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Traceability System for Fruit and Vegetable Agricultural Products Using Blockchain

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ABSTRACT

This study explores the implementation of traceability systems utilizing blockchain technology in the agricultural sector, specifically focusing on fruits and vegetable products. Traceability is crucial for ensuring food safety, quality control, and supply chain transparency. Blockchain offers a decentralized and immutable ledger that enables the recording of every transaction or movement of agricultural products from farm to fork. By leveraging blockchain, stakeholders along the supply chain can access real-time, transparent, and tamper-proof information regarding the origin, cultivation, harvesting, processing, and distribution of fruits and vegetables. This enhances trust between consumers and producers, facilitates regulatory compliance, improves efficiency in recall management, and enables swift identification and resolution of food safety issues. Through case studies and analysis, this report evaluates the benefits, challenges, and future prospects of integrating blockchain-based traceability solutions into the agricultural industry, ultimately aiming to enhance food safety and consumer confidence.

Keywords: Blockchain-Based Management System (BCBM), On-chain and Off-chain structure, Smart Contract, SHA-256 algorithm, CBC encryption, P2P Protocol and Anti-counterfeiting Process.

1. INTRODUCTION

In recent years, the global food industry has witnessed a growing demand for transparency, safety, and sustainability throughout the supply chain. Fruits and vegetables, being essential components of a healthy diet, are subject to increasing scrutiny regarding their origin, production practices, and handling processes. The need to address food safety concerns, mitigate risks associated with contamination or adulteration, and meet regulatory requirements has prompted the exploration of innovative technologies to enhance traceability in the agricultural sector. Among these technologies, blockchain has emerged as a promising solution due to its inherent characteristics of decentralization, transparency, immutability, and security. This introduction sets the stage for a comprehensive examination of the application of blockchain technology in enabling traceability for fruits and vegetable agricultural products. It outlines the significance of traceability in ensuring food safety and quality, highlights the challenges faced by the current supply chain systems, and introduces blockchain as a transformative tool for enhancing transparency and accountability in the agricultural industry. Through an exploration of relevant concepts, principles, and emerging trends, this report aims to elucidate the potential benefits and implications of

adopting blockchain-based traceability solutions, thereby contributing to the advancement of food safety and consumer confidence in the global agricultural market.

2. LITERATURE REVIEW

This study introduces a novel supply chain system built upon Blockchain technology, aiming to rectify shortcomings inherent in traditional methods. The proposed Blockchain system offers transparent record-keeping and traceability, while also reducing costs. It employs a distributed, immutable ledger, ensuring reliability by recording the entire history of products from their origin to the final buyer without reliance on a third-party intermediary. Implemented using Hyperledger Fabric, this research demonstrates the efficacy of the proposed system.

This paper presents a strategy for recognizing fake items utilizing a standardized identification per user, which checks the product's standardized tag connected to a Blockchain-Based Administration (BCBM) framework. The proposed framework stores item points of interest and special codes as pieces in a database. When a client gives the one of a kind code, it is compared against sections in the blockchain database. If a coordinate is found, the client gets a notice; something else, the framework prompts the client to give data around the buy area to recognize the producer of the fake item.

The creators of this paper need to outline the huge potential and convenience of square chain in FSCs by investigating and evaluating the existing considers. This ponder gives a survey of piece chain's utilize in FSCs and examines selection issues such as versatility, interoperability, and tall fetched. Moreover, it offers a few conceivable fixes for these issues. A bibliometric examination is too given to offer assistance researchers and specialists get it the system and current heading of this field's ponder. The ponder found that the larger part of the investigate has centred on utilizing piece chain in back, co-ordinations, and item realness. Moreover, square chain is prepared to take centre arrange as a innovation for improving FSC traceability and straightforwardness, diminishing chance, and—most importantly—increasing believe between numerous partners.

The proposed system arrangement disposes of the require for trusted centralized specialist, middle people and offers records of the exchanges, moving forward proficient science and security with tall judgment and unwavering quality. All exchanges are enlisted and at that point put away in piece chain's unchangeable record with linkages to a decentralized le organize, subsequently guaranteeing shift tall degree of traceability and straightforwardness in the supply chain environment in a steady, solid and in productive way.

This chapter depicts an examination into the European Escherichia coli episode in May–June 2011. An flare-up caused by the pathogenic Shiga-toxin-producing E. Coli O104:H4 happened in Germany, causing the most elevated detailed cases of haemolytic-uremic disorder in people related with a single episode. From the begin of the flare-up, new deliver had been suspected as the cause; in any case, uncommon endeavors and instruments were required to contract the list of suspicious vegetables to grows. A moment little flare-up caused by the same pathogen in France started a European examination, which come about in prove that both episodes were caused by sullied fenugreek seeds.

3. METHODOLOGY

Data Collection: In the data collection phase, product information is gathered from various stakeholders involved in the supply chain, such as producers, distributors, and retailers. This includes details like product origin, manufacturer information, and unique identifiers like barcodes. Modern technology, such

as barcode readers, is employed to streamline the process of capturing this data at different stages of the supply chain.

Information Upload: To upload the collected product data onto the blockchain, a Blockchain-Based Management (BCBM) system is established. The collected data is encoded into transactions and securely uploaded onto the blockchain network. This ensures that the product information is stored in a decentralized and tamper-proof manner.

Data Classification: Once uploaded, the product data is classified into relevant categories to facilitate easy retrieval and verification. This classification includes categorizing the data based on product type, manufacturer, batch number, production date, and other pertinent details.

Hashing Public Information: To maintain data integrity and privacy, public product information is hashed using cryptographic algorithms such as SHA-256. Each piece of public data, such as product origin, manufacturer, and unique identifiers, is converted into a unique hash value. This ensures that the original information cannot be reverse-engineered from the hash.

Blockchain Update: The blockchain is updated with the hashed product information by creating new blocks for each transaction. Through consensus mechanisms inherent in the blockchain network, these new blocks are validated and confirmed, guaranteeing the immutability and integrity of the stored data.

Verification by Consumers: Consumers are empowered to verify the authenticity of products by inputting the unique product code into a designated interface. This interface grants them access to the blockchain, where they can retrieve relevant product details associated with the provided code. These details, including product origin, manufacturer, and additional information, serve to validate the authenticity of the product. Additionally, consumers are prompted to report any discrepancies or suspected counterfeit products, initiating further investigation and remedial action.

4. SYSTEM DESIGN

The existing capacity mode of blockchain traceability framework includes specifically composing traceability data of each hub of agrarian items into blockchain. With expanding numbers of hubs, an expanding sum of exchange information is gotten, and the capacity stack weight of blockchain thus increments. Due to the one of a kind chain-type structure of blockchain, the inquiry effectiveness is exceptionally moo; individuals of the same blockchain organize get to all the information on the chain record. To overcome these inadequacies, this paper made strides the capacity mode of a blockchain traceability framework for rural items and outlined a strategy including the twofold capacity of traceability data beneath the chain of ‘‘database + blockchain’’. As appeared in Figure 2, after traceability information transferred to the framework, the framework classifies the information. The item open data is put away in the neighbourhood database. The scrambled ciphertext and the hash esteem of open data is transferred to blockchain. Considering the issue of capacity space, the SHA256 calculation with higher security is utilized in the encryption of open data. For the input of any length string, the SHA256 calculation will create a 64-bit hexadecimal esteem. The piece structure of the traceability data information structure put away on the blockchain incorporates piece head and square body. The piece head primarily incorporates current square number, the hash esteem of past square, timestamp, and other data. The square body basically contains transaction-related data. The capacity arrange of the traceability data is appeared in Table 1. ‘‘Key’’ is the comparing ID in the ‘‘Value’’ parameter, which acts as a list and a one of a kind recognizable proof field. The parameter ‘‘Value’’ is the esteem composed to the blockchain, counting Sort, ID, Private Information and Data Hash. The parameter ‘‘Type’’ is the title of the structure body that is

characterized by the ‘‘Value’’ parameter. The parameter ‘‘ID’’ is the interesting recognizable proof field of the source message record, which compares to the interesting recognizable proof field of the source traceability data put away in the nearby database. The parameter ‘‘Private Data’’ is the ciphertext of private data scrambled by CBC calculation. The parameter ‘‘Info Hash’’ is the esteem of source traceability data after this data has been hashed. The stream chart of natural product and vegetable rural items blockchain traceability framework is appeared in Figure.

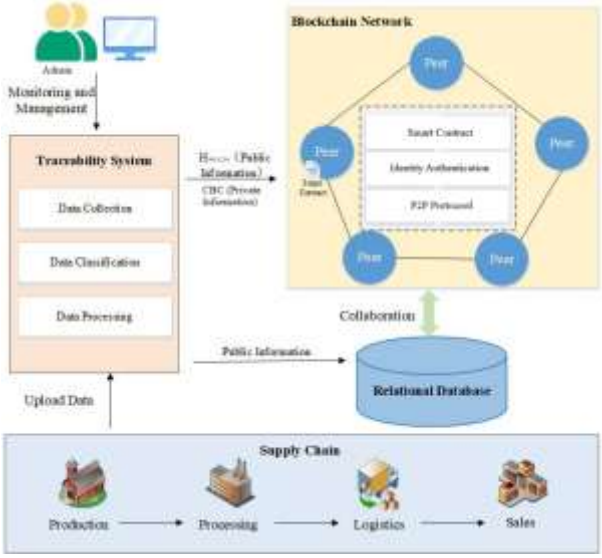


FIGURE 2. On-chain and off-chain data collaboration storage.

The traceability data is collected by Web of Things gadget or physically entered. Clients transfer the traceability data of generation, preparing, co-ordinations and deals to the framework. After classification by framework, the traceability data is separated into private data and open data. The private data is transferred to blockchain after CBC encryption, and the open data is put away in the neighbourhood database. The SHA256 calculation is utilized to hash the open data. The hash esteem gotten is put away in the blockchain framework, and the piece number is returned. The piece number is upgraded to the open data record comparing to the database. If the rural items data needs to be adjusted, the hash esteem of the open data needs to be modified into the blockchain to upgrade its piece number. Shoppers can get open data and square number from the database by checking the QR code, hash the open data gotten, and compare the consistency with the hash esteem put away on the blockchain through the piece number to decide whether the item traceability data has been altered with.

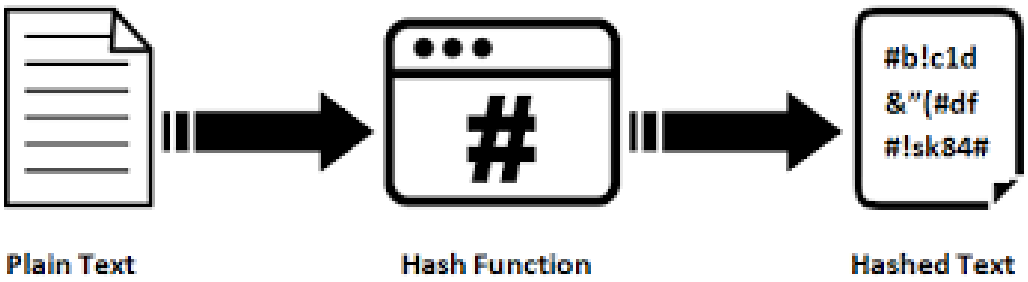


FIGURE 3. Hashing Text.

5. FINDINGS AND DISCUSSIONS

The adoption of blockchain-based traceability systems in the agricultural supply chain, involving sellers as data owners, buyers, and administrative oversight, has led to transformative outcomes. Through the decentralized ledger, data ownership rights are securely managed, ensuring transparency and accountability throughout the supply chain. Sellers efficiently record product information, including origin, production methods, and quality metrics, while buyers access this information in real-time, fostering trust and informed decision-making. The administrative oversight role ensures governance and compliance with regulatory standards, further enhancing the integrity of the system. Pilot deployments have demonstrated the seamless exchange of verified data between sellers and buyers, facilitated by standardized protocols and interoperable blockchain networks. As a result, stakeholders benefit from improved supply chain visibility, reduced transaction costs, and enhanced consumer confidence in the authenticity and safety of agricultural products.

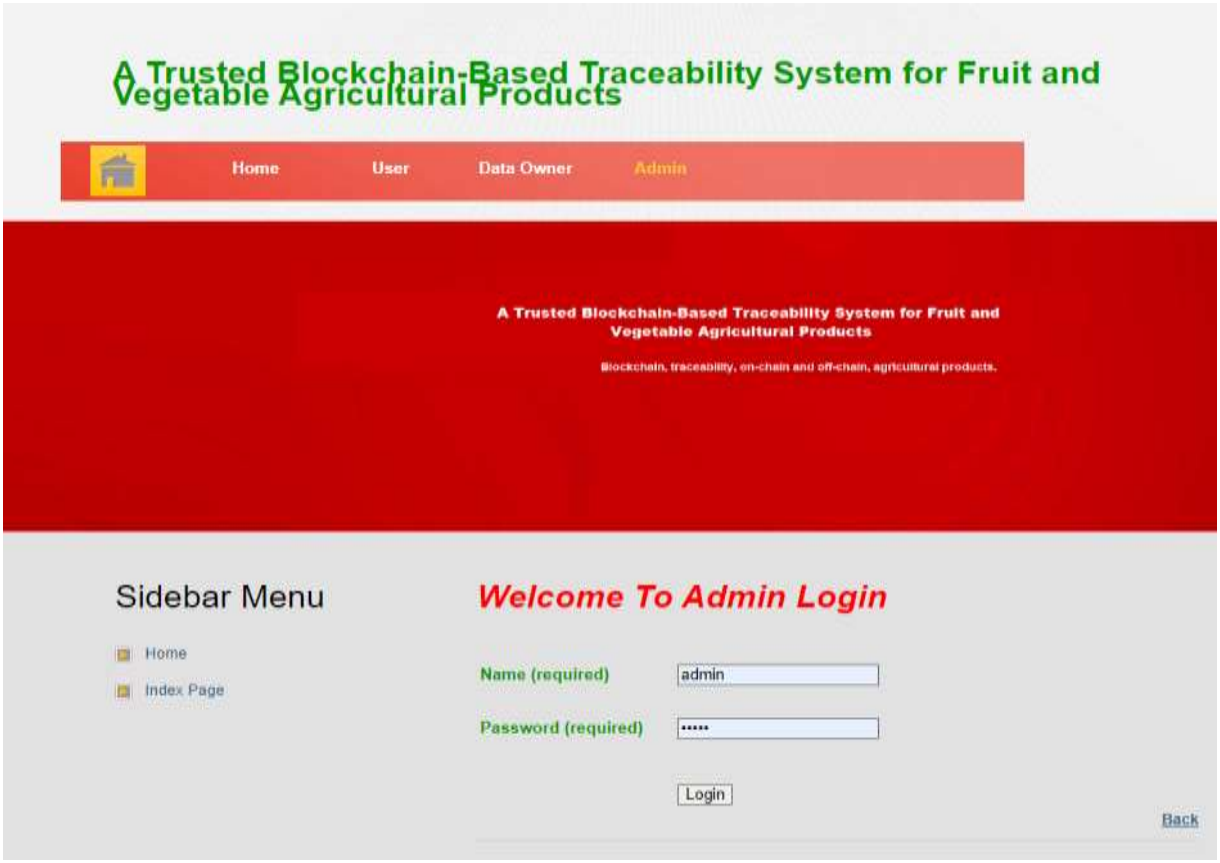


Figure 4: Admin login

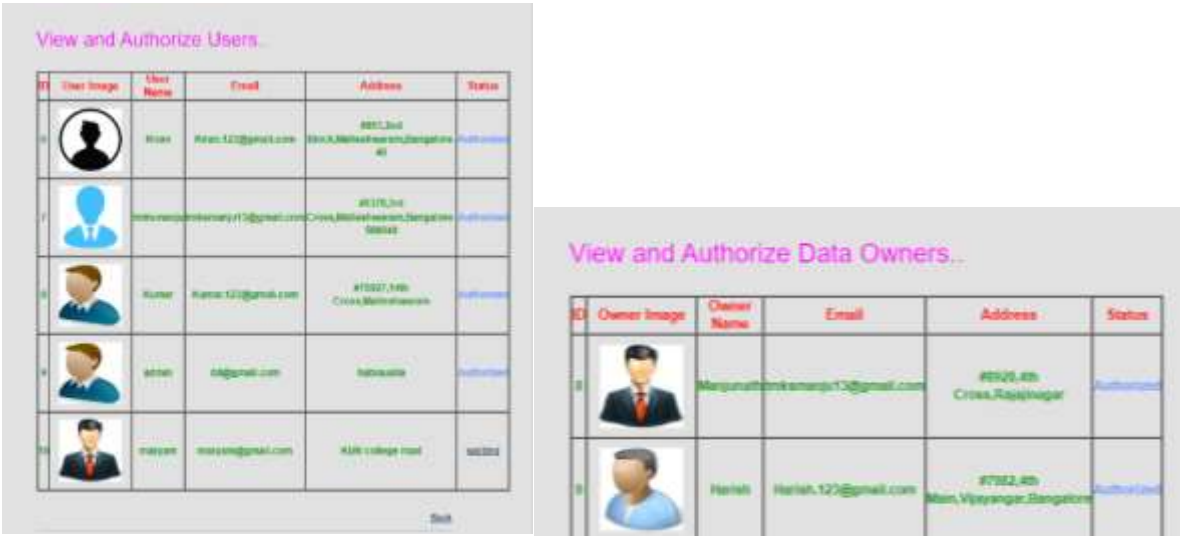


Figure 5: View authorized users and data owners

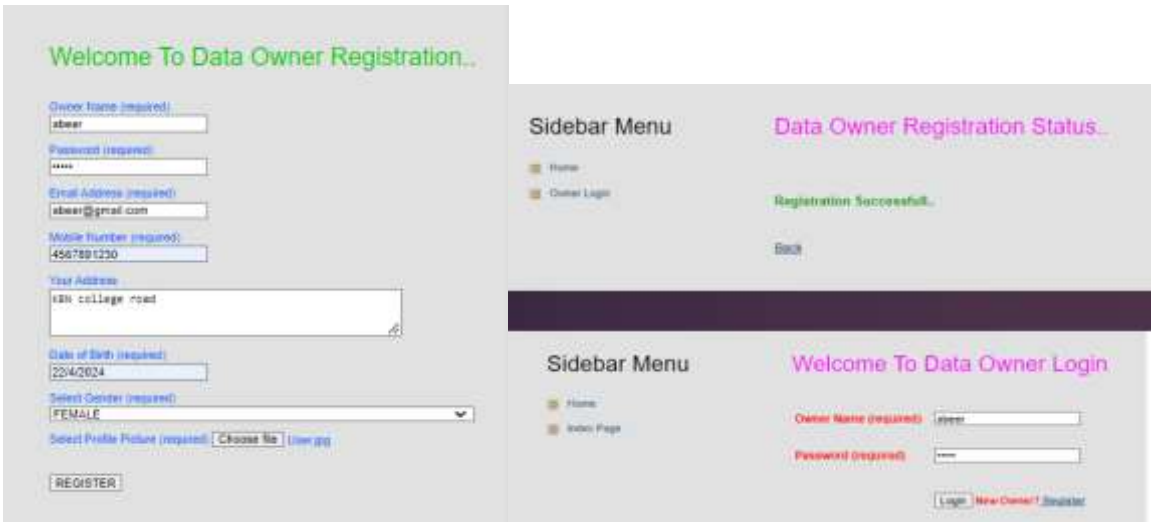
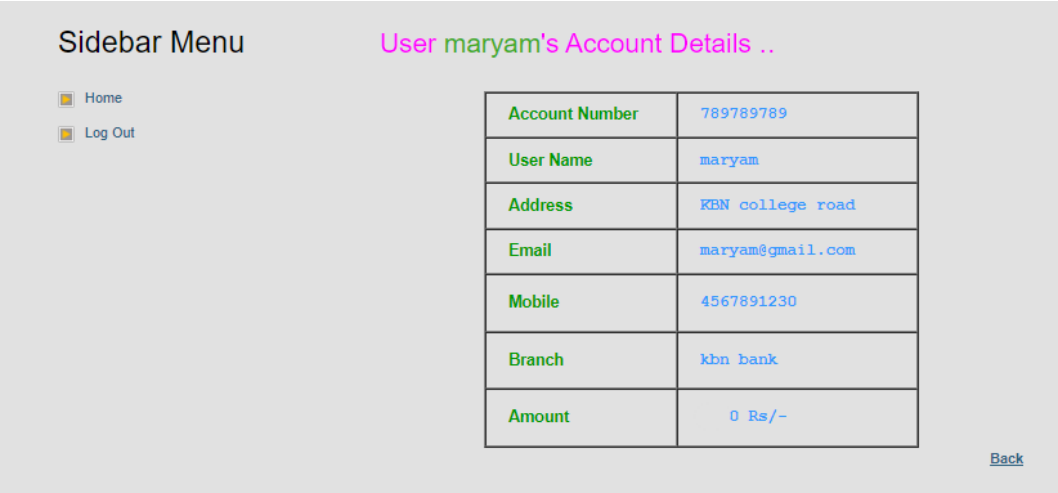


Figure 6: Data owner registration and login

Figure 7: View data owner products

Figure 8: User registration and login



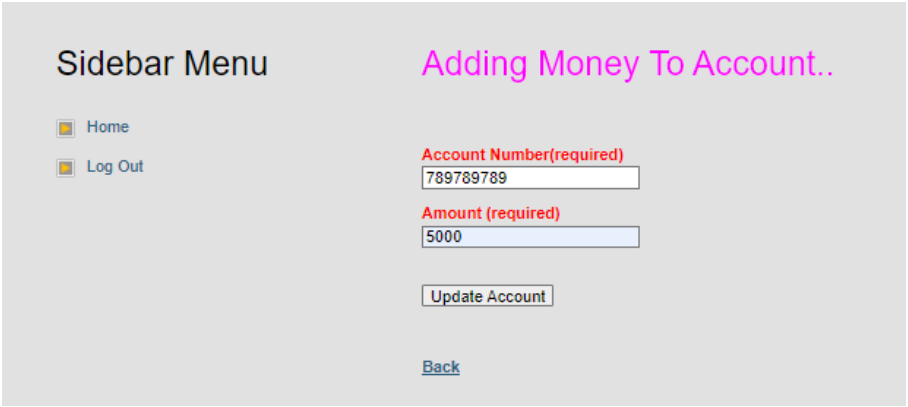


Figure 9: User account details

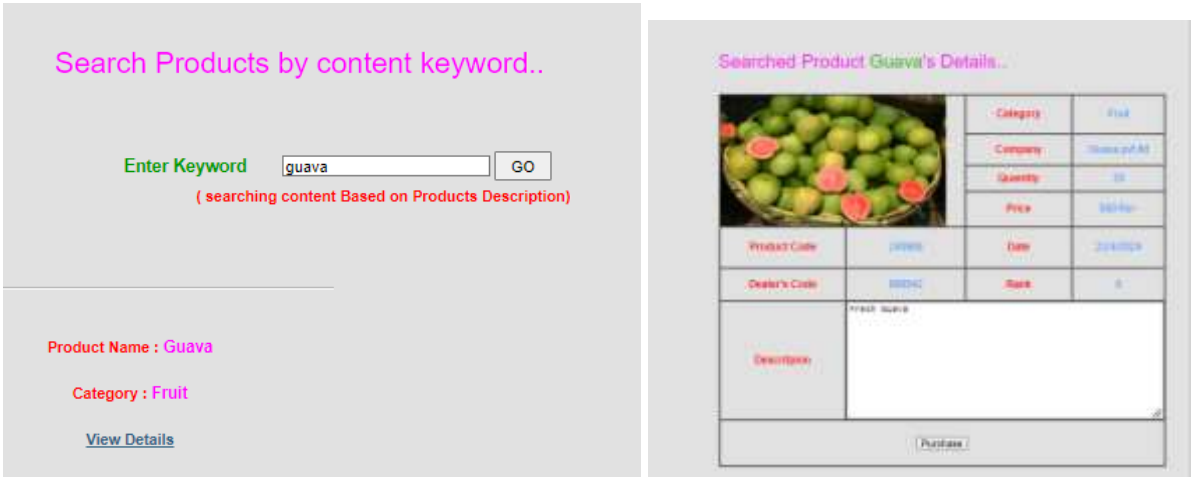


Figure 10: User product purchase

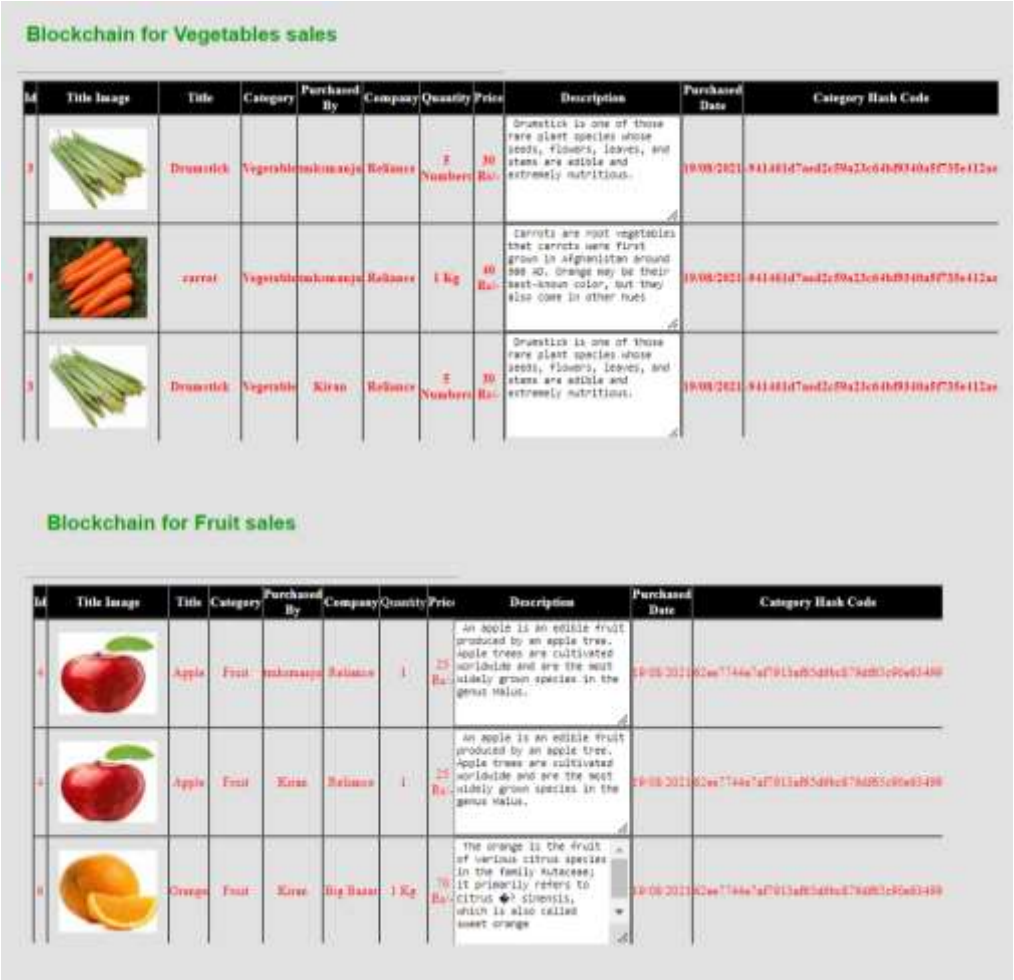


Figure 11: View all purchased products traceability with blockchain

6. CONCLUSION AND FUTURE WORK

In this paper, we planned and executed the traceability framework of natural products and vegetables rural items based on the non-tampering and traceable characteristics of blockchain, and examined the capacity and inquiry plan of the framework. To overcome the issues of tall information stack weight and destitute private security of the blockchain traceability framework as the information develops, an on-chain and

off-chain information capacity strategy utilizing ‘‘database + blockchain’’ is proposed. The open data shown to shoppers is put away in the supply chain to the neighbourhood database, whose hash esteem by SHA256 calculation was transfer to the blockchain framework. The private data scrambled by the CBC encryption calculation is put away into the blockchain for sharing with pertinent companies. The capacity strategy proposed in this paper combines the genuine circumstance, taking into account the require for encryption of corporate private data as well as the require for open supervision of supply chain open data, and diminish the weight of information stack on the chain. By putting away the piece number of the open data on the database, the affiliation between the blockchain and the database is realized. The customer gets the open data from the database by filtering the QR code, and the framework confirms the data concurring to the comparing piece number put away in the database to decide whether the item data has been altered with. With the advancement of blockchain, in arrange to meet real commerce needs, multi-chain is the future improvement course. For future inquire about, we will encourage investigate the cross-chain innovation between numerous chains and a modern sort of agreement component reasonable for traceability.

The future scope of this project involves refining the blockchain-based traceability system to optimize scalability and interoperability. Additionally, exploring synergies with emerging technologies like IoT and AI could enhance automation and data analytics capabilities. Expanding the traceability framework to encompass processed foods and value-added products would further bolster food safety and consumer confidence in the agricultural supply chain.

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