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Fake Product Detection Using Blockchain Technology

Mrs Pooja G, Divya M R, Bhagyshree ,

Mrs Pooja G,Department of Computer Science, Sir M. Visvesvaraya Institute of Technology (SMVIT) Divya M R ,Bhagyshree (Student),Department of Computer Science, Sir M. Visvesvaraya Institute of Technology (SMVIT)

Abstract Counterfeit products have become a major concern in industries like electronics, pharmaceuticals, and consumer goods, creating a strong need for reliable and tamper-proof verification systems. This paper introduces a blockchain-based approach to address this problem by ensuring transparency, immutability, and secure tracking of product information across all stages of the supply chain. In the proposed system, each product is assigned a unique hash that is stored on the blockchain and later converted into a QR code. As the product moves from manufacturer to end consumer, every transaction is recorded, forming a trustworthy and auditable trail. Customers can simply scan the QR code to confirm whether a product is genuine. This method lowers the chances of fraud, builds trust, and improves overall transparency. The results show that blockchain significantly strengthens product traceability compared with traditional, centralized systems.

Keywords

Blockchain, Product Authentication, QR Code Verification, Anti-Counterfeiting, Supply Chain Transparency, Product Traceability.

I. INTRODUCTION Counterfeit products pose a serious challenge across many industries, especially in pharmaceuticals, electronics, and luxury goods. Most existing verification methods depend on centralized databases, which can be easily tampered with, hacked, or corrupted. Blockchain technology offers a strong alternative because it is decentralized, transparent, and tamper-proof. In this paper, we present a blockchain-based approach in which every product is assigned a unique and secure digital identity. Each movement of the product through the supply chain is recorded on the blockchain, creating a reliable history that cannot be altered. This enhances trust and ensures that manufacturers, distributors, and consumers can verify the authenticity of a product at any stage.

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LITERATURE SURVEY

Several research studies have focused on improving product authentication and supply chain transparency using blockchain technology. Bansal et al. (2020) introduced a decentralized tracking mechanism that assigns a unique digital identity to each item, helping reduce manipulation in centralized systems. Singh and Kaur (2021) proposed a QR-code-based verification approach built on Ethereum smart contracts, enabling customers to instantly authenticate products by scanning a code linked to blockchain records.

Zhang et al. (2019) explored Hyperledger Fabric for end-to-end supply chain traceability, showing that permissioned blockchain networks provide high security and accountability among supply chain participants. Other researchers have experimented with integrating IoT sensors into blockchain frameworks to provide real-time monitoring and environmental tracking of goods.

Overall, existing literature suggests that blockchain-based authentication systems offer strong immutability, traceability, and fraud prevention, forming a solid foundation for developing advanced anti-counterfeiting solutions.

PROPOSED SYSTEM

The proposed system presents a blockchain-based approach for detecting and preventing counterfeit products throughout the supply chain. Unlike traditional centralized databases—which can be altered, hacked, or mismanaged—this system relies on a decentralized blockchain ledger that is secure, transparent, and tamper-proof.

Every product is assigned a unique product ID**,** which is then processed through a secure hashing algorithm such as SHA-256. The resulting hash is permanently stored on the blockchain. This hash value is also converted into a QR code and printed on the product's label or packaging.

As the product travels from the manufacturer to the distributor, retailer, and finally to the customer, each stage of movement is recorded on the blockchain. This creates a complete and traceable history of the product that cannot be modified or deleted.

When a customer scans the QR code using a verification app, the app fetches the corresponding blockchain record and compares it with the product's stored details. If the information matches, the product is verified as genuine. If there is any difference, the system immediately flags it as counterfeit or tampered.

By maintaining a secure and transparent record for every product, this system strengthens authenticity, boosts consumer confidence, and provides an immutable audit trail across the entire supply chain.

SYSTEM ARCHITECTURE

The system architecture is designed to ensure secure product verification using blockchain technology. It consists of four main entities: the manufacturer, the distributor, the retailer, and the consumer. Each entity interacts with the blockchain network to record and verify product information.

At the core of the architecture is a blockchain ledger that stores all product-related transactions. When a manufacturer creates a new product, a unique product ID is generated and converted into a cryptographic hash. This hash is then stored as a block on the blockchain. The system also generates a corresponding QR code, which is printed on the product packaging.

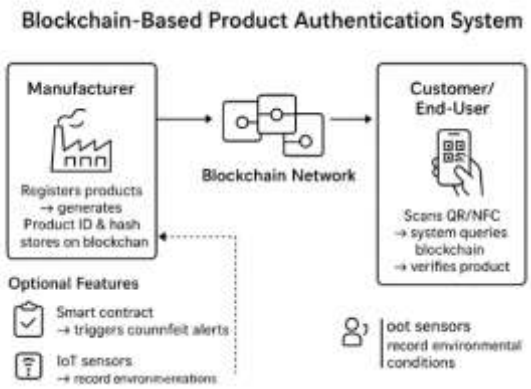
As the product moves through the supply chain, each participating entity updates the blockchain with relevant information such as shipment details, location updates, and ownership transfers. These updates are stored as additional blocks, creating a chronological and tamper-proof history for each product.

Consumers play an important role at the final stage. Using a mobile scanning application, they can scan the QR code to retrieve the product's blockchain record. If the retrieved data matches the expected information, the product is verified as authentic. Otherwise, the system alerts the user about possible counterfeiting.

This architecture ensures transparency, data integrity, and trust among all parties in the supply chain while maintaining strong protection against tampering and fraud.

WORKFLOW / METHODOLOGY

The workflow of the proposed system outlines how a product is tracked, recorded, and verified at every stage of the supply chain. The process ensures that each product receives a secure digital identity and remains traceable until it reaches the customer. The complete workflow is described below:



1. Product Creation

The process begins when the manufacturer produces a new product. A unique product ID is generated for each item. This ID is then processed through a hashing algorithm, such as SHA-256, to create a secure digital fingerprint of the product.

2. Hash Generation and QR Code Creation

Once the unique hash value is produced, it is stored on the blockchain as an immutable record. A corresponding QR code is automatically generated from this hash. This QR code is printed on the product packaging and acts as the key to verify the product's authenticity.

3. Blockchain Recording

The manufacturer uploads essential product details—such as batch number, manufacturing date, and product category—onto the blockchain. Each new entry becomes a block in the distributed ledger, ensuring that no one can modify or delete the information.

4. Supply Chain Tracking

As the product moves from the manufacturer to the distributor and then to the retailer, each transfer is recorded on the blockchain. Every step in the supply chain updates the ledger with the movement history, creating a transparent and chronological record. This ensures complete traceability and prevents unauthorized duplication.

5. Customer Verification

When the product reaches the end user, the consumer can scan the QR code using a verification application. The app retrieves the product's blockchain record and compares it with the product information.

- If the details match, the system confirms the product is genuine.
- If the details differ or no record exists, the system alerts the consumer about a possible counterfeit product.

6. Fraud Detection and Reporting

If any inconsistencies are detected, the system can flag the product, notify concerned authorities, and help identify where in the supply chain the tampering occurred.

IMPLEMENTATION AND RESULTS

The implementation of the proposed blockchain-based fake product detection system focuses on creating a secure, user-friendly, and efficient method for verifying product authenticity. The system is developed using blockchain technology combined with QR code generation for easy product verification.

1. Technology Stack

The implementation uses the following tools and technologies:

- **Blockchain Platform:** Ethereum / Hyperledger (for decentralized data storage)
- **Hashing Algorithm:** SHA-256 for generating a unique digital identity
- **Backend:** Python / Node.js for processing and blockchain interactions
- **QR Code Generator:** Python libraries or online QR tools
- **Frontend / Mobile App:** Android or web-based scanner for verification

These technologies ensure strong security, fast processing, and seamless user experience.

2. Product Registration

During implementation, each product is registered in the system with details such as:

- Product name
- Batch number
- Manufacturing date
- Category
- Unique product ID

A SHA-256 hash is generated from this information and stored on the blockchain. A QR code is then created and linked to this hash.

3. Supply Chain Simulation

To test the system, a simulated supply chain was created with three stages:

- Manufacturer
- Distributor
- Retailer

At each stage, product movement was recorded on the blockchain. The entries remained immutable, demonstrating blockchain's resistance to tampering.

4. Customer Verification

A QR-code scanning interface was implemented where users can scan the code attached to the product. The app fetches the blockchain record and compares it with the expected product details.

- **If the information matches**, the system displays a green verification message indicating authenticity.
- **If it does not match**, a red warning message alerts about possible counterfeiting.

5. Results and Observations

The system was tested with multiple product samples, and the following results were observed:

- Each product's history was accurately recorded and easily retrievable.
- Any attempt to alter or generate a fake QR code resulted in verification failure.
- The blockchain ledger successfully prevented unauthorized editing or data manipulation.
- Users were able to verify product authenticity within seconds.

These results confirm that the proposed system provides high accuracy, strong security, and effective counterfeit detection.

CONCLUSION

The rise of counterfeit products has created serious challenges for industries and consumers, making it increasingly important to have reliable systems that ensure product authenticity. This paper presented a blockchain-based solution that provides a secure, transparent, and tamper-proof method for tracking products across the entire supply chain.

By assigning each product a unique digital identity and storing its information on a decentralized ledger, the system prevents unauthorized modifications and offers complete traceability. The integration of QR codes makes verification simple and accessible for consumers, allowing them to instantly check whether a product is genuine. The results from the implementation show that the proposed system effectively detects counterfeit products and significantly enhances supply chain transparency.

Overall, this blockchain-based model offers a strong foundation for building advanced anti-counterfeiting systems. Future enhancements may include integrating IoT sensors for real-time monitoring or using artificial intelligence to detect suspicious supply chain patterns more efficiently.

Product Verification Process

1. **Product Registration:**
   - Manufacturers register products by generating a unique product ID and hashing product details (like name, batch number, manufacture date) using SHA-256.
   - This hash is recorded on the blockchain along with the product ID.
2. **Supply Chain Tracking:**
   - Every time a product moves along the supply chain (manufacturer → distributor → retailer → customer), the transaction is logged on the blockchain.
   - Each participant uses their private key to sign transactions, ensuring authenticity.
3. **Product Verification:**
   - End customers or retailers can scan a product's QR code.
   - The QR code contains the product ID and hash.
   - By comparing the scanned hash with the blockchain record, the system confirms whether the product is genuine or counterfeit.

System Architecture

1. Components:

- **Manufacturer Module:**
  - Registers products with unique IDs.
  - Hashes product information and uploads to the blockchain.
- **Distributor/Retailer Module:**
  - Logs product transfers on the blockchain.
  - Verifies authenticity when receiving shipments.
- **Customer Module:**
  - Scans QR code or NFC tag on the product.
  - Queries blockchain to verify authenticity.

- **Blockchain Network:**
  - Decentralized nodes store immutable product records.
  - Consensus mechanism (e.g., Proof of Authority or Proof of Stake) ensures data integrity.
- **Smart Contracts (Optional):**
  - Automate verification and alerts for counterfeit detection.

Workflow

1. **Product Creation:**
   - Manufacturer generates a unique product ID and hashes product details.
   - Hash is recorded on the blockchain.
2. **Supply Chain Logging:**
   - Each transfer (manufacturer → distributor → retailer) is logged as a transaction on the blockchain.
   - Each participant signs the transaction with a private key.
3. **Customer Verification:**
   - Customer scans the QR code.
   - The system fetches the corresponding hash from the blockchain.
   - Hash comparison confirms whether the product is genuine.
4. **Alerts and Reports:**
   - Counterfeit products trigger automatic alerts to authorities and manufacturers.
   - System maintains traceable history for audits.

Technologies Used

- **Blockchain:** Ethereum, Hyperledger Fabric, or other permissioned blockchain.
- **Hashing Algorithm:** SHA-256 or SHA-3 for secure product hashing.
- **Frontend:** Web/mobile apps for manufacturers, distributors, and customers.
- **Backend:** Node.js / Python for APIs interacting with blockchain.
- **Database (optional):** Off-chain storage for additional product metadata.

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