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Secure and Transparent Supply Chain Management using Blockchain and IoT

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Abstract— Blockchain technology has emerged as a disruptive force across various industries, and its integration with the Internet of Things (IoT) has unlocked new avenues for supply chain management. The conventional supply chain systems often encounter challenges related to privacy, security, and data integrity. In contrast, blockchain's decentralized and tamper-proof nature ensures a secure, auditable, and transparent record of product movement within the supply chain. By leveraging the immutable properties of blockchain, the system enhances product traceability, authenticity, and accountability while significantly reducing operational costs. IoT devices are vulnerable to attack as due to low processing power, storage limitations etc. Blockchain integrated with IoT provides a solution faced by the several industries. Blockchains and smart contracts are technology that has gained massive attention. The integration of blockchain addresses these shortcomings by providing robust data security and integrity, minimizing the risk of unauthorized access or alteration. This paper presents a system that helps the industrialist to have an access to agricultural data and supply of crops data to farmer. As industries continue to embrace digitization and connectivity, the presented system offers a significant step towards a more streamlined and secure future for agricultural information sharing. This system will be effective for the supply chain management for the trusted delivery.

Keywords-Blockchain; smartcontract; concensus; IoT; supplychain.

I. INTRODUCTION

Due to the frequent changes that affect the systems, the supply chain is a complicated process. These supply chains are crucial since they carry data about the organizations. The supply chain also includes information on the company's forthcoming activities, which creates a requirement for protection because it contains sensitive data. Incorporating IoT (Internet of Things) into these supply chains is essential since it significantly lowers the manpower costs incurred during the process of data collecting and processing. If the organizations follow the production process all the way through to sales, the supply chain may be made more effective [1]. Additionally, via the use of logistics, the relationship between the manufacturer and the supplier, as well as the consumer, is maintained. By using business-to-business and business-to-consumer relationships, these supply chains. Due to the development and competition in the business world, supply chain management of products or goods requires that the items be supplied completely protected from the source to the destination [2]. The use of IoT devices emerges as a viable option to monitor and track the process automatically without manual interventions as a result of the

challenges that arise with protecting the security and integrity of the supply chain model due to the rapid growth in globalization [3].

Despite the fact that IoT devices are often utilized in supply chain management, the modern business community finds it challenging to employ IoT devices for supply chain management owing to their improved methodologies and algorithms. Numerous unauthorized IoT devices use unauthorized access to get to the resources. IoT device security is a significant issue, and an effective solution is to allow the Blockchain network to increase security in the supply chain management that makes IoT devices available [4][8]. IoT device compatibility with Because these networks aid in the authentication and verification of the data in a trust-less environment, the blockchain network in supply chain management becomes a crucial component in many applications [10]. Blockchain is a developing technology that was brought to public attention a few years ago. Through new

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methodologies and the three key supply chain properties of distributed ledgers, transparency, and immutability, it changed the working strategy of many organizations and generated greater prospects. Immutable transactions increased blockchain usage to a new level [11].

IoT devices create enormous volumes of data, which are present in IIoT networks. Confidential and private information can cause a number of security issues by using IoT vulnerabilities. Non-centralized techniques are one potential solution to increase the security and dependability of current IIoT systems. It prevents the system from experiencing a single-point of failure and enables IoT devices and networks to operate over extended periods of time [12]. For current centralized systems that offer data processing, security, and privacy services, high-end computing is necessary. These services are often offered by third parties. Users must have faith in this solution for data handling and archiving. However, this information might be abused and In the worst-case situation, it may also be disclosed to some unauthorized persons [15]. Without the need for a middleman, the blockchain can securely exchange and store data from IIoT system components. Blockchain's ability to be secure will make IIoT systems more trustworthy and safer, which may alter how IIoT handles data [4]. These blockchain systems may be assessed using things like energy use, CPU and memory usage, block size, etc.

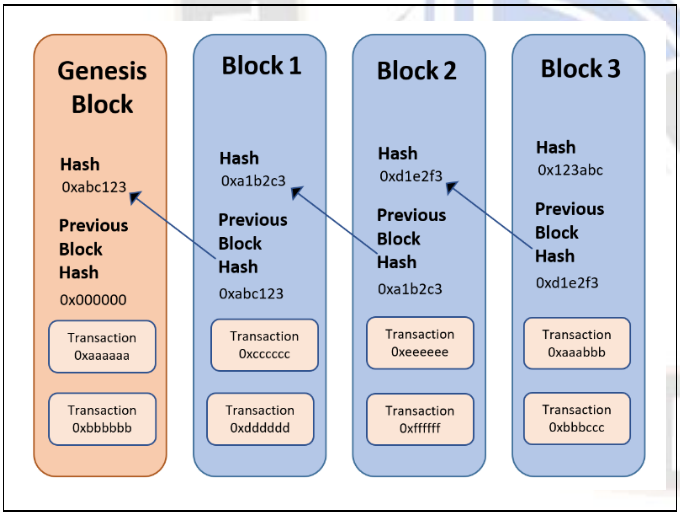

Figure 1: Blockchain Architecture

Blockchains are thought of as decentralized ledgers that are both public and, more recently, private. They consist of a chain of interconnected blocks that store transactional data. In order to achieve consistency, data integrity, non-repudiation, and authentication, asymmetric cryptography and consensus techniques are used [6]. Blockchain transactions are tamper-proof once they have been verified by network peers and added to the chain due to their immutable nature. Reliability and resilience are crucial factors that define blockchains as highly trusted platforms that are deployed on peer networks that lack trust. The ledger will exist in identical form on every node in the network. All other copies of the ledgers within the database are updated whenever the ledgers are updated in a predefined time.

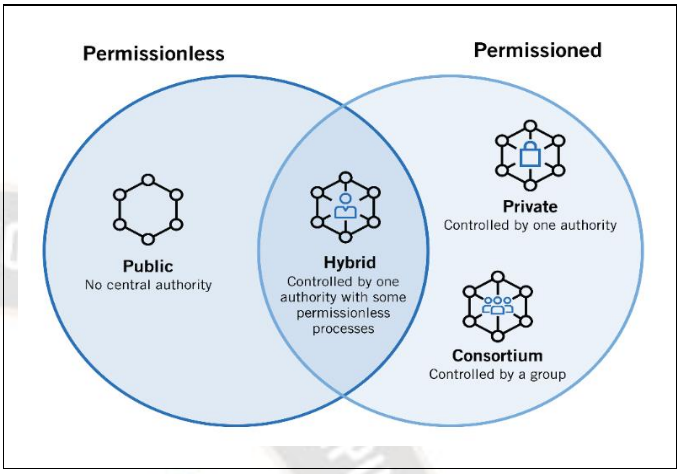

Figure 2: Types of Blockchain

Due to the use of cryptographic algorithms like the hash function and digital signature, this ledger is precise and very secure. Consensus, or shared agreement, governs this alteration or development [7][11]. Due to the lack of a centralized controller in blockchain, consensus algorithms are used. There are various consensus algorithms that can be implemented depending on the need for a distributed consensus. Additionally, there are various kinds of blockchain networks.

1. Public Blockchains: Public blockchains are accessible to anyone and allow anyone to participate in the network as a validator or user. They offer the highest level of decentralization and security due to their large number of participants. Examples include Bitcoin and Ethereum.

- Bitcoin (BTC): The first and most well-known blockchain, Bitcoin is primarily used for peer-to-peer digital currency transactions (cryptocurrencies). It relies on a proof-of-work (PoW) consensus mechanism to authenticate, validate transactions and secure the network.
- Ethereum (ETH): With Ethereum we can use an smart contracts that is program that is self-executing and acts in a legalised way.It uses a similar PoW mechanism but is transitioning to a proof-of-stake (PoS) mechanism with Ethereum to improve scalability and energy efficiency.

2. Private Blockchains: Private blockchains are limited to a specific group of participants, such as a single organization or consortium. They provide more control over the network and are often used for internal purposes.

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3. Hyperledger Fabric: Hyperledger Fabric is designed for enterprise use cases and it was developed by the Linux Foundation,. It allows for customization of consensus mechanisms and data privacy controls. Participants have varying levels of permission to access and validate transactions.

- Corda: Corda is designed for financial institutions to record and manage agreements between parties. It focuses on privacy and allows participants to transact directly while maintaining data confidentiality.

4. Consortium Blockchains: Consortium blockchains are a middle ground between public and private blockchains. They involve a group of organizations working together to maintain the network, often for a specific industry or use case.

- R3 Corda: While Corda can be used for private blockchains, it also supports consortium models where multiple entities collaborate in maintaining the network.
- Quorum: Built on Ethereum, Quorum is designed for enterprise applications and supports private transactions, data privacy, and permissioned participants.

5. Hybrid Blockchains: Hybrid blockchains combine aspects of both public and private blockchains to address specific requirements. They aim to balance transparency and privacy.

- AION: AION is a blockchain platform that allows interoperability between various blockchains, both public and private, creating a network of interconnected blockchains.
- Dragonchain: Dragonchain combines the security of public blockchains with the control of private blockchains, making it suitable for business use cases.

6. Permissioned Blockchains: Permissioned blockchains require participants to be authorized before they can join the network. This helps maintain a higher degree of control and privacy.

- Stellar: Stellar is designed for cross-border payments and asset transfers, with a focus on connecting financial institutions.
- Quorum: As mentioned earlier, Quorum is a permissioned blockchain with enhanced privacy features.

Type of Blockchain	**Description**	**Examples**
Public Blockchains	Open to anyone; highest decentralization and security; used for cryptocurrencies and more.	Bitcoin (BTC), Ethereum (ETH)
Private Blockchains	Restricted to specific participants; used for internal purposes; more control over the network.	Hyperledger Fabric, Corda
Consortium Blockchains	Group of organizations collaborate; balance between public and private; specific industry use cases.	R3 Corda, Quorum
Hybrid Blockchains	Combine features of public and private blockchains; interoperability; balance transparency and privacy.	AION, Dragon chain

TABLE 1: Types of Blockchain

Without the need for a third party or other controller, a smart contract is a computer code that serves as a mutual agreement or understanding between several stakeholder groups [22]. It is a binding agreement between the parties and a line of code that is run when a certain condition is satisfied. Smart contracts are essential to the business elements of blockchain technology. Normally, you would need to contact a lawyer, hire them, and then wait for them to deliver the documents. However, if you use smart contracts to carry out the process, pay for it, and then receive the paperwork, you could avoid needing to hire a lawyer. the necessary paper [39]. In contrast to conventional contracts, which merely specify the terms and conditions of an agreement, smart contracts go one step further by automatically enforcing/executing the stipulated obligations. thus, significantly reducing the possibility of fraud and scam. Smart contracts offers number of benefits, including accuracy, speed, transparency, security, paperless trust, and more. Using programming languages like Solidity, Python, or GoLang, Smart Contracts describe the terms of an agreement between two people or organizations just like a traditional legal contract (on paper). Smart Contracts are a popular Blockchain application. An illustration of buying real estate [9].

Let's say A party transfers the property to B party, in which case B will pay the agreed-upon amount. Or, if B pay the agreed amount. Or when B pays the agreed amount, Party A will transfer ownership on behalf of Party B. Any condition/term can be included in the smart contract. And only when the set of conditions is successfully met will the smart contract execute and validate the transaction. In addition, the smart contract is stored in a distributed system, the two parties can interact in real time without the requirement for third-party intervention. This will save a huge amount of time and money. These encrypted contracts are stored in a decentralized ledger, ensuring that they cannot be deleted [8]. It can be useful for various applications in real estate, healthcare, insurance, supply chain, etc.

II. LITERATURE REVIEW

Pinchen Cui et al. [1] proposed a blockchain system that aids in tracking and tracing each chip as it moves fully through the supply chain. A permissioned blockchain is the foundation of the suggested structure. The framework is implemented using Hyperledger and a thorough study is used to demonstrate the viability of suggested strategy.

Yung Po Stang et al. [2] suggested a technique that combines the distinctive use of blockchain and IoT technologies into a thorough traceability. A blockchain-based IoT-based food traceability system (BIFTS) has been created to regulate the shelf-life of perishable foods. In order to meet the criteria for food traceability, lightweight and vaporized characteristics are implemented in the blockchain, and an integrated consensus mechanism that takes into consideration shipment transit time, stakeholder assessment, and shipment volume is constructed.

U Agrawal et al. [3] discussed about the supply chain management (SCM), a key corporate activity in charge of transferring goods and services between different stakeholders and points. carries out a thorough review of the literature on the BC implementations, features, and the business effects in various cycle of SCM.

M. Nasir et al. [4] proposed a model that update the perishables' quality alongside the SCM with a focus on transportation, it was suggested to build a secure Internet of Things-based monitoring and reporting system.

B. Wang et al. [5] proposes a hybrid and Delegated Proof-of-Stake consensus algorithm. the nodes perform the functions of block production and validation, respectively, using modified Proof-of-Probability consensus algorithm and Delegated Proof-of-Stake consensus algorithm. Every time a transaction occurs, the system broadcasts a number of target hash values to the whole network. Each customized Proof-of-Probability node has its own mining priority because to the different sorting algorithms it uses.

Kelao li et al. [6] proposed a novel consensus Proof of vote (PoV), a revolutionary consensus technique, allows dispersed nodes owned by consortium members to agree by voting, allowing for decentralized arbitration. With the fundamental concept of creating distinct security identities for network nodes, PoV separates the voting rights and accounting rights.

S. Tanwar et al. [7] present give a thorough analysis of current blockchain-based technologies, especially for applications based on Industry 4.0. The advantages and disadvantages of several state-of-the-art methodologies are discussed. In order to offer academics and professionals a thorough knowledge of the blockchain's issues, interoperability and governance are underlined.

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Oscar Nova et al. [9] proposed the advantages and difficulties of blockchain technology's decentralization. Additionally, the idea of various distributed consensus, the operation of consensus algorithms with a permissionless protocol, and an in-depth case study on decentralized supply chain management using a blockchain were covered. A framework for deciding on IoT roles and permissions.

Jaime Chan et al. [10] presented The new architecture is a blockchain-based, completely distributed IoT access control system. The design has been tested in actual IoT settings and is supported by a proof-of-concept implementation.

Yu Chen et al. [11] presented an Access Control Lists (ACL), Role-based Access Control (RBAC), and Attribute-based Access Control (ABAC), which used a Traditional AC approach, are unable to provide a scalable, manageable, and effective mechanism to meet the needs of IoT systems. A proof-of-concept prototype has been developed and tested on a local private blockchain network using both resource-constrained devices (such as Raspberry PI nodes) and more powerful computing devices (such as laptops). The experimental findings show that the Blend CAC can provide an IoT system with a decentralized, scalable, lightweight, and fine-grained AC solution.

Hamda et al. [12] proposed a decentralized IoT data access control system that uses blockchain and trusted oracles along with blockchain and smart contract functionality to provide a scalable, decentralized management solution and secure access to IoT data. Additionally, oracle serves as a gateway to the blockchain, IoT data servers, and remote users to provide unified, trusted, and decentralized source flows for IoT data.

The document also covers architectural design, interactions, logic flows, algorithms, implementation details, and cost, compute, and security assessments.

S. Tanwar et al. [13] discussed that the use blockchain in the supply chain has the potential to improve transparency and traceability while lowering administrative expenses, as was previously highlighted. Blockchain supply chains can assist players in managing supply chains by storing sensitive information such as price, date, location, quality, certification, and more. The blockchain's accessibility to this data can increase the traceability of the raw material supply chain, decrease market loss and counterfeiting, increase compliance and visibility, open up contract manufacturing.

Rejeb et al. [14] discussed that using Blockchain technology in conjunction with IoT infrastructure can improve value chain

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networks and modernise supply systems. By influencing important IoT properties like scalability, security, immutability and auditability, information flow, traceability, and interoperability, among others, the usage of Blockchain technology can build the groundwork for further research initiatives.

Mabrook S. et al. [15] introduced a traceability-based framework that resolved the challenges aroused due to the security factors in supply chain mechanism. The scalability, costs and quantum resilience are maintained through the distributed ledger technology. The system attained good traceability along with tractability and security but, the consummation of power and computational capacity should be further improved.

Majid et al. [16] discussed These issues were discussed in relation to a Prochain, a Provenance-aware Traceability Framework for IoT-based Supply Chain Systems that also offered a comprehensive framework of all the data collected by the sensors and the whole collection of provenance data. A detailed simulation of the suggested framework on the Raspberry PI 3B IoT device also examined the effectiveness of Prochain in both local and cloud simulation scenarios. Traceability, transparency, and complicated security were all proved by Prochain.

Qun Song et al. [17] suggested peer-to-peer backup mechanisms, access control systems, and internal data isolation and transmission techniques. A registration module and an inspection module are both part of the access control system. All businesses in the supply chain are required to register information according to a registration policy, and the registration module is largely in charge of doing this. This technique is completely taken into account for network stability and fault tolerance to maintain the resilience of the system.

Muhammad Nasir et al. [18] perpetuated the supply chain management systems through continuous monitoring and reporting of information to the networks that highly ensured the privacy and security of the system as well as this method provided a digital ledger for the availing of the information about the goods. Although the supply chain is enhanced, this method mainly focused on agriculture and can be generalized for overall purposes.

Yaou Qian et al. [19] presented a cross-disciplinary research on distributed ledger technology and supply chain management in business. According to the discussion and testing, identified three key advantages that blockchain adoption may offer to modern supply chain management. We have also identified a few issues that the current blockchain application cannot successfully address.

III. CONSENSUS ALGORITHM

A. Proof of work(PoW)

The consensus algorithm known as PoW was first implemented in Bitcoin and many other pioneering blockchain platforms. In PoW, nodes compete to solve a challenging mathematical challenge (commonly referred to as miners). The right to add the following block of transactions to the blockchain and payment of transaction fees go to the first miner who successfully solves the puzzle. The difficulty of the puzzle is adjusted over time to maintain a consistent block creation rate. Miners expend computational power to find a hash value that meets certain criteria, and this process is energy-intensive. The longest valid chain with the most accumulated computational effort is considered the valid chain, and all other competing chains are discarded. Its advantage is High security due to the substantial computational effort required to create blocks. Decentralization since multiple participants are involved in maintaining the network. Its disadvantage is High energy consumption. Potential centralization over time as miners with more resources gain an advantage.

B. Proof of stake(PoS)

PoS is an alternative consensus algorithm that aims to address the energy consumption and centralization issues of PoW. In PoS, participants (validators) are chosen to create new blocks based on the amount of cryptocurrency they "stake" or lock up as collateral. Essentially, the more cryptocurrency a participant holds and is willing to lock up, the higher their chances of being selected to validate transactions and add new blocks. Validators are incentivized to act PoS protocols often include mechanisms to randomly select validators and prevent concentration of power.

C. Delegated Proof of Stake(DPoS)

A variation of PoS where token holders vote for a limited number of delegates who validate transactions. Delegates take turns creating blocks. Faster block confirmation and reduced centralization risk compared to PoS.

D. Proof of Authority (PoA)

Validators are selected based on their identity and reputation, rather than computational resources. Suitable for private or consortium blockchains where participants are known entities. Reduces the risk of malicious behaviour but is less decentralized.

E. Proof of Space (PoSpace)

Miners prove that they have allocated a certain amount of disk space. Used in combination with Proof of Time to create blocks. Less energy-intensive but can be resource-intensive.

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F. Proof of Burn (PoB)

Participants destroy (burn) existing cryptocurrency to mine new cryptocurrency. Proportional to the amount burned, participants gain the right to mine new blocks. Intended to show commitment to the network, used in some experimental systems.

G. Hybrid Concensus Algorithm

Combine different consensus mechanisms to balance their strengths and weaknesses. For example, combining PoW and PoS to achieve security and energy efficiency.

IV. SUPPLY CHAIN MANAGEMENT

Supply chain management is one of the emerging technologies in the blockchain space. Blockchain is a digital record system developed for a cryptocurrency network that can help supply chain users meet some of their challenges by creating a history of information and financial flows in a transparent transaction. transparency and anti-counterfeiting [13][21]. Blockchain enables firms to deal directly, improving the efficiency of the global supply chain. It offers financial and logistical service integration, allowing data collaboration across many stakeholders. Stakeholders can record price, date, location, quality, certification, and other pertinent information using blockchain supply chains to improve supply chain management. The inclusion of data in the blockchain can enhance contract manufacturing visibility and compliance, improve loss from counterfeiting, and boost the traceability of the material supply chain. It is not surprising that supply chain management is increasingly utilizing blockchain technology. Numerous international organizations have embraced Blockchain technology as of April 2018, according to Statista's Figure 3. In fact, nearly 53% of respondents concur that use case research is being done at their organization to provide chain [37].

Blockchain technology enables transparent and accurate product tracking with the supply chain. Organizations can digitize their physical products and create an immutable, decentralized record of every transaction that tracks products at every stage of the supply chain, from production to delivery. ultimately to the customer [22]. A key strategy for managing food insecurity and issues related to public health is supply chain management. Supply chain management establishes dynamic collaborative connections between suppliers, manufacturers, retailers, and end users. It also involves the flow of information, capital, logistics, and commerce. In today's world, supply chains models are becoming highly complex and mechanized organizations, that offers a lot of multiple benefits. As a result, SCM agro-food products has a strong focus on technical advances that allow for significant reductions in losses and better control in terms of health and safety. SCM has implemented quality control and traceability procedures that are particularly stringent for the food industry due to the requirement for food safety [19]. Plus, with many suppliers and companies involved, globalization and reallocation make the culinary scene that much more appealing.

V. INTEGRATING IOT WITH BLOCKCHAIN

Integrating Internet of Things (IoT) with blockchain technology offers several potential benefits and use cases, although it's necessary to note that the decision to integrate these technologies should be based on the exact needs and goals of a particular project or application. Here are some reasons why integrating IoT with blockchain might be advantageous:

Data Integrity and Security: One of the main advantages of using blockchain in conjunction with IoT is enhancing data integrity and security. IoT devices generate and transmit a massive amount of data, which can be vulnerable to tampering or unauthorized access. Blockchain's decentralized and immutable nature makes it well-suited for ensuring the integrity of IoT data. Once data is recorded on the blockchain, it becomes very impossible to alter or manipulate without consensus from the network participants.

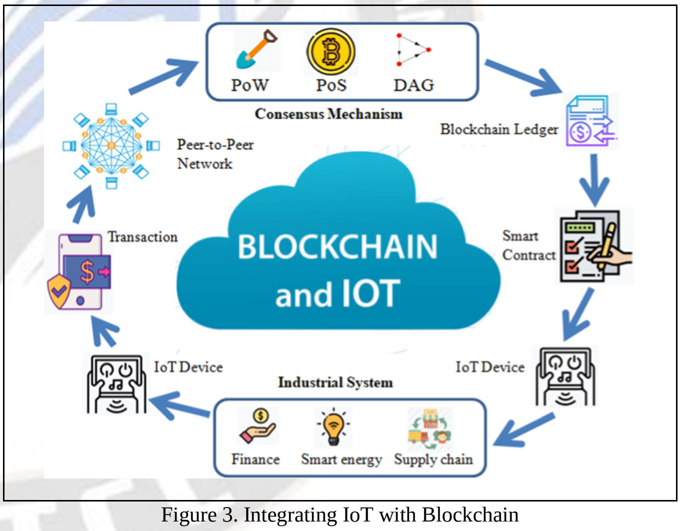

Figure 3. Integrating IoT with Blockchain

Transparency and Trust: Blockchain's transparent and tamper-resistant nature creates a trust layer in IoT ecosystems. All parties involved can check the authenticity and origin of data, reducing the need to rely on centralized intermediaries for data validation. This can lead to improved trust between stakeholders in IoT networks, such as manufacturers, suppliers, customers, and regulators.

Smart Contracts: Blockchain platforms often support smart contracts, It consist of rules and conditions that are self-executing. Integrating smart contracts with IoT devices can enable automated actions based on predefined triggers. For instance, a smart contract could automatically execute a

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payment when predefined conditions are met, such as a shipment of goods being received and verified by IoT sensors.

Supply Chain Management: IoT and blockchain can work together to increase supply chain transparency and traceability. By tracking goods through IoT sensors and recording each step on a blockchain, companies can ensure the provenance and authenticity of products. This is particularly valuable for industries like agriculture, pharmaceuticals, and luxury goods.

Data Monetization: IoT data has value, and blockchain can provide a secure and transparent way for IoT device owners to share or sell their data to interested parties. Smart contracts can facilitate the direct exchange of data between data providers and data consumers, reducing the need for intermediaries.

Decentralization: Both IoT and blockchain promote the idea of decentralization. Integrating the two can further distribute control and decision-making across a network, reducing single points of failure and enhancing system resilience.

Regulatory Compliance: Certain industries, like healthcare and finance, are subject to strict regulatory requirements. Blockchain's ability to provide an immutable audit trail can help organizations demonstrate compliance with data handling and privacy regulations.

Energy and Resource Management: IoT devices can be used to monitor and manage energy consumption, resource usage, and environmental conditions. By integrating blockchain, these systems can become more efficient, transparent, and accountable, enabling better management of resources.

VI. PROPOSED ARCHITECTURE OF SUPPLY CHAIN

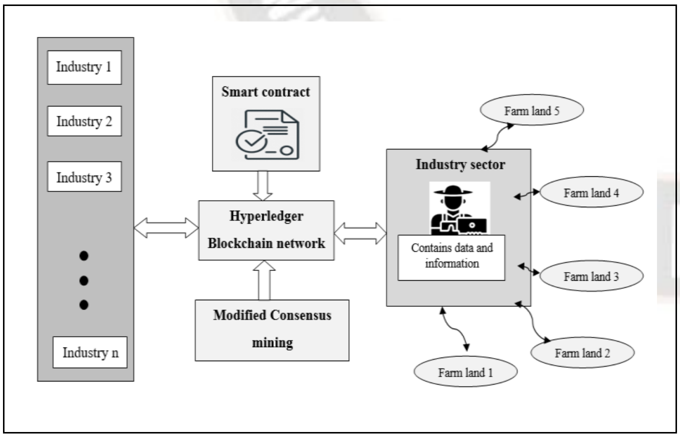

Figure 4. Proposed Architecture

The main aim of the research is to provide the essential information for the individuals in the industry involved in farming about the agricultural techniques or any other information regarding to farming with minimal time for the legalized users through Blockchain enabled IoT systems from the agricultural industry. In this research, initially the industrialist, who needs the information about the crops, will transmit a request to the agriculture industry sector. The agricultural industry can be either government, or an organization, which contains all the necessary information about the agricultural field. The request will be transmitted through the Blockchain network for enhancing the privacy and security of the data along with that the smart contract is also enabled. The Blockchain is incorporated with the consensus mechanism, where the valid record of the transmission data is stored and the consensus mechanism acts as an agreement for the distributed resources between the farmer and the officials of agricultural industry. The consensus mechanism boosts up the speed and security of the transaction and the smart contract keeps track of the transmission of data between the owner and the user for the avoidance of futuristic legal obligations. Whenever there is a need for the data, the legalized user can access the data from the source through the Blockchain network without complexities. The significance of the research will be proved using the Crop Recommendation Dataset [46] in software Python The schematic representation of the research is shown in figures below. Two different dataset is used from Crop Recommendation the one which consist of crop production year wise of different states and the other one cost of cultivation of specific crop yearly state wise. DAPP is developed that demonstrate the effectiveness of the system with details of request for crop with two different datasets with transaction and accounts details using Ganache.

VII. ALGORITHM

Step 1: Initialization

1.1 Define data structures for Request, Transaction, and Block.

1.2 Initialize the blockchain with a genesis block containing no transactions.

1.3 Implement the calculate_hash function to calculate the hash of a block.

Step 2: Data Request

2.1 Industrialist sends a data request to the Agricultural Industry.

2.2 Create a new Request containing requester, requested_data, and timestamp.

2.3 Create a new Transaction with sender as the requester, receiver as "Agricultural Industry," and consensus_status as False.

2.4 Append the new Transaction to the latest block's transactions in the blockchain.

Step 3: Respond to Requests

3.1 Iterate through the transactions in the latest block.

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3.2 If a transaction is from "Agricultural Industry" and not yet consensed, process the request.

3.3 Implement the process_request function to handle the consensus mechanism.

3.4 Update the transaction's consensus_status to True after reaching consensus.

Step 4: Consensus Loop

4.1 While not all transactions are consensed:

4.2 Call respond_to_requests to process pending requests.

4.3 Implement all_transactions_consensed function to check if all transactions are consensed.

4.4 If all transactions are consensed, exit the loop.

Step 5: Access Data

5.1 Legalized user accesses data from the blockchain.

5.2 Iterate through blocks and transactions to find a consensed transaction matching the user's request.

5.3 Return the requested transaction containing the desired data.

Step 6: Validate Blockchain

6.1 Implement the validate_blockchain function to check the integrity of the blockchain.

6.2 Check block hashes, transaction integrity, and other validation criteria.

6.3 Return true if the blockchain is valid, otherwise return false.

Step 7: Usage

7.1 Send a data request from an industrialist.

7.2 Run the consensus loop to process requests and achieve consensus.

7.3 Access data from the blockchain using a legalized user's request.

7.4 Validate the blockchain's integrity using the validate_blockchain function.

VIII.RESULTS

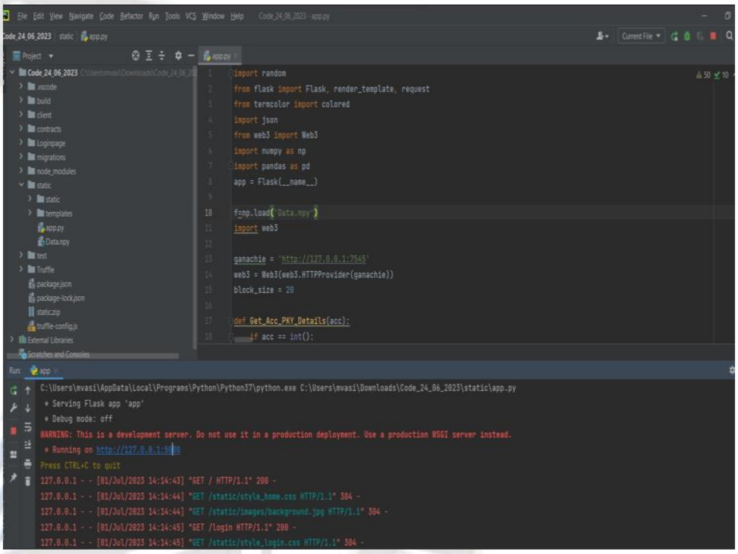

Figure 5. Executing the DAPP

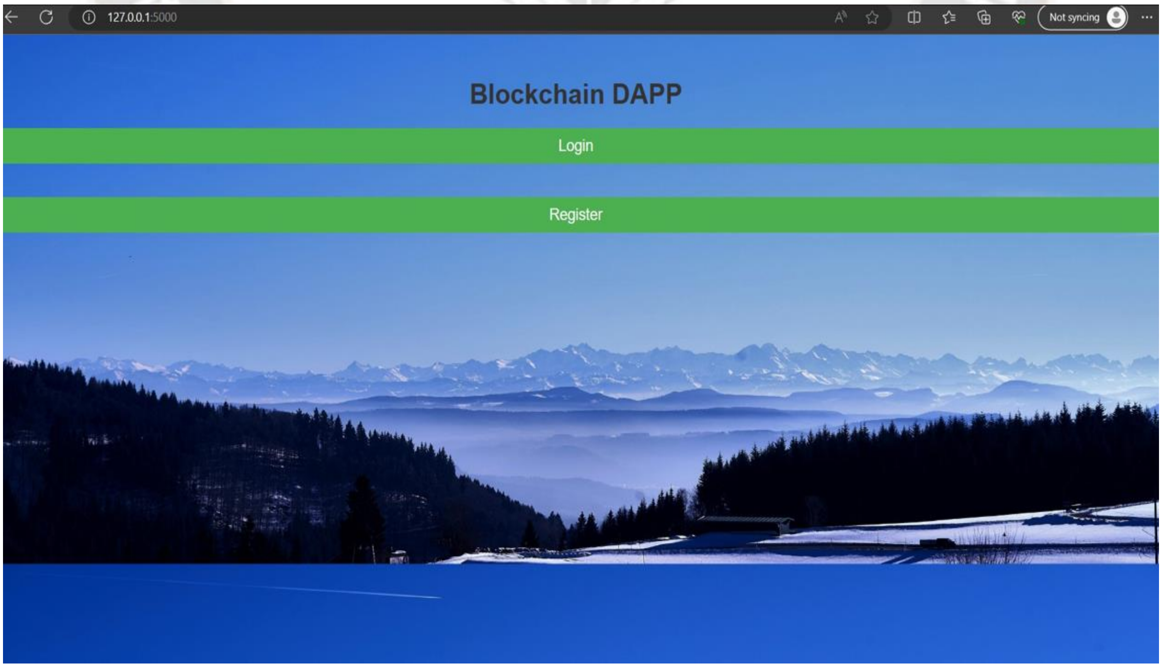

Figure 6. Registering the user

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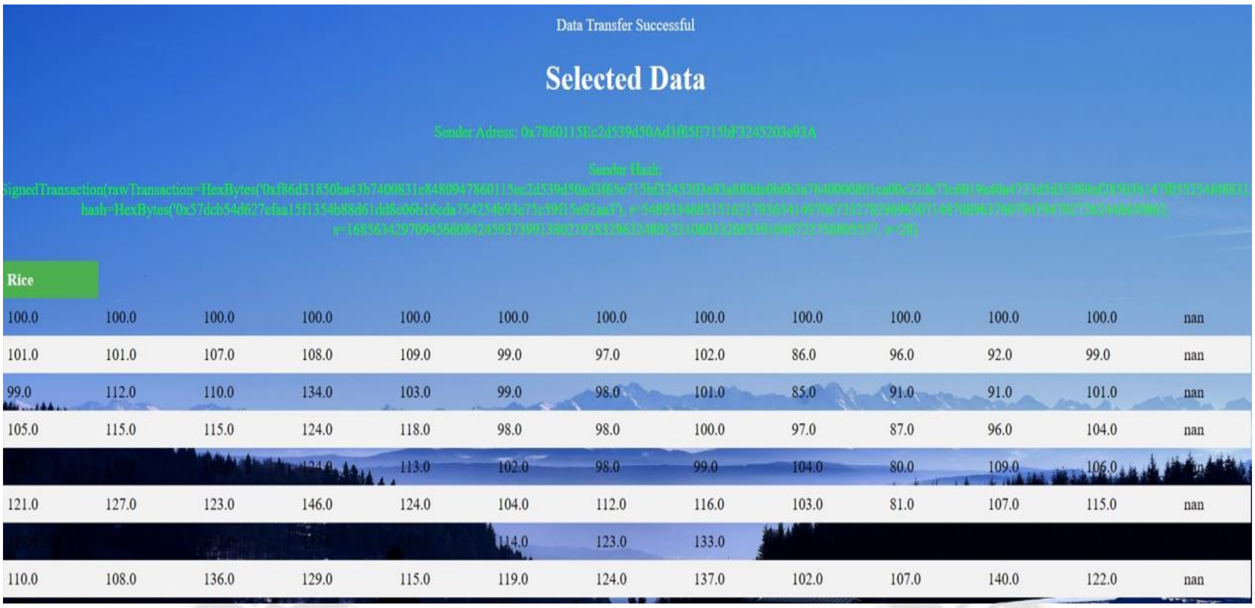

Figure 7. Getting crop production year wise Information with database 1

Figure 8. Getting cost of cultivation of crops state wise with database 2

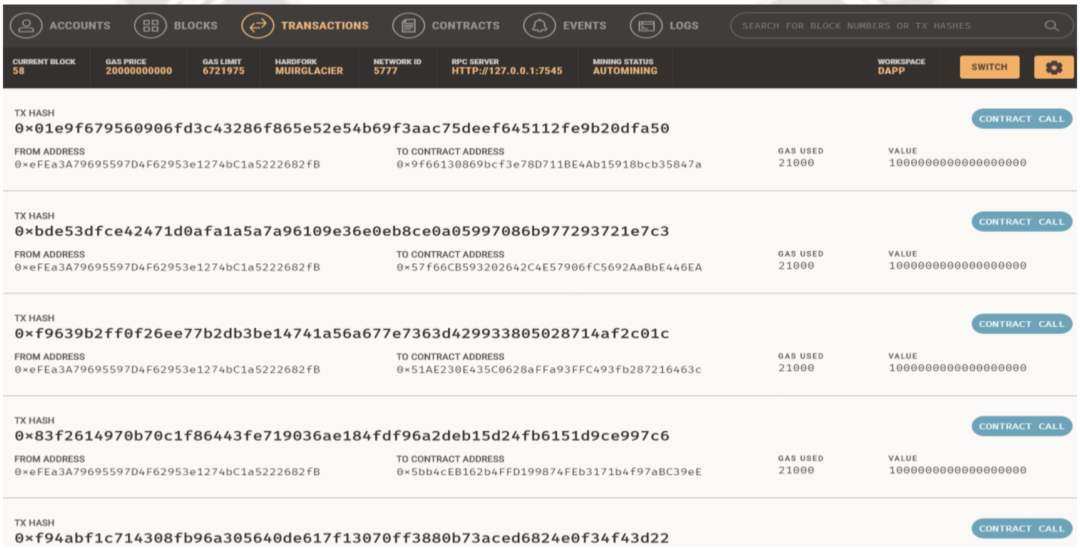

Figure 9. Transaction information using Ganache

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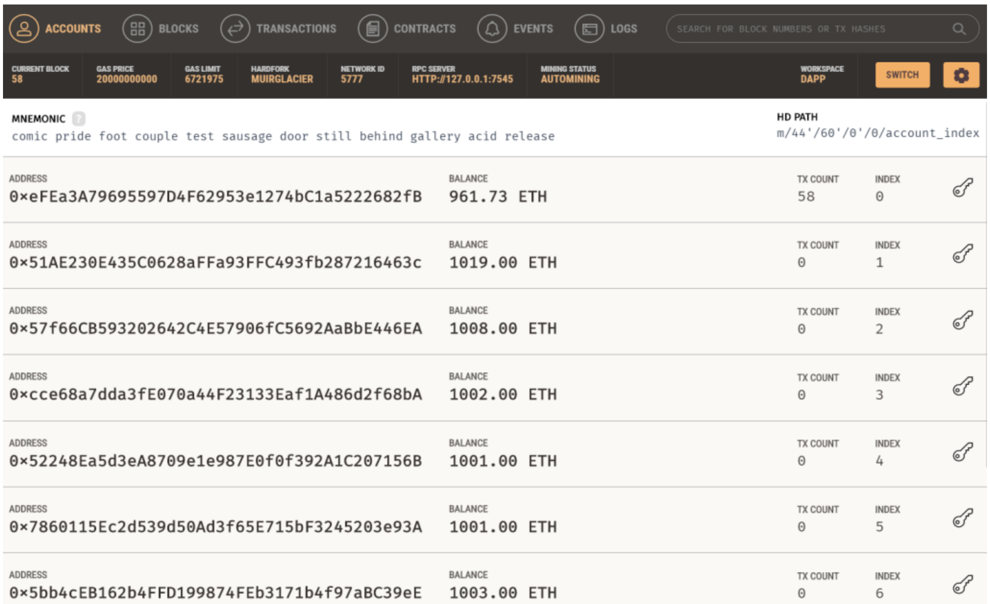

Figure 10. Account information using Ganache

Figure 11. User transaction details with sender and receiver hash

IX. CONCLUSION

In this paper we discussed about the supply chain model with respect to blockchain and IoT that will help the farmers and industrialist to have a supply of crops and also to get the detail information about the crop with total production and cost of the crops. The proposed algorithm outlines a structured process that begins with an industrialist's data request, which is then transmitted securely through the Blockchain network. The integration of a consensus mechanism enhances the security and confidentiality of transactions, fortifying the fault-tolerant nature of distributed and multi-agent systems. This mechanism, combined with the inherent capabilities of Blockchain, paves the way for a reliable and tamper-resistant record of data exchanges with crop recommendation dataset. Also, the presented mechanism contributes to the ongoing digital transformation of the agricultural industry, fostering efficient and secure data exchange that aligns with contemporary demands.

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