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Research Article

A Comprehensive Literature Review For The Use Of Blockchain Technology In Supply Chain Management In Agricultural Sector

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ABSTRACT

Traditional supply chains in the agricultural industry are plagued by a number of serious issues, including a large number of players, difficult communication brought on by extended supply chain timeline, lack of trust, and a centralized system. Particularly for the fundamental agricultural food supply chains that make up most people's daily diets, it is particularly difficult to track product safety or quality issues due to the complex, interconnected nature of an agricultural supply chain. With the advent of blockchain technology, a nagging issue with the traceability mechanism of agricultural food supply chains has been successfully resolved. Since it offers safe traceability and control, immutability, and the development of stakeholder confidence in a low-cost IT solution, blockchain has emerged as a leading technology. The widespread adoption of blockchain in supply chains is hampered by several factors, despite the fact that it is having a substantial impact in many other areas. This paper presents a comprehensive review of the various applications of blockchain technology in logistic and supply chain management systems implemented in the agricultural industry. It also discusses the directions of future research in the field and a Blockchain-powered framework is proposed.

Keywords: Blockchain, SCM, Agriculture Blockchain.

1 Introduction

The Supply Chain Management (SCM) process is a collection of multiple individual processes performed to turn raw materials into finished goods, maximize customer value, and secure a sustainable competitive advantage for an organization. The supply chain process can also be seen as a network of organizations that make up the entire system, from manufacturing to trading. The supply chain creates a complicated network chain structure by connecting a wide range of businesses, including suppliers, logistics service providers, processors, distributors, retailers, and consumers. This intricate supply chain is most often comprised of hundreds of intermediate steps, thus taking a lot of time and involving many different geographical areas. The authorities involved in the supply chain must be effective and precise in their information delivery to win the trust of end users. They also must be the ones to uphold the quality and credibility of the supply chain.
These organizations help both buyers and sellers, but there are some obvious problems with this "middleman system" [4]. First off, it fosters dependence because of its centralized nature. The transaction processing now has a single point of failure, which is the second issue. Additionally, some businesses take a while to process transactions. Additionally, the intermediary adds costs to the services, lowering margins. For instance, greater bill of lading fees for maritime freight operations or higher interchange fees for credit and debit cards. Additionally, central institutions oversee one of the future's most important assets: the full transaction data, which jeopardizes the privacy of all parties [5] .
The importance of new technology-based competitors has been the subject of numerous discussions [6]. In this environment, academics are debating whether new, emerging technology might finally serve as a panacea to solve this 'middleman problem.' The question of whether blockchain technology may take use of the financial advantages of decentralization is being discussed in this context by experts from a variety of fields, including banking, government infrastructure, property and ownership, and education. Blockchain is receiving interest

from researchers and professionals in SCM research in addition to the expanding interest within these disciplines [7]. The prevalent SCM systems in the agricultural industry have three main issues. First, there are a lot of people involved in the supply chain, and communication between them is difficult, making the chain's entire cycle take a long time. The information sharing is then subpar as a result of the vast number of participants and dissemination across several networks, and data is not trusted by participants. Additionally, the agricultural food supply chain is a centralized system with readily altered data and authority concentrated under a single management. [8]. Despite the fact that the central manager is supervised by government agencies, human oversight is never perfect.

2 Background

In this section we provide a rough overview of Blockchain technology, its roots and the possible applications on blockchain technology in the field of Supply Chain Management in the Agricultural industry.

2.1 What is Blockchain technology?

Blockchain is a decentralized database in the form of a point-to-point (P2P) network that is composed of sequential blocks containing timestamps. Decentralization, immutability, anti-tampering, and traceability are hence its qualities. This blockchain technology emerged with the Bitcoin Cryptocurrency systems where it finds use to control transactions and data. [9] The technology's original concept can be summed up as a decentralized ledger, which maintains a concrete account of all the transactions between all the connected nodes connected to a decentralized peer-to-peer network. In blockchain, a simultaneously recorded version of the transaction is created when the transaction data gets disseminated between all the nodes. Blockchain, however, is more than just a database record because it has evolved to be able to manage and store programs called smart contracts. Smart contracts are digital programs that are kept in a blockchain with less danger of outages, censorship, or fraud than central databases, enabling automated transactions between participants without the involvement of a third party [10]. In managing interactions between entities based on data, smart contracts perform best when predefined requirements are satisfied.

2.2 How do Blockchains work?

A blockchain transaction starts with the transaction initiator node. The node's wallet is used to start the transaction. The unconfirmed transaction pool is where all transactions are first deposited. The transactions are collected by people around the world called 'Blockchain miners' from the pool. A blockchain miner runs special blockchain mining software wherein they communicate with other miners in the network. Then, the transaction data, which contains six parameters, is hashed using the SHA-256 hashing method. Thus, the transaction has been validated and the hash is produced. The Merkle tree, which culminates in a single hash value known as the Merkle root, is constructed similarly using the hashes of all confirmed transactions. Every confirmed transaction is added to the transaction pool that the miners themselves administer.

Once the root of the Merkle tree has been generated, the miners need to perform computation to generate the nonce. The miners thus undertake in a race to generate the nonce value, and thus the new block in the chain. The ‘winner’ of this race broadcasts the newly generated block to the other miners in the networks. Six parameter values, including the created nonce, have been subjected to the SHA256 algorithm in this freshly generated Block. All the other ‘unsuccessful’ miners cease generating the nonce and start validating the shared blockchain. With distributed ledger technology, the validity of this shared chain is replicated to all miners once it has been verified by more than 51% of the miners. This process is called as ‘Proof-of-work’ [12].

2.3 Supply Chain Management Training Programme by Government of India

Supply chains [34] are concerned with the movement of goods and information among their constituent companies, including the acquisition of raw materials, their transformation into finished goods, and their distribution to final consumers. But in India, the agriculture industry is innately plagued by a variety of problems that create a lot of difficulties in the supply chains. The training program also covers sourcing, logistics, organizational management, and the customer response system, which make up a general supply chain. The management of India's Agri-supply chains is currently changing to adapt to the new marketing realities brought on by the wave of globalization and other internal developments. In the past few years, coordinated supply chains for fruits and vegetables in India are emerging which cater to the high-end domestic market. Detailed specifications are provided through structured relationships between producers, traders, processors, and buyers in coordinated supply chains. Heavy post-production village sales of agricultural products as well as immediate sales of agricultural goods are significant aspects of the traditional marketing system for agricultural commodities.

2.4 Uses of Blockchain Technology in SCM systems

There has been extensive research in the field of blockchains, resulting in classification of the technology into public and private blockchains, although it is still uncertain whether all of them are pertinent for SCMs. Everyone can access public blockchains, and all transactions are transparent and encrypted. Private blockchains

appear to have compelling uses for SCMs even if few academics see a use case for public blockchains due to their ability to build up privacy constraints with predefined, configurable criteria. Consortium blockchains are private blockchains that have various preset authority inside the blockchain network [13]. They are a subclass of private blockchains. Consortium blockchains offer several specified members as network authorities, in contrast to standard private blockchains, which only have one leading member. The partnership between IBM and Maersk is an early illustration of a consortium blockchain in SCM [11]. Public blockchains might contribute to SCMs, but as of right now, private and consortium blockchains have great potential applications in the field.

3 Related Work

As mentioned earlier, there are three major issues which affect agricultural SCMs. They are: (1) The lack of transparency and security of transaction information; (2) reduced trust and credibility in agricultural SCMs; and (3) traceability and quality issues arising from subpar implementations of agricultural SCMs. In the years following the invention of Blockchain technology by Satoshi Nakamoto, there has been a lot of research into the potential application of blockchain technology in the agricultural SCMs, aiming to solve the aforementioned problems. SCM systems are using blockchain to provide all of their operations with transparency, security, neutrality, and dependability. Most of the problems with the Internet of Things' security and dependability will also be resolved with the aid of blockchain.
In this section, we look at the existing literature in the domain of interest as well as track the progress of some organizations which utilize blockchain-enabled SCM systems.

3.1 Literature Work

a. Literature regarding the use of Blockchain Technology to improve transparency and security in Agricultural SCMs

Iqbal et. al. has proposed an Internet of Things (IoT) based farm intrusion system to pave way for smart and safe farming [14]. They have focused on the production stage in the farming process and integrated the system with a Blockchain based framework to improve transparency in the process. Chod et. al. have proposed a cost effective blockchain protocol based on the famous Bitcoin network to demonstrate that blockchain can be utilized to ensure transparency in SCM systems at scale. According to the authors, SCMs face a systemic problem with financing operations that is exacerbated in developing countries. This problem might be greatly reduced by opening a small window of transparency into a firm's supply chain, in particular, its input transactions [15].
Zelbst et. al. has used newly developed measurement scales to monitor the potential applications of radio frequency identification (RFID), Industrial Internet of Things (IIoT) and Blockchain technologies on transparency in SCM systems. In this paper, they have reviewed data from 211 managers working for manufacturing plants in the US and have concluded that IIoT and Blockchain technology significantly enhance the information provided by RFID and thus the three technologies combined can improve transparency in SCM systems [16].
Malik et. al. observe that consumers now demand openness in the production and processing of food products due to a rise in the frequency of food mislabeling and handling in recent years. The present transparency solutions struggle with problems such information dispersal across many silos and susceptibility to collecting inaccurate data, making it difficult for them to reliably provide 'farm to fork' product tales. Based on these observations, the authors propose ProductChain, which is a permissioned Consortium Blockchain Framework which achieves end-to-end traceability and transparency in the agricultural supply chain network. The framework also offers a special transaction vocabulary that can quickly be linked to a single essential ingredient, ensures no one party has authority over the blockchain with the aid of a access controlled consortium blockchain network, and a sharded tiered network design to address scalability [17].
Arena et. al. propose BRUSCHETTA which is a transparency framework powered by blockchain for improving the traceability in the supply chain involving the production and distribution of Extra Virgin Olive Oil. The authors specifically target the Extra Virgin Olive Oil supply chain as it is one of the most falsified products in Italy. The main contribution of BRUSCHETTA is that it traces the entire supply chain from the Olive plantations to the shops and consumers and enforces its certification. The end goal of the authors' research efforts is to allow the consumer to get access to a tamper-proof history of the produced Olive Oil involving all the subprocesses involved in the supply chain which is made possible with the help of IoT technology which proves to be instrumental in connecting the IoT sensors used for quality control to the blockchain [18].

b. Literature regarding the use of Blockchain Technology to improve trust in Agricultural SCMs

Zhang et. al. they have identified multiple inherent problems in the long lifecycle grain supply chain. Also, they identified shortcomings in existing solutions for the SCM systems. Their research proposes a multimode storage mechanism that combines chain storage and a novel architecture for the supply chain powered by blockchain technology. This proposed system differs from conventional systems in that it offers real-time sharing of hazardous material information, information interconnection and intercommunication, data security and reliability, and information interconnection and communication. The proposed system allows for exchange of

information throughout the supply chain and in the process, ensures the credibility of information storage and transmission, and prevent any tampering of data [19].
Yang et. al. proposes an agricultural produce traceability system to solve multiple problem facing traditional food traceability systems. The supply network for agricultural products uses this proposed blockchain-based traceability system to store and search for product information. The decentralization and tamper-proof nature of blockchain technology are two features that the writers use to boost the legitimacy and transparency of traceability data. It has been suggested to implement the secure sharing of private information in the blockchain network using blockchain technology and cryptography. Additionally, in order to encourage network nodes to submit traceability data, the authors have proposed a reputation-based smart contract. It has also been suggested by the authors that a cross chain technology between multiple chains could be implemented to further improve the credibility of the solution [20].

c. Literature regarding the use of Blockchain Technology to ameliorate traceability issues prevalent in contemporary Agricultural SCMs

Shahid et. al. have proposed a comprehensive blockchain-based solution for an agriculture and food supply chain. It makes use of smart contracts and other blockchain technology that is deployed on the Ethereum blockchain network. The authors note that while blockchain offers immutability in the network as one of its most important features, it still struggles to address some of the most pressing issues in traditional SCM systems, like the credibility of the concerned participants, accountability of the trading process, and product traceability. All transactions in the proposed system are recorded on a blockchain and uses the InterPlanetary File System (IPFS) to store the necessary data. It provides an efficient, safe, and trustworthy solution by returning a hash of the data that is saved on blockchain. Their solution offers smart contracts in addition to their algorithms to demonstrate how system elements interact. This work also includes examinations of security and vulnerability as well as simulations and evaluations of smart contracts [21].
Sun et. al. presents a liquor anticounterfeiting traceability system based on Ethereum and RFID in conjunction with blockchain and Internet of Things technologies in light of the current scenario of counterfeit alcohol in the beverage sector [22]. The system employs RFID scanners to automatically upload data across the supply chain for alcoholic beverages, and it maintains the data's hash value in the blockchain to ensure that it cannot be altered and can be tracked. Different query permissions might be opened by the smart contract depending on the users. The community's confidence in the company can be increased through this approach, which also supports the modernization process and the healthy growth of the alcohol sector.
Pigini et. al. propose a Near Field Communication (NFC) based solution to gather information from the entire agricultural supply chain and make it transparent so that the consumer will be able to view it freely. The authors discuss the various problems faced to make traceable information rapidly available to the consumers, which is done using a paper-bases system in contemporary SCM systems. They also discuss the utility of RFID and NFC identification techniques. The proposed architecture includes an identification system powered by NFC tags, which accumulates data from all phases of the supply chain. With this system, the authors aim to enhance and optimize the SCM process, and it will also aid in improving traceability of agricultural products. They concluded the research by identifying the main shortcomings of the proposed solution, which is mainly related to finding a match between the interests of the producer and the consumer [23].
Tsang et. al. have proposed a Blockchain-powered Food Traceability system which aims to integrate Blockchain, IoT and Fuzzy Logic into a perishable food management system. In this system the authors have implemented fuzzy logic qualities in the blockchain to enhance traceability in the system and an integrated consensus mechanism that takes into account stakeholder evaluation, and shipment volume is built [24]. The adoption of IoT technology is combined with the power of blockchain results in accurate and trustworthy data for adjusting shelf life and fuzzy logic for assessing the decline in food quality. Table 1 enlists all the publications referred in the literature survey performed.

Table 1. Existing research in blockchain-aided SCM systems in the agricultural industry.

No.	Year	Industry	Issues Targeted in Research	Source
1	2020	Agriculture	Transparency Issues	[14]
2	2020	Agriculture	Transparency Issues	[15]
3	2020	Agriculture	Transparency Issues	[16]
4	2018	Agriculture	Transparency Issues	[17]
5	2019	Agriculture	Transparency Issues	[18]
6	2020	Agriculture	Trust Issues	[19]
7	2021	Agriculture	Trust Issues	[20]

8	2020	Agriculture	Traceability Issues	[21]
9	2019	Agriculture	Traceability Issues	[22]
10	2017	Agriculture	Traceability Issues	[23]
11	2019	Agriculture	Traceability Issues	[24]

3.2 Real-world use cases of Blockchain-powered SCM systems

The extensive research performed in the blockchain-aided SCM domain has motivated many organizations to either enhance existing SCM systems with blockchain or make blockchain powered SCM systems from scratch. Table 2 enlists some startups which have succeeded in utilizing the power of blockchain to empower current-gen SCM systems.

Table 2. A list of successful startups using Blockchain-powered SCM systems

No.	Year	Use Case	Companies Involved	Description of Application	Source
1	2017	Food Safety	Walmart, JD.com, IBM	Improve Food Safety by implementing a system for traceability of goods.	[25]
2	2018	Wine SCM	Origintrail, TagItSmart	System for traceability of Wines using Blockchain Technology	[26]
3	2017	Coffee in Kenya	Kahawa 1983	Coffee tracking issues are alleviated using Blockchain technology's traceable property.	[27]
4	2017	Various	ShipChain	End to end solution for SCM.	[28]
5	2017	Various	Blockhead Technologies	Improve traceability and transparency in Supply Chain Systems	[29]
6	2016	Various	Trust Square Service AG	Improve data integrity and streamline SCM systems	[30]

3.3 Existing Blockchain-powered Agricultural Marketplaces

1. AcreCX

AcreCX [31] is a decentralized, blockchain-powered Agri-marketplace for spot and forward sales. It offers a digital marketplace supported by smart contracts that enables farmers and buyers to buy and sell commodities

at later times while removing transaction risks. It consists of a contract book which allows the user to create, sign digitally, agree on payment terms securely in one place. It also allows the user to keep track of current prices in commodity markets using price discovery. Along with the above features it also provides warehouse management which controls inventory, shipping, sorting, and storing.

2. Farm2Kitchen:

To enable Farmers, Producers, Packagers, Distributors, Transporters, Restaurants, and Retailers to seamlessly communicate and securely share information to track the movement of products through the Food Value Chain and be able to trace the products from the origin to the endpoint and back, Farm2Kitchen [32] is a global farmer's market with food traceability on Blockchain. F2K Token (an ERC20 Standard Token) was released by Farm2Kitchen. The Farm2Kitchen Token, which is utilized by consumers, stakeholders, and outside business partners across the world, powers the Farm2Kitchen ecosystem. The publicly traded digital asset that is utilized for all platform-related operations is the F2K token.

3. NinjaCart

Ninjacart [33] is a fresh produce supply chain startup that uses internal applications to power end-to-end operations to link food growers with merchants, restaurants, and service providers. By taking charge of the supply chain and utilizing technology and analytics, intermediaries are removed. Ninjacart provides features like:

- Forecasting- Weekly planning to reduce wastage and maintain supply chain/maximize profit.
- Pricing- Collected from markets 1 day before delivery date.
- Farmer harvests and brings to Collection centers.
- Items checked for quality and weighed in front of the farmer. Farmer gets a receipt and gets paid within 24 hours.
- Realtime tracking to move product into company inventory and then delivered.

4 Proposed Architecture

After conducting an extensive literature review, we discover that most current research in this field focuses on conceptual ideas and proof-of-concepts, but very little empirical study is performed of blockchain solutions that are being used in real-world businesses. Thus, we developed a peer-to-peer trading platform for farmers built on a decentralized network, which enables farmers to trade goods with small-scale companies without the need for intermediaries. This reduces the impact of any intermediary to the greatest possible extent. This platform will be developed as a smartphone application as well as a web-based application. The platform will support two types of users: the farmers, i.e., the entity that is aiming to sell most or all their goods and the driver, i.e., the one who buys goods from the farmers. The primary aim of the application is to serve as a platform for all farmers to sell their goods to small-scale grocery shops. The farmers will be able to post products like fruits and vegetables for sale on the app and the grocery store owners will be able to view the posts and buy these goods. The grocery stores will also be allowed to post their requirements on the app and the farmers can accept these requests if they have the necessary goods at hand.

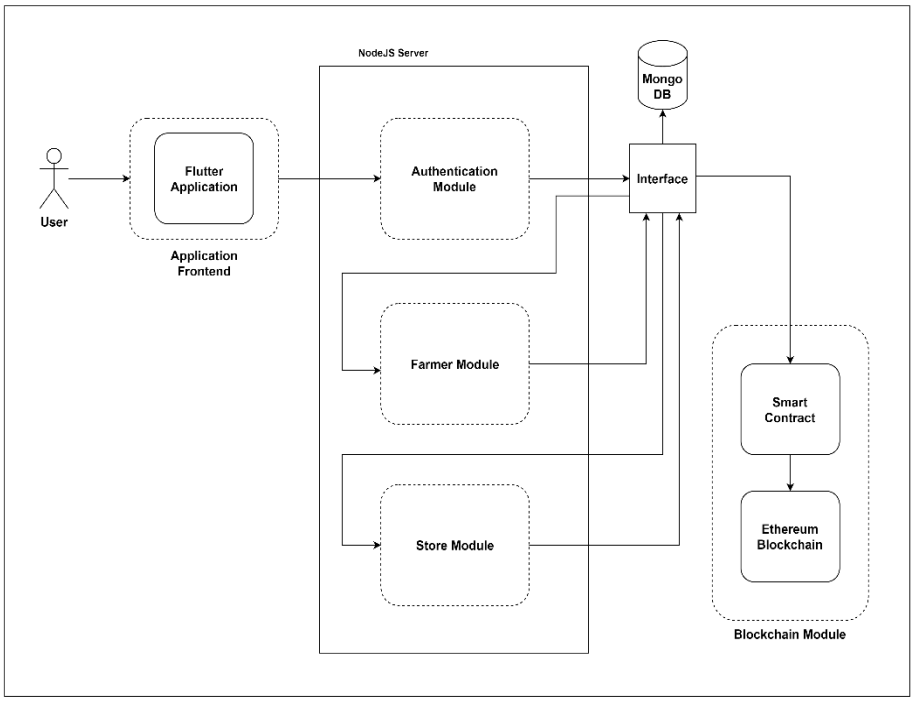

Fig. 1. Proposed System Architecture

Figure 1.1 highlights the system architecture of our proposal. Our proposed application uses a three-tier system architecture model, consisting of a front-end layer built using Google's Flutter Framework, a NodeJS server that handles all application logic and database management, and a blockchain layer built on the Ethereum-Solidity ecosystem

Application Frontend: The application frontend is the user interface of the platform that farmers and small-scale grocery shop owners will use to interact with the system. The frontend is developed using Flutter, which is a popular framework for developing cross-platform mobile applications. The Flutter framework enables the development of beautiful, responsive, and highly performant applications. The front end of the application will have separate sections for farmers and shop owners. The farmers will be able to create posts about the products they want to sell, while the shop owners will be able to browse through these posts and request products from the farmers. Additionally, the interface will display the available inventory and prices of the producers. Additionally, shop owners can publish their needs on the application, which farmers can then fulfill.

Authentication Module: The authentication module manages the login and registration procedure for farmers and store owners. The module will implement secure authentication using OTP (One-Time Password) authorization and JWT (JSON Web Token) tokens. The registration system will be incorporated on both the farmer and retailer sides of the application. The signup process will involve typical signup pages for the users and their details will be stored on the MongoDB Server through the backend REST APIs built using Node.js. When a user registers on the platform, they will be required to provide their name, phone number, email, and password. The authentication module will send an OTP to the user's registered phone number or email address for verification. After successful verification, the module will generate a JWT token that will be used for subsequent requests to the system. The authentication module will also handle password reset requests from users. If a user forgets their password, they can request a password reset by providing their registered email address or phone number. The authentication module will then send a link or OTP to the user's registered email address or phone number, allowing them to reset their password securely. The login system will also involve typical user interfaces for both the farmer and store owner. For login the users will have to enter their phone number then this phone number is then fetched to backend via REST APIs where the Nodejs backend will generate the OTP and send SMS to user which the users will have to enter to get authenticated.

Posting Module: The posting module is responsible for managing the 'posts' that the farmers will create about the products they want to sell. Farmers will be able to generate posts with product-specific information, such as the name, description, quantity, and price. Farmers can also add images of their products to their posts to make them more appealing to store owners. The module for posting will ensure that only authenticated producers can create posts. The module will also give farmers the option to edit or delete their entries if necessary. The store owners will have access to the available posts and will be able to request products from the farmers. The module will also include search functionality to aid shop proprietors in locating particular products.

Requests Module: The requests module manages the requests made by store owners on farmers' posts. When a shop proprietor discovers an product posting they wish to purchase, they can request it from the farmer by clicking the 'request' button on the post. The requests module will generate a request for the farmer to review comprising the requested product's specifics. The farmers can reconsider the requests and approve or reject them based on their availability and pricing. If the farmer accepts the request, the requests module will notify the store proprietor, who can then complete the transaction. If the farmer rejects the request, the requests module notifies the store proprietor that their request has been denied.

Blockchain Module: The blockchain module is responsible for storing the details of the requests made by the shop owners on the farmers' posts. The module uses smart contracts to store the details securely and immutably. The smart contract will contain the details of the requested product, the price agreed upon, and the transaction details. The blockchain module ensures that the details of the requests made on the platform are transparent and tamper-proof. The module also provides an audit trail for the transactions made on the platform, making it easier to track any disputes that may arise.

Smart Contracts on the Ethereum Blockchain: Our application uses the Ethereum blockchain to deploy smart contracts written in the Solidity programming language. These smart contracts allow for the initialization of transactions between farmers and grocery store owners, accepting or declining transactions, and completing transactions. The sequence diagram shown in Figure 1.2 captures the interactions between the system users, i.e. the farmers and the grocery shop owners, and the main solidity smart contract deployed on the blockchain.

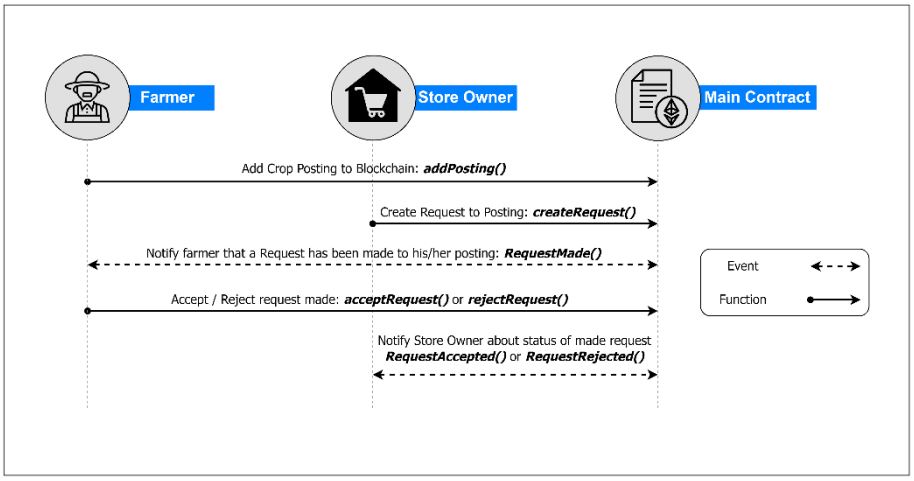

Fig. 2. Sequence diagram showing the interactions of the users with the smart contract.

Smart Contract Functionality: As shown in the figure above, there are two entities present in the working of the application: the Farmer and the Store Owner. These two are linked to each other with the help of the smart contract. Initially, the farmer adds a Crop Posting to the Blockchain using the addPosting() method. After the crop posting is made by the farmer, the store owner creates a request to the posting using the createRequest() method. This contract method is conjoined with the RequestMade() event. The event RequestMade() notifies the farmer that a request has been made to his/her positng. After getting a notification in the application tied to this event, the farmer can accept or reject the request made using the acceptRequest() or rejectRequest() methods. The events RequestAccepted() or RequestRejected() notifies the store owner when the farmer accepts or rejects the store owner's request.

NodeJS Server with MongoDB Database Connectivity: To manage the application's complete functionality while maintaining secure transactions, we utilize a NodeJS server that connects to a MongoDB database. The server generates a One-Time-Password for authentication purposes and stores user details of both farmers and grocery stores in the MongoDB database. The server also connects to the blockchain to deploy and execute transactions involved in the process.
By utilizing this three-tier system architecture model, we've created an efficient and secure platform for farmers and grocery store owners to engage in transactions. The Flutter framework provides a robust and adaptable front-end, while the Ethereum blockchain and Solidity smart contracts ensure secure and transparent transactions. The NodeJS server and MongoDB database offer a secure and reliable foundation to manage the application's complete functionality.

Benefits of Solution: The following are the benefits of the proposed system:
1. The system reduces the influence of a middleman to the greatest degree possible for smartphone platforms like Android.
2. The system doesn't require special technical knowledge from the users' side, i.e., the farmers and the grocery shop owners. The system is easy to use with regional translation for all the pages of the application.
3. No specialized hardware is needed for the system to run for either the user or the development team. Any Android mobile phone with entry-level specifications is sufficient.
4. Using Flutter means that the application is hypothetically easy to port to other platforms apart from Android like iOS and the web.

5 Conclusion

Based on the extensive literature survey, we find the current research inadequate in terms of concrete solutions and it is advised that future study focus on empirical studies for evaluating blockchain performance in real-time agri-food SCMs. The advantages of the technology for stated traits like traceability, credibility and immutability may be strongly supported by such data-driven analyses. An integrated evaluation of the performance of blockchain in conjunction with other complementary technologies would be a significant research contribution that is presently missing from the mainstream literature (such as IoT, AI, big data, and cloud computing). This assessment should include accurate measurements of the expense, scalability, and efficiency these interventions have on SCMs.
Blockchain technology is crucial from the standpoint of environmental sustainability since it allows for transparent monitoring of the use of raw materials, energy use, and emissions during production, as well as product

lifecycle visibility in SCs. Because blockchain technology is currently not subject to any legal frameworks, there are legitimate concerns about governance, privacy, confidentiality, and data security. Due to regulatory uncertainty and legal dangers, such obstacles impede technological development as well as adoption and diffusion. Regulators face a hurdle because of the decentralized nature of blockchain, which raises questions about how to enforce laws.

Using our system, we aim to connect the farmers directly with small-scale grocery shop owners without any middleman involvement. Integrating the project with the unrealized power of blockchain provides a secure and transparent way to track and manage transactions between the farmers and the grocery shop owners. Using smart contracts, we automate the process of managing transactions, such as verifying the quality and quantity of the produce being sold and ensuring that payment is made once the goods have been received and verified. This eliminates the need for intermediaries who would traditionally be involved in the transaction to perform these tasks, making the process faster and more efficient. By providing a secure and transparent platform for transactions, the module can aid in fostering greater trust and accountability between the parties, resulting in more dependable and efficient transactions. Additionally, the system can facilitate enhanced supply chain traceability. By tracing the history of each crop from the farmer to the shopkeeper, the system can provide greater assurance of the produce's quality and origin. The system can help reduce waste in the supply chain by enabling farmers to market their produce more efficiently and directly to retailers.

Therefore, the system has the potential to simplify and streamline the purchasing and selling of produce for farmers and store proprietors. It enables farmers to reach a wider market and shop owners to access a variety of fresh produce options. With proper maintenance and updates, the system can continue to provide value to users and contribute to the growth of the agriculture industry.

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