

# COUNTERFEIT PRODUCT IDENTIFICATION SYSTEM USING BLOCKCHAIN

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**Abstract** - The increasing prevalence of counterfeit products in supply chains poses significant risks to consumers and manufacturers alike. This paper presents *verify Chain*, a block chain-powered product verification system designed to ensure authenticity and traceability throughout the supply chain. The system allows manufacturers to register products with unique QR codes and SHA-256 hash keys, which are recorded in a blockchain ledger as immutable blocks. Distributors and retailers verify and transfer product ownership via hash based authentication, maintaining a tamper-proof supply chain history. Customers can scan the product QR code to verify authenticity and access detailed supply chain information, augmented by an AI-driven assistant that answers product-related queries. *Verify Chain* leverages the transparency and immutability of blockchain, combined with real-time AI guidance, to combat counterfeiting effectively and enhance consumer trust. Experimental deployment demonstrates accurate product verification and real-time traceability across multiple supply chain stages

**Key words :** Block chain, Product Verification, Counterfeit Detection, Supply Chain Traceability, QR Code Authentication

## 1. INTRODUCTION

In recent years, the rapid growth of global trade and e-commerce has significantly increased the circulation of counterfeit products across multiple industries. These fake products not only damage the reputation and revenue of legitimate manufacturers but also pose serious risks to consumer safety. Traditional product tracking systems that rely on centralized databases are often vulnerable to manipulation, data loss, and lack of transparency. Hence, there is a pressing need for a secure, decentralized, and reliable mechanism to verify product authenticity throughout its lifecycle.

To address these challenges, this work proposes *verify Chain*, a block chain-based system that integrates cryptographic hashing, QR code verification, and artificial intelligence for real time product authentication. The system enables manufacturers to register products with a unique SHA-256 hash and QR code, forming the genesis block in a transparent supply chain ledger. Distributors and retailers further validate and transfer ownership through verified blockchain transactions, ensuring end-to-end traceability. At the consumer level, a QR code scan provides authenticity

verification and displays the complete supply chain history. Furthermore, *verify Chain* incorporates a Gemini 2.5 Flash-powered AI chatbot to assist customers by answering product-related queries and clarifying supply chain details. This integration not only enhances user interaction but also promotes transparency and consumer confidence. The proposed system, leveraging blockchain's immutability and AI's contextual intelligence, offers a scalable and tamper-proof solution for mitigating counterfeiting and enhancing supply chain trustworthiness.

## 1.1 Challenges of Counterfeit Products

Counterfeit products are a major issue affecting industries worldwide, causing enormous financial losses and posing health and safety risks, especially in sectors like pharmaceuticals and electronics. Traditional methods of verifying authenticity, such as barcodes and serial numbers, are often easy to forge, while manual inspections are time-consuming and prone to error. Tracking counterfeit items throughout the supply chain is extremely difficult due to a lack of transparency among suppliers. Consumers often cannot differentiate between real and fake products, which reduces trust and damages brand value. Companies spend significant resources on anti-counterfeiting campaigns, while governments and regulatory bodies struggle to enforce product authenticity. E-commerce platforms also face challenges detecting fake products online, and cross-border trade adds complexity to tracking genuine goods. These challenges highlight the urgent need for a secure, reliable, and transparent system to ensure product authenticity. Blockchain technology emerges as a potential solution, offering a way to efficiently overcome these issues and protect both businesses and consumers.



Fig -1: Blockchain verification for product authenticity

## 1.2 Motivation and Problem Overview

Block chain technology offers a decentralized and secure approach to product authentication. By assigning each product a unique digital identity recorded on the blockchain, every transaction—from manufacturing to sale—is logged transparently. Smart contracts can automate verification of authenticity at every stage, allowing consumers to instantly scan a product and confirm its legitimacy. Manufacturers can trace the origin and supply chain history of each item, while tampering with blockchain records is virtually impossible. Real-time monitoring allows for early detection of counterfeit activity, and integration with IoT devices ensures automated updates on product status. Blockchain reduces reliance on intermediaries, increasing trust and transparency across the supply chain. Operational efficiency improves, and businesses can quickly recall defective or counterfeit items. Customers gain confidence in the authenticity of the products they purchase, and companies save costs on traditional anti-counterfeiting measures. The following diagram illustrates how blockchain tracks a product from manufacturer to customer, ensuring its authenticity at each step. Platform.

## 2. PROPOSED SYSTEM

The proposed system, verifies Chain, leverages block chain technology, QR code verification, and AI-driven interaction to ensure transparent and tamper-proof product authentication throughout the supply chain. Each product registered by the manufacturer is assigned a unique SHA-256 hash and a QR code, which acts as a digital fingerprint. This code encapsulates essential product data, making duplication nearly impossible.

When products move from manufacturers to distributors and retailers, each transaction is stored as a block within the blockchain, containing details such as ownership transfer, location, timestamp, and status. These immutable records allow consumers to verify the authenticity of products by simply scanning the QR code.

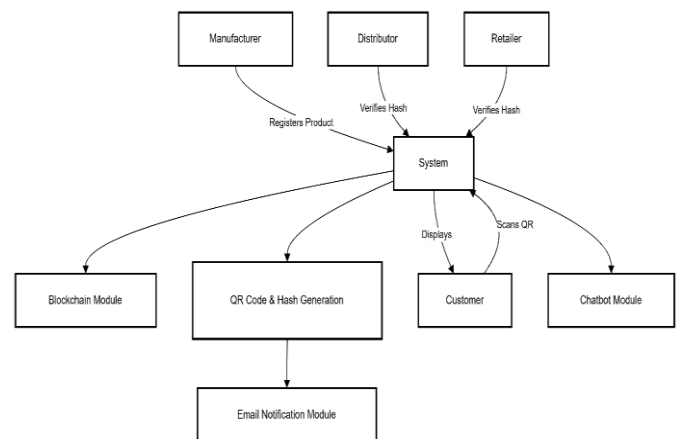
Additionally, an integrated Generative AI chatbot (Gemini 2.5 Flash with Lang Chain) assists users by answering product-related queries and summarizing supply chain history. The system features multiple access levels — including manufacturer, distributor, retailer, and customer modules — ensuring secure and role-specific functionalities. This architecture enhances trust, traceability, and accountability while minimizing counterfeit risks. The decentralized ledger structure ensures that all data remains secure, auditable, and transparent, providing an end-to-end verification mechanism for product authenticity in real time.

### 2.1 System Architecture

This architecture shows a blockchain-based product verification system. The process starts with

the Manufacturer, who registers a product in the system. When the product is registered, the system generates a unique hash and QR code for that product and stores the details securely using the Blockchain Module, which ensures data cannot be changed or tampered with. The Distributor and Retailer later interact with the system to verify the product hash, confirming that the product is genuine as it moves through the supply chain.

On the user side, the Customer scans the QR code on the product. The system checks the hash on the blockchain and displays the product authenticity details to the customer. If needed, the Chatbot Module helps customers by answering questions related to the product or verification process. Additionally, an Email Notification Module sends alerts or confirmations during important actions like product registration or verification. Overall, this architecture ensures transparency, security, and trust across the entire product lifecycle—from manufacturer to end customer.



**Fig -2: System Architecture of the AI-Driven Blockchain verification for product authenticity**

### 2.2 Data Product Registration Module

The product registration module is the first and most important part of the proposed system. In this module, the manufacturer registers every product by entering details such as product name, batch number, manufacturing date, expiry date, and manufacturer information. After registration, the system generates a unique cryptographic hash value that acts as a digital identity for the product. Along with the hash, a QR code is also generated and attached to the product packaging. These details are then stored in the blockchain network, ensuring that the information cannot be modified or deleted. This module prevents duplication of product identities and blocks fake product entries. By assigning a unique identity to every product, the system ensures authenticity from the point of origin. This module forms the foundation of the counterfeit detection process.

## 2.3 Block chain Storage Module

The blockchain storage module is responsible for securely storing all product-related information. Each product record is stored in the form of a block that contains the product hash, timestamp, and transaction details. These blocks are linked to each other using cryptographic techniques, making the data immutable and tamper-proof. Once data is added to the blockchain, it cannot be altered by any unauthorized entity. This ensures transparency and trust among manufacturers, distributors, retailers, and customers. Decentralization removes the risk of a single point of failure in the system. The blockchain module also maintains a complete history of product transactions. This makes it easier to trace the product's journey across the supply chain.

## 2.4 QR Code and Hash Verification Module

3. The QR code and hash verification module allows users to verify the authenticity of products easily. Each product contains a QR code that is linked to its blockchain record. When the QR code is scanned, the system extracts the hash value and compares it with the hash stored in the blockchain. If both values match, the product is verified as genuine. If the values do not match, the product is marked as counterfeit or suspicious. This module helps in quick and accurate verification without the need for complex processes. It can be used by distributors, retailers, and customers. The verification process is fast, reliable, and user-friendly. This module plays a key role in detecting fake products.

## 3. IMPLEMENTATION DETAILS

The implementation of the Counterfeit Product Identification System Using Blockchain is carried out using a web-based approach to ensure ease of access and usability. The system is developed with a frontend interface that allows manufacturers, distributors, retailers, and customers to interact with the application. The backend handles product registration, QR code generation, and verification logic. Blockchain technology is integrated to store product details securely in an immutable manner. Each registered product is assigned a unique hash and QR code during implementation. Verification logic compares scanned QR data with blockchain records in real time. Security mechanisms ensure that only authorized users can register products. The system supports verification at every supply chain stage. Testing is performed to validate accuracy and performance. Overall, the implementation ensures reliable detection of counterfeit products

### 3.1 System Development Environment

The system is implemented using a web-based architecture to ensure accessibility and ease of use. The frontend is developed using HTML, CSS, and JavaScript to provide a simple and interactive user interface. The backend logic is implemented using Python with the Flask framework, which

handles user requests and system operations. A relational database is used to manage user credentials and system roles. Blockchain integration is handled using cryptographic hashing techniques to ensure data security. The system runs on a local or cloud-based server. This environment supports scalability and efficient performance. The modular design allows easy future enhancements.

### 3.2 Product Registration Implementation

During implementation, the manufacturer registers products through a secure web interface. Product details such as name, batch number, manufacturing date, and unique identifiers are collected. A cryptographic hash is generated using these details to create a unique digital identity for the product. The system then generates a QR code containing the product hash or ID. Both the hash and product data are stored in the blockchain. This process ensures that each product has a unique and tamper-proof identity. Duplicate registrations are automatically prevented. This step initializes the product lifecycle securely.

### 3.3 Block chain Integration Implementation

The blockchain is implemented to store product transactions in an immutable manner. Each product record is stored as a block containing the product hash, timestamp, and previous block hash. Blocks are linked sequentially to maintain data integrity. Any attempt to modify stored data breaks the chain and is immediately detected. The decentralized nature of blockchain ensures that no single entity controls the data. The system uses blockchain validation before approving any verification request. This implementation guarantees trust and transparency. It also enables complete traceability of products.

### 3.4 back end Development and Sentiment Analysis

The QR code generation is implemented using standard QR libraries during product registration. The QR code is printed or attached to the product packaging. When the QR code is scanned, the system extracts the encoded product hash. This hash is compared with the blockchain-stored hash to verify authenticity. The verification result is returned instantly to the user. This process is simple, fast, and efficient. It can be performed using mobile devices or web scanners. This implementation allows real-time product authentication.

## 4. RESULTS AND PERFORMANCE ANALYSIS

The results of the Counterfeit Product Identification System Using Blockchain demonstrate that the system effectively identifies genuine and counterfeit products. During testing, all registered products were successfully verified using QR code scanning and blockchain hash comparison. The system accurately detected duplicate or invalid QR codes, proving its reliability in counterfeit identification. Verification responses were generated within a short time, showing good

system performance. Blockchain storage ensured that product data remained secure and tamper-proof throughout the testing process. The system handled multiple verification requests without performance degradation. Email notifications and chatbot responses functioned correctly during verification events. The supply chain verification process maintained complete product traceability. User interactions were simple and error-free. Overall, the system achieved high accuracy, security, and efficient performance

#### 4.1 Product Verification Accuracy

The system produced accurate results during the product verification process. All registered products were successfully verified using QR code scanning and blockchain hash comparison. When invalid or duplicate QR codes were scanned, the system correctly identified them as counterfeit. No false verification results were observed during testing. The blockchain-based storage ensured that product data remained unchanged, improving accuracy. Verification results were consistent across manufacturer, distributor, retailer, and customer modules. This confirms the reliability of the authentication mechanism. The system effectively prevents fake products from entering the supply chain. High verification accuracy proves the effectiveness of the proposed approach.

#### 4.2 System Performance and Response Time

The performance of the system was evaluated based on response time and system efficiency. Product verification responses were generated quickly after QR code scanning. The backend processed multiple verification requests without delay. Blockchain operations such as data retrieval and validation were performed efficiently. The system showed stable performance even with repeated scans. No system crashes or delays were observed during testing. The lightweight frontend ensured smooth user interaction. Performance remained consistent across different user roles. This demonstrates that the system is suitable for real-time product verification.

#### 4.3 Security and Reliability Analysis

The security analysis shows that the system provides strong protection against data tampering. Blockchain technology ensures immutability, making unauthorized data modification impossible. Role-based access control prevents unauthorized users from registering products. All verification transactions are securely recorded in the blockchain. Repeated invalid scans triggered alerts, improving system reliability. The system maintained continuous availability during testing. Secure data handling increased trust among users. The combination of blockchain and QR code technology ensures a reliable and secure solution. Overall, the system proved to be robust and dependable.

## CONCLUSION

The Counterfeit Product Identification System Using Blockchain provides an effective and secure solution to identify counterfeit products in the market. The system uses blockchain technology to store product information in an immutable and tamper-proof manner. Each product is assigned a unique hash value and QR code during registration. This ensures that every product has a unique digital identity. The system allows verification at every stage of the supply chain, including manufacturer, distributor, retailer, and customer. Customers can easily verify product authenticity using a QR code scan. Blockchain ensures transparency and prevents unauthorized data modification. The integration of supply chain verification improves traceability. The system reduces the circulation of fake products. It also increases consumer trust in genuine brands. Security mechanisms prevent unauthorized access. The system performs efficiently during verification. Overall, the project successfully achieves its objective of counterfeit detection.

## FUTURE WORK

The future enhancement of the *Counterfeit Product Identification System Using Blockchain* can focus on improving scalability and usability. The system can be extended to support large-scale industries with millions of products. Integration with mobile applications can make verification more convenient for customers. Advanced blockchain platforms can be used to improve transaction speed and reduce cost. IoT devices such as smart scanners can be added for automated verification in warehouses. Artificial Intelligence can be integrated to detect suspicious verification patterns. Multi-language support can be introduced for global users. Cloud deployment can improve availability and performance. Integration with government or regulatory databases can increase trust. Enhanced analytics dashboards can help manufacturers monitor product movement. Offline QR verification can be explored. Stronger encryption methods can improve security. Overall, future work can make the system more intelligent and widely adaptable.

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