reduces the risk of mistakes caused by manual access. In order to ease the construction of a service foundation, improve the comprehension of client operators, and expedite the process as a whole, real-time integration of QR code information may be used. Despite the fact that the Blockchain record is open and decentralised, the data is still protected and can be checked for accuracy. It is vital to make use of cryptographic analysis methods for the purposes of encoding in order to meet the requirements for mitigating the existence of illegal information handling.

Hence, our objective is to develop a software prototype using Java for web-based applications, with the aim of implementing Blockchain Technology (BCT) in the domain of supply chain management. The inclusion of elements such as decentralisation, visual cryptography, hash algorithms, and encrypted databases is being considered for incorporation into the blockchain system.

Utilise the Java programming language. This enables the surveillance of the agricultural supply chain and the determination of a minimum price for certain commodities.

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