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Counterfeit Product Detection Using Blockchain Technology

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Abstract

In today's bustling marketplace, the demand for products is skyrocketing, prompting an increase in production from numerous sources. However, this surge has brought along a concerning uptick in counterfeiting activities, presenting significant challenges for companies operating in the consumer market. Not only do these counterfeit goods result in substantial financial losses, but they also inflict damage on brand reputation. Moreover, the proliferation of counterfeit products can have adverse effects on the economy, affecting sales and profitability. For genuine manufacturers, competing with counterfeiters is a daunting task. These counterfeiters often compromise on quality control and utilize cheaper materials to replicate original products, including packaging and branding. This puts authentic manufacturers at a severe disadvantage. To address the rampant production of counterfeit products, effective measures must be implemented. Blockchain technology offers a promising solution for authenticating original manufactured products by securely storing critical details and ensuring data integrity through its decentralized architecture. Information such as manufacturing specifics, materials used, and distribution history can be securely recorded in immutable blocks linked together in a chain. To improve consumer convenience, QR technology can be effortlessly incorporated into product packaging. This allows users to effortlessly scan a product's QR code with any camera-equipped device, granting them access to its unique identification stored securely on the blockchain. By harnessing blockchain technology for product authentication, businesses can effectively combat counterfeiting while enhancing supply chain transparency and fostering consumer trust. This approach not only safeguards brand reputation but also ensures consumer safety. The successful implementation of blockchain-based solutions necessitates collaborative efforts among manufacturers, technology providers, and regulatory authorities. However, the potential benefits, including reduced counterfeiting, improved brand integrity, and enhanced consumer safety, make it a worthwhile endeavor for companies navigating today's fiercely competitive market landscape.

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INTRODUCTION

In the global market, the proliferation of counterfeit goods poses a serious challenge to legitimate manufacturers. These illicit products not only result in financial losses but also undermine the brand equity of companies, potentially irreparably damaging consumer trust. Counterfeiting spans across various industries, including food, merchandise, and pharmaceuticals, among others. Counterfeit items, often manufactured at lower

costs, saturate the market, presenting a formidable obstacle. To tackle this challenge, it's crucial to enable consumers to distinguish between genuine and counterfeit products. Utilizing blockchain technology offers a promising solution by securely storing genuine product identification data. Consumers can then verify this information using QR (Quick Response) codes, which contain unique product identifiers. By scanning these codes with internet-enabled devices equipped with cameras, consumers can authenticate products quickly and reliably.

Implementing a robust system for detecting fake products based on blockchain technology holds the potential to safeguard consumer interests, protect brand reputations, and restore integrity to the market.

OBJECTIVES

The project sets out to accomplish the following goals:

- Creation of an anti-counterfeit system leveraging blockchain technology.
- Establishment of measures to protect product information utilizing QR codes and images.
- Ensuring client safety through the provision of secure data access.

SCOPE AND LIMITATION OF PROJECT

The escalating rise of counterfeit goods presents an ongoing challenge, with consumers often unwittingly purchasing such items due to a lack of awareness. Recent research has documented an increase in counterfeit incidents over the past few years, exacerbating the difficulty of distinguishing between genuine and fake products in the market. Finding a solution entails addressing the imperative for simplicity and accessibility, ensuring that every individual with a smart device can easily utilize it. Through scanning the QR code on a product, users can promptly verify its authenticity.

However, the counterfeit product detection system encounters several limitations:

- *Data accuracy maintenance:* The reliability of the blockchain system depends heavily on the precision of data entry. Inaccuracies may compromise the system's integrity and result in erroneous verification outcomes.
- *Financial implications:* Integrating blockchain technology can incur substantial costs, particularly for small businesses. This financial burden may hinder widespread adoption and diminish the effectiveness of the system.

SYSTEM DESIGN

System architecture refers to the placement and organization structure of the system software and hardware. Figure 1 shows the workings of fake product detection from both consumers and manufacturer perspectives. The process starts with the manufacturer registration. After successfully registering, the manufacturer can add the product details. With that, the blockchain takes the data and generates a QR specific to that product, which contains the information about the product as well as the proof that the product is legit. The added product can be seen in the database for keeping track.

On the other hand, after the registration, the consumer can scan the product through a smart device with a working camera and can scan the QR, thus performing a blockchain search and identifying whether the product is real or fake, and which gives the end result to the consumer.

IMPLEMENTATION

The Fake Product Detection System (FPDS) aims to leverage blockchain technology to combat counterfeit goods in the market. By integrating blockchain into the supply chain, this system ensures the authenticity and traceability of products from manufacturer to consumer.

The technologies required to achieve the desired outcome:

- Blockchain
- JavaScript

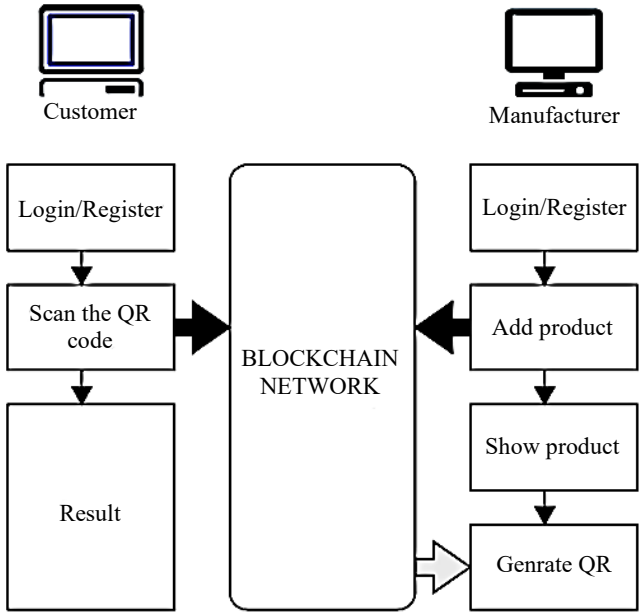

Figure 1. System architecture.

- CSS
- HTML
- Solidity

COMPARISON WITH THE EXISTING SYSTEM

In a centralized system, a single point of control or authority exists, with all data and decision-making processes routed through this central entity. Examples of this include traditional databases, where data is stored on a central server managed by a single entity, such as a company or government.

In a decentralized system, there is no single point of control. Instead, data is distributed across a network of nodes, each possessing a copy of the data and participating in the decision-making process. Blockchain technology exemplifies decentralization. In a blockchain, transactions are recorded across a distributed network of computers (nodes), and consensus mechanisms ensure that all nodes agree on the system's state.

The following is a level 0 data flow diagram (DFD) outlining the basic functionalities of the FPDS:

Entities

- *Manufacturer:* The entity responsible for producing genuine products. They initiate the product entry into the blockchain.
- *Blockchain network:* the decentralized ledger technology used to record transactions and product information securely.
- *Retailer:* Businesses that sell products to consumers. They verify product authenticity before selling to customers.
- *Consumer:* The end-user who purchases the products can verify their authenticity using the system.

Processes

- *Product registration:* The manufacturer registers genuine products onto the blockchain network. This process involves recording essential product details like serial numbers, batch numbers, manufacturing date, etc., onto the blockchain.

- *Verification:* The retailer confirms the product's authenticity by checking the blockchain network. They can access product information and verify its legitimacy.
- *Purchase:* On verification, consumers purchase the product from the retailer. The purchase transaction can also be recorded on the blockchain for transparency.

This Level 0 DFD offers a high-level overview of the interactions between various entities and processes within the FPDS. Subsequent levels of DFD can further elaborate on these processes, adding more detail and refining the system's functionalities (Figure 2).

The Level 1 DFD provides a more detailed view of the processes involved in the FPDS using blockchain technology. It expands on the processes outlined in the Level 0 DFD and illustrates the interactions between different components of the system (Figure 3). Represents the main class responsible for managing the FPDS. It contains a reference to the Blockchain class and provides methods to register and verify products (Figure 4).

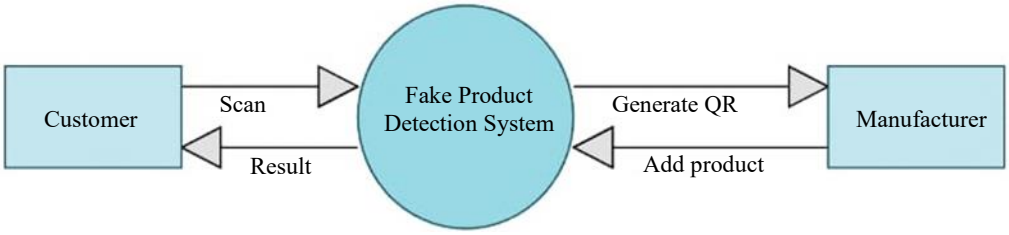

Figure 2. DFD Level 0.

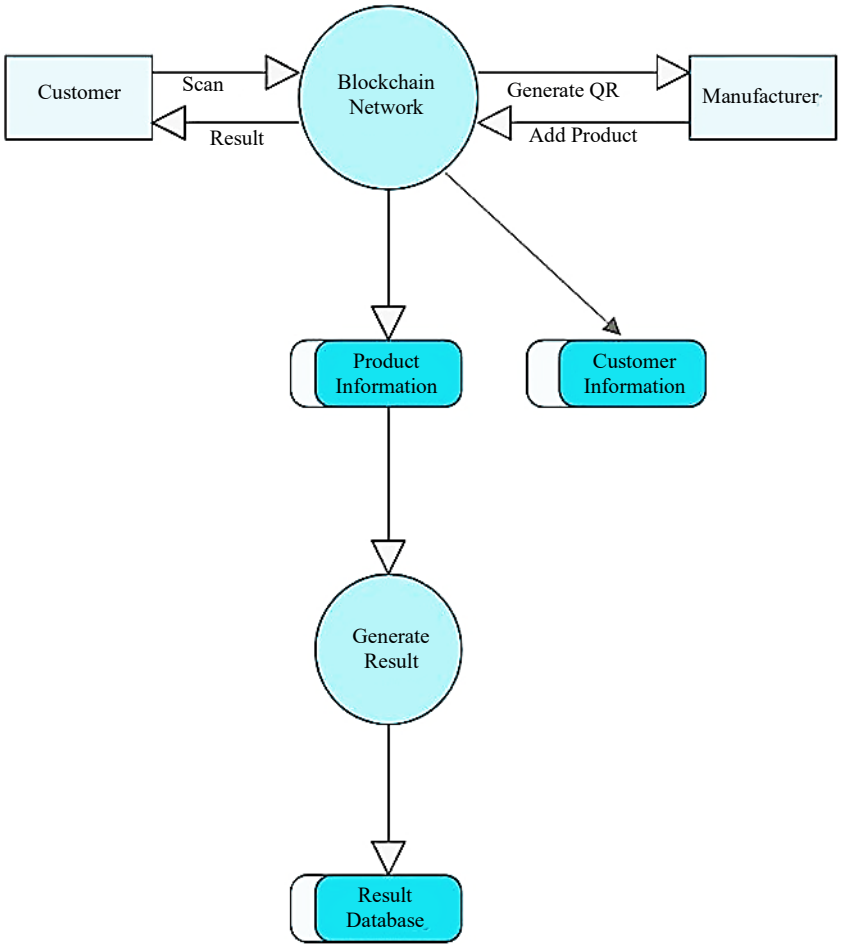

Figure 3. DFD Level 1.

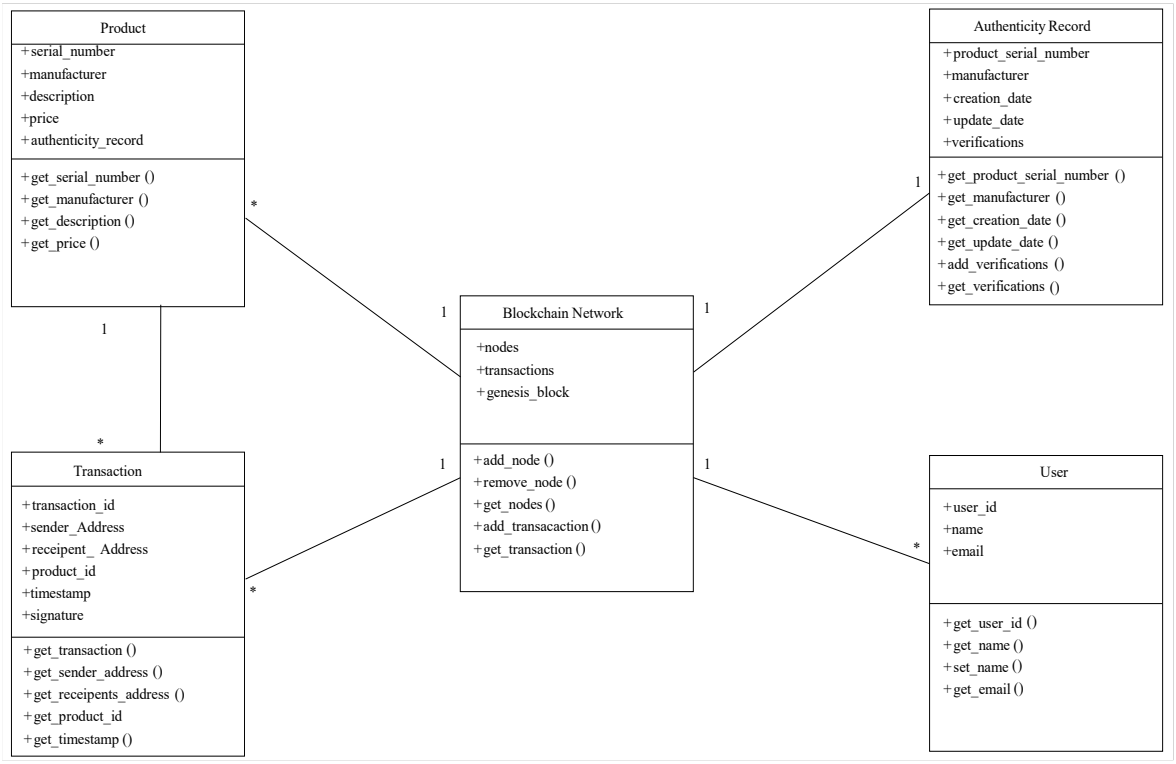

Figure 4. Class diagram.

Blockchain: Simulates the blockchain technology used in the system. It maintains a map of products registered on the blockchain. It provides methods to register and verify products.

Product: Represents a product in the system. It contains attributes such as serial number, manufacturer, and authenticity status. It provides methods to get and set these attributes.

Each use case represents a specific action or task that can be performed within the FPDS. The interactions between the actors (manufacturer, retailer) and the system are depicted in this Figure 5.

RESULT

Detect and prevent false products with advanced QR code verification technology using SHA-256 encryption (Figure 6).

This product has been flagged as potentially counterfeit based on the detected discrepancies in its QR code verification (Figure 7).

This product has been identified as counterfeit based on mismatched seller information (Figure 8).

Detection of counterfeit products using QR-based technology linked to the Seller Database (Figure 9).

Ensuring authenticity by detecting and eliminating false products (Figure 10).

LITERATURE REVIEW

The main motivation behind creating such a system is to absolutely eliminate the manufacturing of counterfeit products that mislead consumers, which has been taking place in recent years. This causes distrust in the consumer market, which badly affects a company's brand value and creates chaos on both the consumer and manufacturer sides.

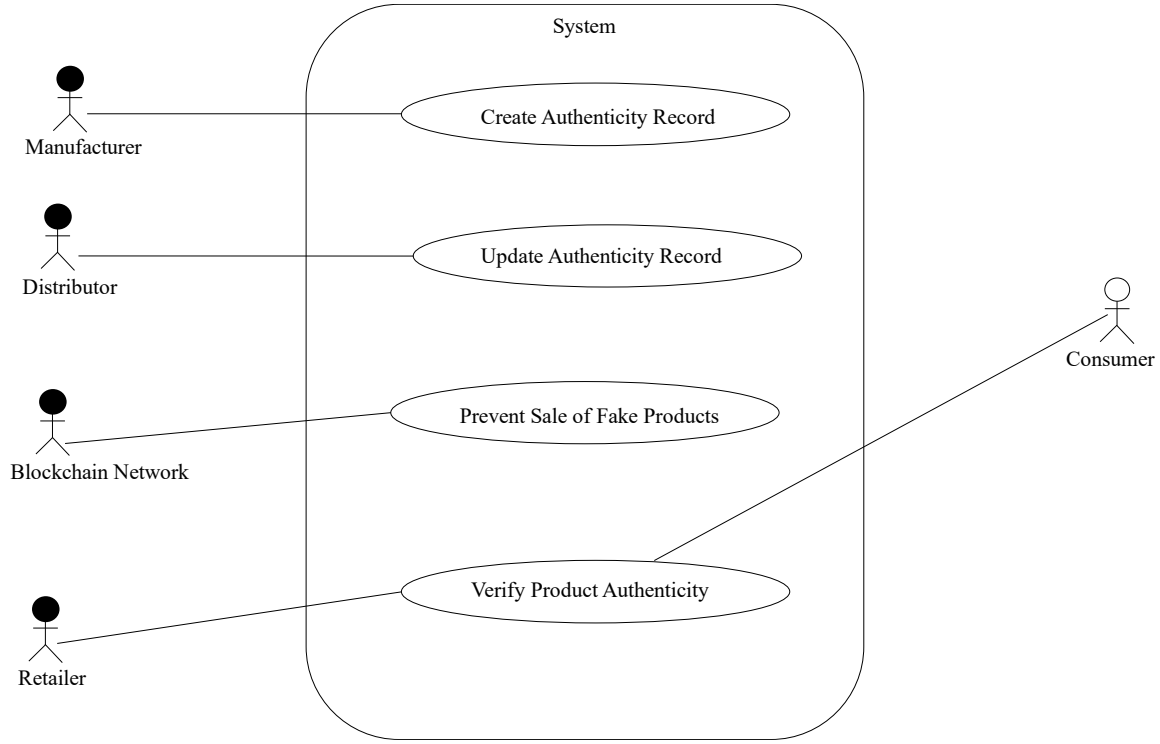

Figure 5. Use case diagram.

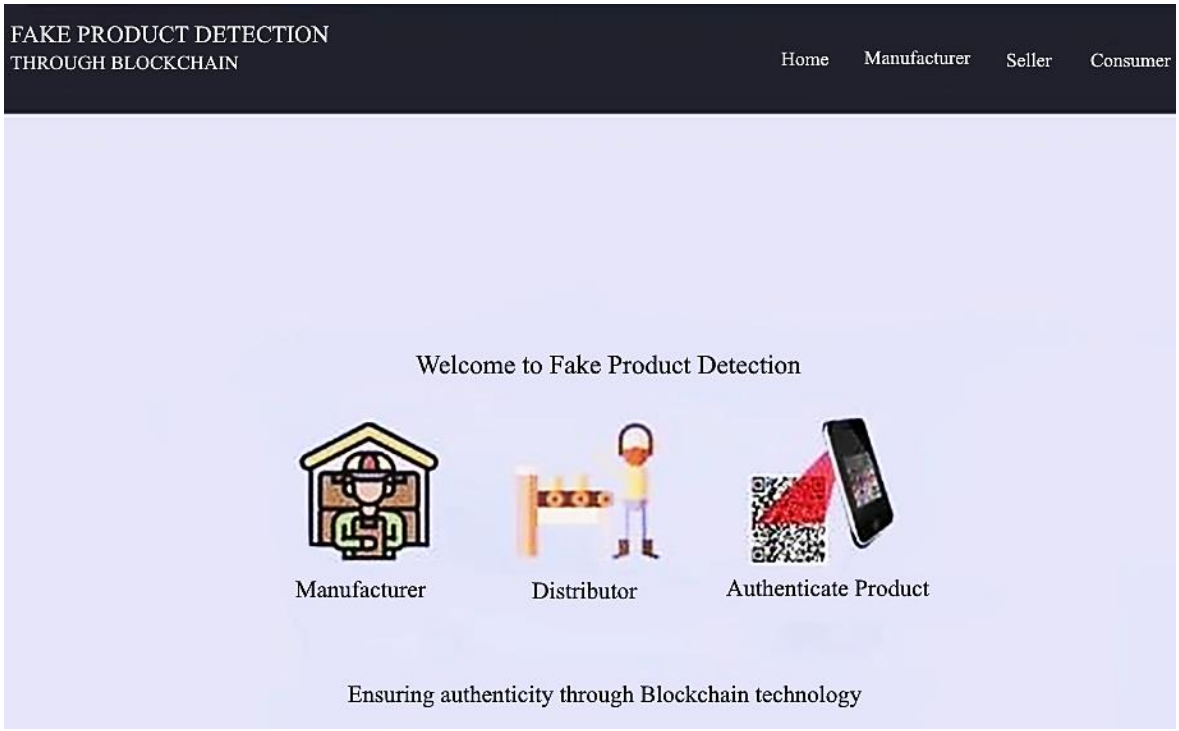

Figure 6. Homepage.

A survey paper authored by Goli Sai Sampath Reddy, Jeedipali Thrishul Reddy, and Jeripothula Ravi Kiran Goud, published in 2023 in the International Journal of Research in Engineering Science and Management (IJRESM) [1], demonstrates the use of QR-based technology for identifying and learning product details through the SHA-256 algorithm. SHA-256, a patented cryptographic hash function, produces a 256-bit output value.

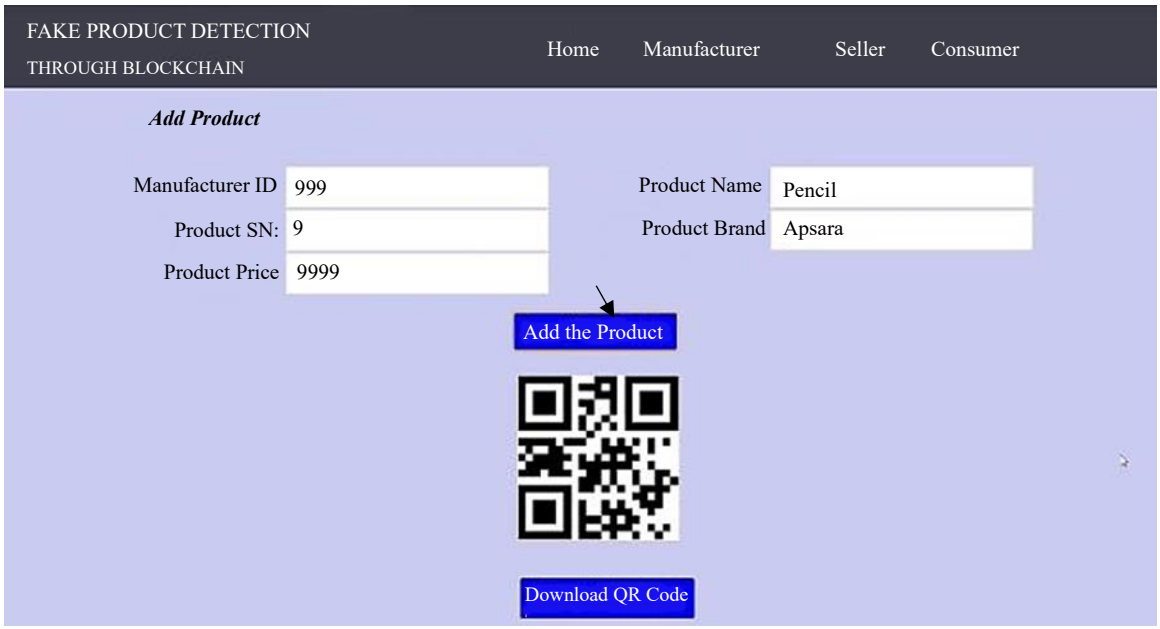

Figure 7. Product details.

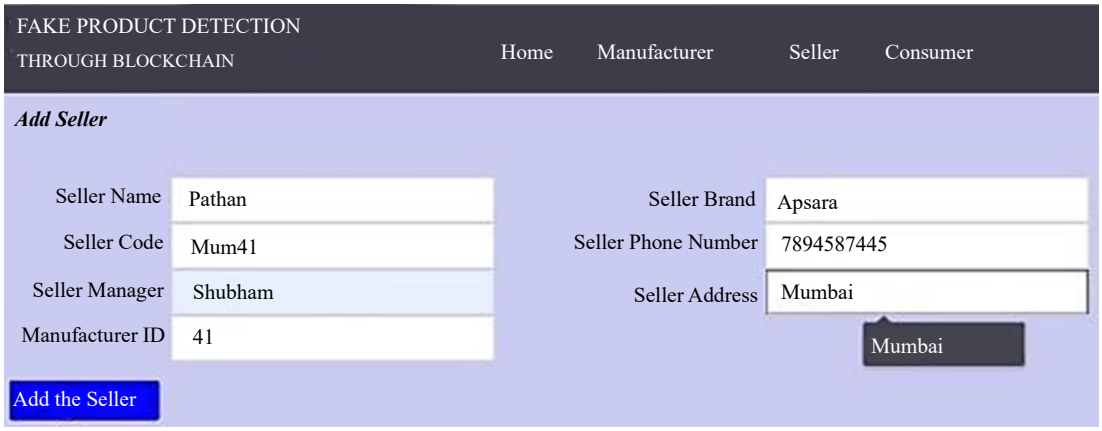

Figure 8. Seller details.

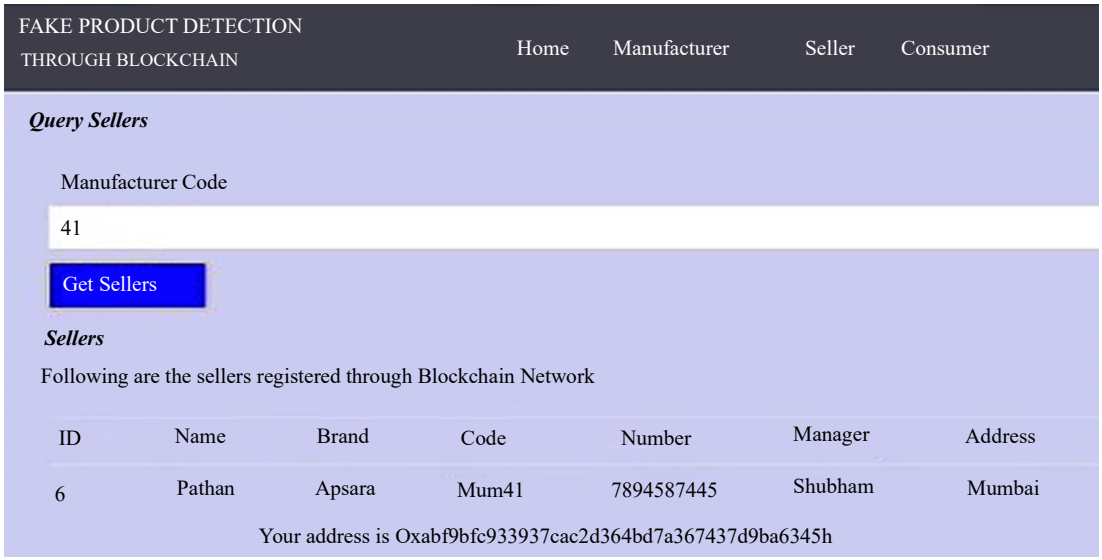

Figure 9. Seller database.

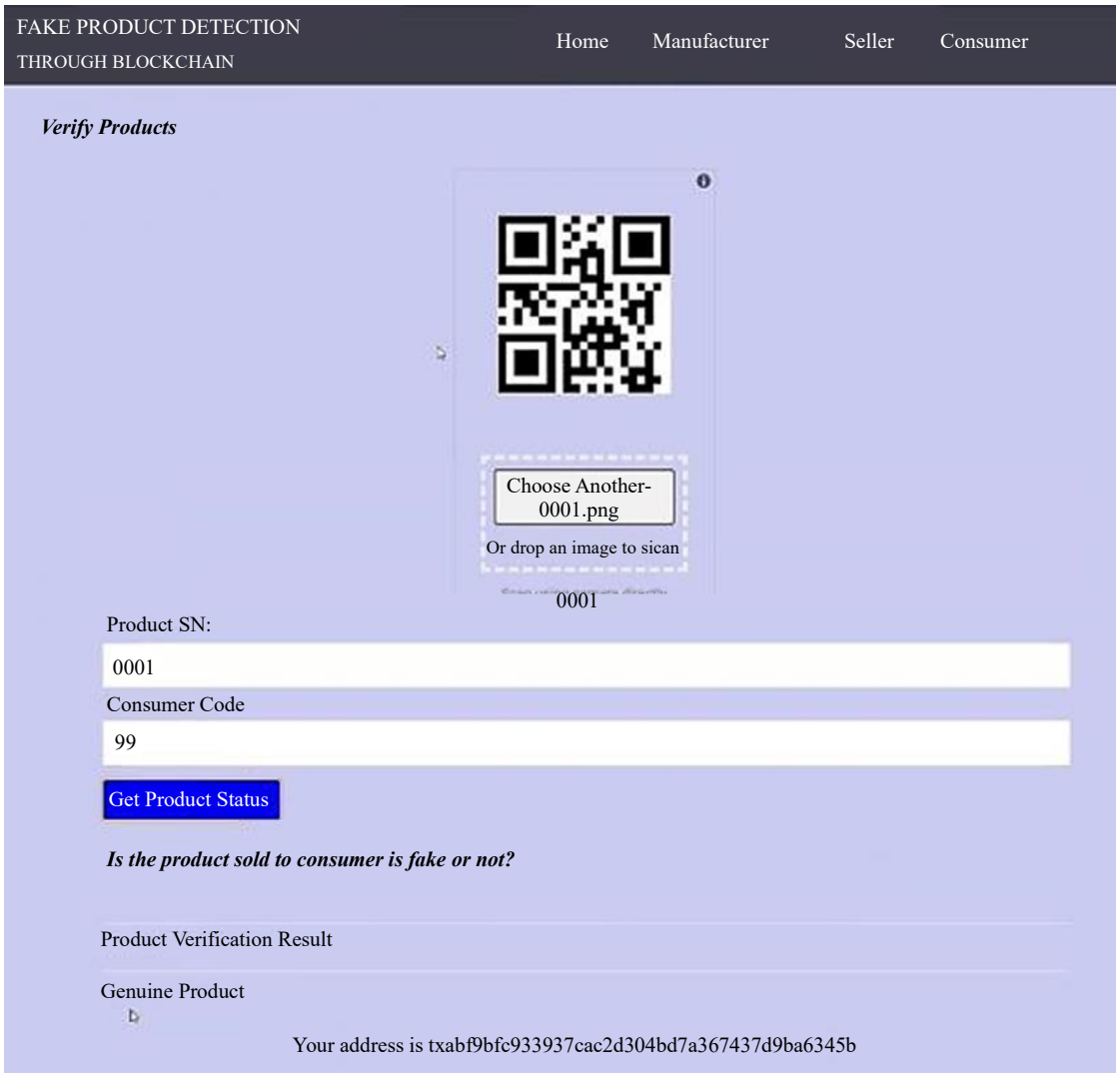

Figure 10. Product verification.

Abdul Khan, Aditi Sahay, Athmika BV, and Lavanya MV published in the IRMETS (International Research Journal of Modernization). Results are provided with this study with architecture and DFD and other user cases [2].

Nafisa Anjum and Pramit Dutta published in the IEEE–2021 [3]. This study paper shows the identification of counterfeit product in supply chain. In this, the algorithms are given for creating the registration page, adding product, selling and as for manufacturing end as well.

Tambe Tejaswini, Chitalkar Sonali, et al. published in the IJARIIE in this paper systematically differentiates between all other techniques which are currently used[[4]. For example, RFID, Magnetic strip, barcode and hologram, and so on. It shows their advantages and disadvantages.

Nruthya Ganapathy, Keerthan kumar, Poojary Shreya Jaya, Rajath D Shetty, and Dr. Shreekumar T published in the IJCRT (International Journal of Creative Research Thoughts)–2022 [5]. This research shows the architecture of system and end results.

Tejashri Mitbavkar, Swarangi Pedamkar, Saloni Kuvalekar, Prof. Kumud Wasnik IJRASET (International Journal for Research in Applied Science & Engineering Technology)–2023 [6]. This study shows the system design with DFD.

Srikrishna Shastri C, Vishal K, Sushmitha S, Lahari, Ashwal R Shetty, (IJARCCE) International Journal of Advanced Research in Computer and Communication Engineering–2022 [7]. It provides with step-by-step methodology and tools which are needed in process to create a working system.

Kunal Wasnik, Isha Sondawle, Rushikesh Wani, Namita Pulgam, ITM Web of Conferences–2022 [8]. The research shows and discuss importance of blockchain and its advantages with whole affect counterfeit products in industry.

Renukadevi B, Bharathy R, Abinesh K, IJNRD (International Journal of Novel Research and Development)–2022 [9]. The paper shows the methodology and end result with an actual system.

Kishan Tiwari, Nikita Patil, Akshay Gupta, Akash Sabale, Vina Lomte published in the IRJET (International Research Journal of Engineering and Technology)–2023 [10]. This study shows different algorithm which are needed like SHA which provides security. As well Proof of Work (PoW) for its simple design and decentralized characteristics and at the last Proof of Stake (PoS) it is faster than PoW.

Subeg Singh Kapoor, Tushar Suryawanshi, Swapnil Jadhav¸ and Prof. S. V. Shinkar published in the IJRPR (International Journal of Research Publication and Review)–2023 [11]. Thus, literature survey shows advantages of blockchain system in product selling market with its features and compare it with previous technologies.

T. Shreekumar, Puneet Mittal, Sukhwinder Sharma, Rajesh N Kamath, Sreeja Rajesh, B. and Nruthya Ganapathy published in the Journal of Algebraic Statistics–2022 [12]. It provides suggestion which can be added in end product with different features with information abkut etherium.

Tejaswini Tambe, Sonali Chitalkar, Manali Khurud, Madhavi Varpe, and S. Y. Raut published in the IJARII (International Journal of Research and Analytical Reviews)–2021 [13]. It suggests software like Android Studio and Firebase Cloud for developing the application with system architecture and algorithms with results.

Naif Alzahrani and Nirupama Bulusu, Computer Science Faculty Publications and Presentations–2019 [14]. A new product anti-counterfeiting blockchain using a truly decentralized dynamic consensus protocol. It shows the disadvantages of existing centralized system and how to overcome them.

Fran Casinoa, Thomas K. Dasaklisb, and Constantinos Patsakis published in the Telematics and Informatics–2019 [15]. The literature review gives an overall overview, characteristics of blockchain technology with its limitations and future scope.

CONCLUSION

The actual system for detecting counterfeit products presents several advantages that can positively impact the economy while eliminating vulnerabilities. This ensures that fraudulent activities are effectively prevented, leading to a decline in the production of imitation goods over time. Here are some detailed benefits:

Decrease in Imitation Goods

Implementing the counterfeit product detection system effectively halts the cycle of counterfeit production and distribution. This creates more opportunities for genuine merchandise to flourish and enhance.

Simplified Product Verification

The integration of digital signatures embedded in QR codes facilitates straightforward confirmation of product authenticity. This discourages the proliferation of fake goods in the market.

Enhanced Transparency in the Supply Chain

By providing comprehensive details from the product's inception to the end consumer, transparency between the product and consumer is significantly heightened. This transparency eradicates any suspicion and ensures the integrity of the product throughout its journey.

Streamlined Approval of Purchases

Through smart devices or any internet-enabled device with a camera, consumers can effortlessly verify the authenticity of products, enabling well-informed purchasing decisions.

Assurance of Product Authenticity

Products that can circulate in the market without external interference inspire greater confidence among customers. This enhances the company's reputation and attracts more patrons.

Enhanced Data Security

Blockchain technology ensures the security of product-related data, thwarting unauthorized access and safeguarding confidentiality. This fortifies security measures and reduces the risk of illicit activities.

Efficient Management of Warranties

The individual product storage capability facilitated by the counterfeit product detection system allows for more efficient after-sales services, particularly for genuine products. This includes providing warranties or guarantees exclusively for authentic products.

Accurate Product Monitoring

By leveraging blockchain technology, companies can accurately monitor the journey of genuine products, gaining valuable insights into their manufacturing and distribution processes.

Future Enhancement

The implementation of additional technologies holds significant promise for refining the product assessment system. Several potential enhancements could elevate the overall system:

Scalability Solutions

Addressing counterfeit product issues could open doors to broader applications within the supply chain. This might involve expanding platforms to accommodate a wider array of products, thus enhancing the system's scalability and adaptability.

User-Friendly Interfaces

Incorporating intuitive interfaces is paramount to ensuring widespread adoption of the product assessment system. A straightforward and comprehensible UI can streamline the identification process, saving time and reducing complexity for users with busy schedules.

Exploring the integration of alternative technologies with blockchain can further refine and optimize the entire system, delivering improved functionality and efficacy.

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