Fake Product Identification System Using Blockchain Technology

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Abstract - The Fake Product Identification System (FPIS) is a cutting-edge solution that tackles the global issue of counterfeit products by leveraging blockchain technology. In this system, each genuine product receives a unique digital identifier and is recorded on the blockchain during its production phase, ensuring a tamper-proof and traceable record. When consumers purchase a product, they can easily verify its authenticity through a mobile application that interfaces with the blockchain to retrieve relevant information. By eliminating the need for centralized databases and intermediaries, the FPIS provides a transparent and secure environment, protecting sensitive data and preventing potential fraud. With its decentralized consensus mechanism, the system maintains the integrity and immutability of product information, ensuring consumers can make informed choices and trust the authenticity of their purchases. Ultimately, the Fake Product Identification System aims to enhance consumer trust and revolutionize supply chain management, promoting a safer marketplace for all stakeholders.

Keywords-Consumer Protection, Product Authenticity, Decentralization, Immutability.

I.INTRODUCTION

In recent years, blockchain technology has emerged as a promising solution to address these challenges. Blockchain, often associated with cryptocurrencies like Bitcoin, is a distributed ledger technology that allows secure and transparent data sharing across a network of participants. Its inherent characteristics of immutability, decentralization, and consensus-based verification make it an ideal platform for improving supply chain management in the Indian agricultural sector.

This document shows the suggested format and appearance of a manuscript prepared for The Fake Product Identification System (FPIS) is an innovative and robust solution designed to tackle the persistent problem of counterfeit products in today's global market. Counterfeiting poses significant risks to consumers, businesses, and economies, leading to financial losses, compromised safety, and reduced consumer trust. To address this pressing issue, the FPIS utilizes the power of blockchain technology, renowned for its decentralized, transparent, and immutable nature.At the core of the FPIS lies the creation of unique digital identifiers for genuine products. During the manufacturing or production phase, each product is assigned a cryptographic hash, essentially a digital fingerprint, which encapsulates crucial information about its origin, manufacturing date, and supply chain journey. This information is then securely recorded on a blockchain, a distributed and tamper-proof ledger accessible to all authorized parties within the network.

When a consumer purchases a product, they can easily verify its authenticity through a user-friendly mobile application. By scanning a QR code or inputting the product identifier, the application interacts with the blockchain, retrieving the stored information and cross-referencing it with the data provided by the manufacturer. If the product is genuine, the application displays a confirmation, instilling confidence in the consumer's purchase decision. If the product is found to be counterfeit or tampered with, the FPIS raises an alert, empowering consumers to avoid potential harm and report fraudulent activities. One of the primary advantages of the FPIS is its decentralized and transparent nature, which eliminates the need for centralized databases and intermediaries. This decentralized approach ensures that sensitive information is encrypted and accessible only to authorized participants, such as manufacturers, retailers, and regulatory authorities, reducing the risk of data manipulation and enhancing overall data security. The blockchain's consensus mechanism plays a critical role in maintaining the system's integrity and immutability. Once the product information is recorded on the blockchain, it becomes practically impossible to alter or delete it without the consensus of the entire network. This inherent characteristic of blockchain prevents malicious actors from tampering with historical data, providing an indisputable record of each product's authenticity and journey.

The Fake Product Identification System (FPIS) stands as a promising solution to combat counterfeit products using blockchain technology's decentralized, transparent, and immutable features. By providing a tamper-proof record of each genuine product and enabling consumers to verify

authenticity with ease, the FPIS aims to foster a safer and more trustworthy marketplace for all stakeholders involved.

II. RELATED WORK

[1] Blockchain-based Supply Chain Traceability:
Researchers have extensively explored the use of blockchain technology to enhance supply chain traceability and combat counterfeit products. By recording every step of a product's journey on an immutable blockchain ledger, stakeholders can verify the authenticity of goods at each stage. Blockchain's decentralized nature ensures transparency, making it difficult for malicious actors to manipulate or alter the data. Smart contracts are often employed to automate supply chain processes, ensuring adherence to predefined rules and regulations. This approach not only prevents counterfeit products from entering the supply chain but also facilitates efficient recalls and product quality management.

[2] NFC and QR Code Solutions for Anti-counterfeiting:
Several studies have investigated the integration of Near Field Communication (NFC) and Quick Response (QR) codes with blockchain technology to tackle counterfeiting. Manufacturers embed NFC tags or QR codes on product packaging, which consumers can scan using their smartphones to access realtime product information stored on the blockchain. This approach provides a seamless and user-friendly way for consumers to verify product authenticity, ensuring they can make informed purchase decisions. Additionally, these technologies can be combined with blockchain's decentralized consensus to further enhance security and eliminate potential points of vulnerability.

[3] Decentralized Product Verification Platforms:
Certain research efforts have proposed decentralized platforms that allow users to collectively verify the authenticity of products. These platforms use blockchain's distributed consensus mechanism to enable users to vote on the legitimacy of a product. The collective decision-making process reduces the influence of malicious actors and ensures accurate product identification. Such systems promote community-driven authentication, fostering trust among consumers and establishing a reliable anti-counterfeiting mechanism.

[4] Collaborative Blockchain Networks for Industry Collaboration:
To combat counterfeiting at an industry-wide level, collaborative blockchain networks have been suggested. These networks facilitate secure data sharing among manufacturers, suppliers, distributors, and retailers, enabling real-time tracking and verification of product information. By maintaining a shared and auditable record of product provenance, these platforms strengthen supply chain integrity and create a collective defense against counterfeit products.

[5] Blockchain-based Consumer Protection:
Researchers have explored the concept of empowering consumers through blockchain technology to protect themselves from counterfeit products. By providing direct access to product information stored on the blockchain, consumers can verify authenticity independently. This direct communication between consumers and the blockchain ensures transparency and eliminates the reliance on intermediaries, reducing the risk of misinformation or manipulation.

[6] Blockchain-powered Intellectual Property Protection:
In the realm of intellectual property protection, blockchain has been considered as a solution to safeguard trademarks, patents, and copyrights. Blockchain-based systems enable companies to register and verify their intellectual property rights, establishing an indisputable record of ownership. This discourages counterfeiters from producing and selling fake goods, as the legitimacy of the original products can be easily verified through the blockchain.

[7] Blockchain-based Product Certification:
Some research has explored the concept of using blockchain to establish product certification standards. Manufacturers can undergo a certification process, and the validated data is then recorded on the blockchain. Consumers can easily verify the authenticity of certified products by accessing the blockchain records, thus ensuring the legitimacy of their purchases.

[8] Blockchain-based Anti-Counterfeiting Labels:
Innovative anti-counterfeiting labels integrated with blockchain technology have been proposed. These labels can contain encrypted QR codes or NFC chips with unique identifiers, allowing consumers to scan and verify product authenticity easily. The blockchain backend ensures that the labels cannot be replicated, providing an additional layer of security against counterfeit products.

[9] Multi-tiered Supply Chain Tracking:
Blockchain solutions have been developed to track products across multi-tiered supply chains. From raw materials to the final product, each stage is recorded on the blockchain, offering complete visibility into the supply chain. This comprehensive tracking helps identify potential points of counterfeiting and enhances traceability throughout the production and distribution process.

[10] AI and Machine Learning in Counterfeit Detection: Some researchers have combined blockchain with artificial intelligence and machine learning algorithms to detect counterfeit products. AI-driven image recognition and pattern matching techniques can help identify subtle differences between genuine and fake products, thereby assisting consumers and businesses in distinguishing authentic items from counterfeits.

[11] Incentive Mechanisms for Reporting Counterfeits:
Blockchain-based incentive mechanisms have been proposed to encourage consumers and stakeholders to report counterfeit products. By rewarding users who report fraudulent activities, the system can gather valuable data on counterfeit trends and improve overall anti-counterfeiting efforts.

[12] Blockchain-based Authentication Services: Entrepreneurial initiatives have emerged to offer blockchainbased authentication services to brands and manufacturers. These third-party services use blockchain to verify product authenticity and provide consumers with real-time information, bolstering their confidence in purchasing genuine products.

[15] Blockchain Integration with RFID Technology: Researchers have explored the integration of Radio-Frequency Identification (RFID) technology with blockchain to enhance anti-counterfeiting measures. RFID tags can carry unique product identifiers that are linked to blockchain records, enabling real-time tracking and verification of product authenticity.

III. METHODOLOGY

The system proposed here uses MetaMask cryptocurrency wallet for transactions and and the smart contract here has been deployed in the Rinkeby Test Network of the Ethereum Blockchain. The DApp is based on three major stakeholders, the Manufacturer, the Seller and the Consumer.

A.System Diagram

Figure 1 depicts the system diagram of the proposed DApp. Every user of the DApp has to be authenticated before logging in. This authentication system has been implemented using Firebase which is a platform provided by Google for developing interactive mobile and web applications. After successful authentication, the manufacturer can add their company to the DApp and enroll products of the company. The contract address of the company is provided to the manufacturer and all the company data as well as manufacturer's account address are stored in the blockchain network. After a product has been included in the blockchain, it is assigned a QR code for verification. The sellers can buy products from manufacturer after registration. The ownership transfer of the product can be tracked through the QR code.

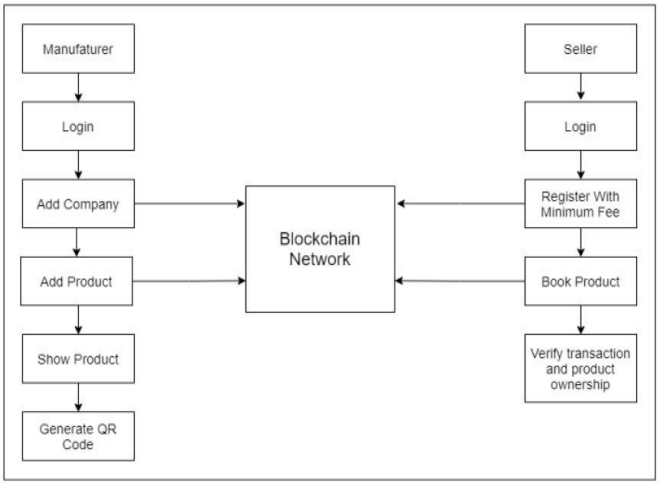

Figure 1. System Design
Source: https://ieeexplore.ieee.org/document/10057923

B. Manufacturer

The manufacturer's functions include adding the company to the blockchain by providing company name and setting the minimum registration fee to become a seller or retailer for the company. The manufacturer solely preserves the rights to enroll products in the network. The manufacturer can Fig. 2. Manufacturer's Working Process also control the distribution status of products and transfer ownership after a seller has bought the product stock. The manufacturer performs two major functions namely adding and distributing products in this system.

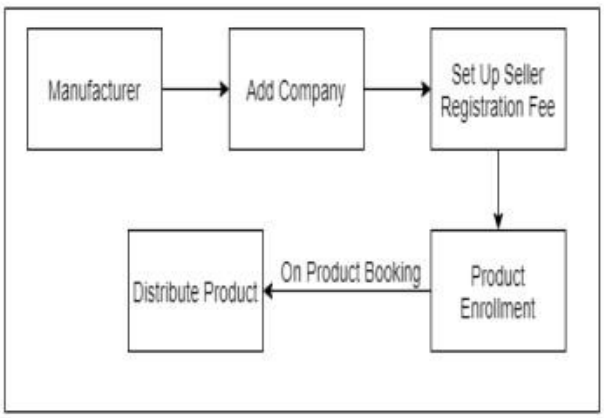

Figure 2. Manufacturer's working process
Source: https://ieeexplore.ieee.org/document/10057923

C. Seller

A seller can pay the minimum fee set by the manufacturer and register for the company. After registering once, the seller can buy any product as well as track its distribution. A product status is set from 'Ready To Go' to 'Shipped' after the manufacturer ships it out to the seller.

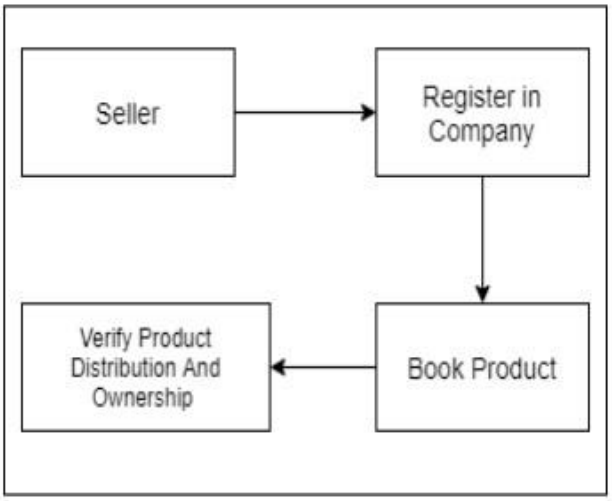

Figure 3. Seller's Working process
Source: https://ieeexplore.ieee.org/document/10057923

D. Consumer

A consumer can scan the QR code provided with each product and verify the transfer of ownership of product from manufacturer to seller. The consumer can also verify the name of the current owner of the product and check its distribution status.

E. Blockchain

Blockchain technology provides promising opportunities in the supply chain management paradigm. Blockchain data is stored on nodes where each node has a complete copy of the blockchain database. Orders, payments, accounts, price of products etc. can be tracked, shared and secured using a blockchain network. Some important features of blockchain technology in supply chain management includes: 1) Security and Privacy: Blockchain uses public key encryption method of cryptography for data security. Users have public and private key pair which are used to validate transactions and these transactions are immutable and permanent.

2) Decentralization: As blockchain is a distributed ledger technology, it doesn't rely on third party or any centralized authority.

3) Transparency: Data stored in Blockchain is public and anyone can enquire on their transactions. The transactions can be governed by a set of rules known as the smart contract. The system proposed here uses MetaMask cryptocurrency wallet for transactions and and the smart contract here has been deployed in the Rinkeby Test Network of the Ethereum Blockchain. The DApp is based on three major stakeholders, The Manufacturer, the seller and the consumer.

IV.EXPERIMENTAL RESULTS AND PERFORMANCE EVALUATION

Sending data to the Blockchain comes with some cost referred to as transaction cost. Miners tend to prioritize transactions with higher costs. Transaction cost is measured in gas and gas fees are paid in Ethereum's native currency ether (ETH). The table indicates the transaction cost and gas fees required for the proposed system.

Sl No.	Function Description	Transaction Cost (gas)	Gas Fee (ETH)
1	Deploy Contract of our system	133405	0.001333
2	Adding New Company	1068597	0.001069
3	Seller Registration	45755	0.000046
4	Product Enrollment	208571	0.000209
5	Buying Product	41581	0.000042
6	Product Distribution	55578	0.000056
Total=0.002755 ETH/ $8.56			
Deploy= $4.14			

Table 1. Cost Calculation

Source: https://coinmarketcap.com/alexandria/categories/cmcresearch

Here CoinMarketCap [10] was used to convert Ether to US dollars. Remix which is a web browser IDE for developing DApp was used determine the gas needs. MetaMask was used for contract interaction and determining the costings. The cost for deploying our contract in the Rinkeby Test Network is 0.001333 ETH which is equivalent to 4.14 US dollars. The overall costing for the system is less than 10 US dollars which proves the cost effectiveness of the proposed model. The product ownership transfer as well product quality assurance costs are also reduced here compared to current market trends to verify product authenticity. A consumer can scan the QR code and verify the ownership transfer of the product. The manufacturer's account address, the seller's account address and name as well as the status of product is recorded in the QR code. If the product status is 'Shipped', the product transfer is genuine and the order is set to 'complete' in the blockchain. The QR code is provided with copy-sensitive digital image pattern.

V. FINDINGS AND IMPLICATIONS OF THE RESEARCH

Findings:

1. Enhanced Product Authentication: Blockchain-based fake product identification systems offer enhanced product authentication capabilities. The use of unique digital identifiers and tamper-proof records on the blockchain helps consumers

and stakeholders verify the authenticity of products with a high level of confidence.

2. *Transparency and Trust:* The transparency and immutability of blockchain provide a trustworthy environment for product verification. Consumers can access real-time information about the product's origin, manufacturing details, and supply chain journey, reducing the likelihood of falling victim to counterfeit products.

3. *Traceability and Supply Chain Integrity:* Blockchain enhances supply chain traceability by recording each stage of the product's journey. This end-to-end visibility ensures greater supply chain integrity and reduces the risk of counterfeit products entering the market.

4. *Decentralization and Data Security:* Decentralization eliminates the need for central authorities, minimizing the risk of data manipulation or single points of failure. Data privacy and security mechanisms on the blockchain protect sensitive information from unauthorized access and tampering.

5. *Efficient Consumer Protection:* Blockchain-based systems empower consumers to actively participate in product verification, leading to more informed purchase decisions. The ability to report suspected counterfeit products contributes to a collective effort to combat counterfeiting.

6. *Cross-Industry Collaboration:* Blockchain facilitates crossindustry collaboration by providing a shared, transparent platform for multiple stakeholders. Manufacturers, retailers, regulators, and consumers can collaboratively combat counterfeit products, creating a more robust defense against fraud.

Implications:

1. *Consumer Confidence and Safety:* The FPIS enhances consumer confidence by providing a reliable and transparent method to verify product authenticity. Consumers can make informed purchase decisions, knowing that the products they buy are genuine and safe. This increased trust can lead to higher customer loyalty and satisfaction.

2. *Brand Reputation:* Implementing the FPIS can bolster brand reputation for manufacturers and retailers. With a secure system to prove product authenticity, brands can differentiate themselves from counterfeit competitors, establishing trust and credibility among consumers.

3. *Economic Impact*: Counterfeit products impose significant economic losses on legitimate businesses. By curbing counterfeiting, the FPIS can help protect revenues and encourage investments in innovation and product development.

4. *Supply Chain Efficiency:* The transparency provided by blockchain enhances supply chain efficiency by streamlining information flow and reducing the time and effort spent on verification processes. Supply chain stakeholders can identify and address inefficiencies, improving overall productivity.

5. *Intellectual Property Protection*:The FPIS can support intellectual property protection by providing a tamper-proof record of product ownership and trademarks. This can discourage counterfeiters from producing fake goods that infringe on established brands' intellectual property.

6. *Regulatory Compliance:* The FPIS can aid in regulatory compliance, especially in industries where product authenticity is critical, such as pharmaceuticals and luxury goods. It can facilitate adherence to quality standards and regulations, ensuring consumer safety and product integrity.

VI. CONCLUSION AND FUTURE WORK

The Fake Product Identification System (FPIS) using blockchain technology offers a powerful solution to combat counterfeit products and enhance consumer trust in the marketplace. By leveraging the decentralized and immutable nature of blockchain, the FPIS provides a transparent and tamper-proof record of product authenticity, enabling consumers to make informed purchase decisions. The system's integration with supply chain management ensures end-to-end traceability and supply chain integrity, reducing the risk of counterfeit products entering the market. Additionally, the FPIS fosters cross-industry collaboration, encouraging stakeholders to work collectively in the fight against counterfeiting. The implementation of the FPIS has implications for consumer confidence, brand reputation, economic impact, intellectual property protection, and supply chain efficiency.It also poses challenges related to data privacy, security, and user adoption that require careful consideration and ongoing research.The FPIS represents a significant step towards building a safer and more trustworthy marketplace for all stakeholders involved.

Ownership tracking system is being reshaped through distributed ledgers of Blockchain technology. Due to rapid changes in the Ecommerce and business sectors, the current trends of supply chain are being affected. The DApp developed here ensures greater transparency in the supply chain management and can also be entrusted for use in Ecommerce. As such, administrative costs and complicated procedures are eliminated by this process. Besides, the cost for enrolling each product in the proposed model is only 0.000209 ether which is equivalent to 0.65 US dollars that can sufficiently reduce costs for large chain stores. The model also ensures enduser verification system through a QR code and transactions here can be verified on Etherscan too. As future work of the proposed model, the functions included can be improved further to bring reliability in the supply chain management

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