TrustSeal (Recogonizing Untrusted Materials By Blockchain Technology)

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Abstract - The Proliferation of many products in the market causing problems to generate counterfeiting of products. These products are merely low-quality counterfeits of a certain brand. However, to resolve this issue many methods have been adopted to prevent the proliferation of counterfeit products such as RFID tags, Artificial Intelligence, Machine Learning etc. Nevertheless, the disadvantages of such methods are severe Ex: QR codes may be copied from QR codes that may be from real products to fake ones, and AI&ML must have high computational power. Fake products are a huge problem for companies and customers. They damage a company's reputation and trick people into buying low-quality items. To solve this, we created a system that uses blockchain and QR codes. Each product gets a unique QR code linked to a blockchain (a secure digital record). When a customer scans the QR code, the system checks the blockchain to see if the product is real. If the code does not match any records, the customer gets a warning that the product might be fake. This method is simple, and secure, and helps people trust what they buy.

Keywords: Counterfeit products, QR codes, Blockchain.

I.INTRODUCTION

In ever evolving landscape of digital commerce, the proliferation of fake products poses a significant threat to consumers and brands alike. The rise of e-commerce platforms has led to an influx of counterfeit goods, jeopardizing trust a consumer confidence. Conventional methods of detecting the circulation of fake products often fall short due to their limitations in efficiency, accuracy, and adaptability for emerging counterfeit techniques. Blockchain is a modern technology that consists of an organized recording of information that is difficult to change. All records will be stored in the form of blocks in the blockchain database. To overcome in these situations, we have introduced a solution to is that is TRUSTSEAL.

This is the answer to the problem of saving counterfeit products worldwide. Now you can trust the given Brand and check for the proper quality of the given product by seeing its branding and all correct serial numbers, Item, Color, Current Situation of the Product, Size, and Dimensions and trust the other attributes via locking all the attributes correctly that all of them are correct and in safe hands the person will ensure that right item it being purchased and later if any default or imperfections are being caught then it will be the issue of manufacturer, not any other middlemen problem. Thus, there will be a good connection between the consumer and the Provider. This Seal between them will be trusted and then there can be a high chance for more connection in the future between them.

Now, telling real items apart from fakes is hard. So, Our idea uses blockchain —a technology that stores data securely across many computers, making it nearly impossible to tamper with. Here's how it works:

Each product gets a unique QR code.

The QR code links to a blockchain database that stores the product's details. When you scan the code, the system checks if it matches the blockchain records. If it does not match, the product is likely fake. This system is transparent, secure, and works with any smartphone. No special tools are needed—just scan the code to know if your product is genuine.

1. Existing Solutions:

Researchers have tried different methods to fight fake products.

Blockchain Supply Chains: Some use blockchain to track products from factory to store.

Smart Tags: Wineries use QR codes and special inks on labels to verify authenticity.

AI Technology: Apps analyze logos or product images to detect fakes using machine learning.

RFID Tags: Electronic tags store product data, but they're expensive.

Our solution improves on these by combining QR codes (cheap and easy to use) with blockchain (secure and unchangeable) which is TrustSeal. Unlike AI, our method does not require training data or complex algorithms—just a quick scan.

2. How Our System Works?

Step 1: When a product is made, the company assigns it a unique QR code.

Step 2: The code and product details (like batch number, and date) are saved as a "block" in the blockchain.

Step 3: Customers scan the QR code using their phone.

Step 4: The system checks the blockchain for a matching code. If it is found, the product is real.

If not, the customer gets an alert like "This product may be fake."

This process takes seconds and works for any item—medicines, electronics, clothes, etc.

3. Benefits of Blockchain:

1. Accuracy: Blockchains are distributed systems. A blockchain database is spread amongst the different network nodes that are part of the computer network. A computing error caused by Blockchain technology resulted in this great accuracy.

2. Cost Reductions: Blockchains eliminate the involvement of third parties, such as banks, which has a very positive impact on cost reductions in transactions. Nevertheless, there will be no minimal transaction fees on the Blockchain because it does not have a Central Authority.

3. Decentralization: Blockchain is a decentralized distributed system. So, the blockchain database has many copies and is spread across the different computers in a computer network. This property of blockchain has been in data protection.

4. Efficient Transaction: Blockchain is a type of transaction. Decentralized and it's not supervised by an authority of any kind because we are aware that the authorities are operating their business. It provides an efficient way of carrying out transactions.

5. Transparency: Cryptocurrencies provide transparency as the majority of them are freely available software. So, we will have the ability to check our code, which will give us some suggestions for improving blockchain technology. Only if the majority of network users consent, these proposals will be put into practice.

II. LITERATURE SURVEY

The proliferation of counterfeit products poses significant challenges to consumers and brand owners alike. Conventional method of product authentication often falls short in providing the necessary security and transparency.

Blockchain and QR code Integration:

A study titled "QR-based fake product detection using blockchain" proposes a novel approach that leverages blockchain technology in conjunction using QR codes. In this system, each authenticated product is assigned a unique QR code linked to a blockchain-based ledger. Whenever consumers scan the QR code, they can instantly verify the product's authenticity and distribution history. The immutable nature of blockchain ensures data integrity, making it nearly impossible for counterfeits to manipulate or replicate the information.

Similarly, the paper "Detection of counterfeit products using blockchain" discuss various systems that utilize QR codes and blockchain for fake product detection. The methods include providing products with public and private keys embedded in QR codes should have cryptographic functionality to decrypt it. The manufacturer is also supported to run a server to accept request and match the buyer's name and item code.

Dynamic QR codes and blockchain:

Another approach is the use of dynamic QR codes in conjunction with blockchain technology. The paper "To Implement and Identify Counterfeiting Product in Supply Chain" proposes an updated method for counterfeit product detection based on blockchain technology. By joining dynamic QR code generation with blockchain, the system ensures that each product has a unique identifier that can be updated and verified through the supply chain.

Product identification systems:

An Ethereum-based product identification system for anti-counterfeits has also been proposed. This system introduces a decentralized blockchain-based application with a view of identifying counterfeit products in the supply chain system. A consumer can verify the product distribution and a ownership information by scanning the QR code generated by the application for each product linked to the blockchain.

Commercial Implementations:

Commercial solutions such as Scan Trust have developed QR code systems with an additional layer of protection against copying. This is achieved by inserting a copy of the detection pattern and a secure graphic which loses information when copied. The technology does not require special materials like inks, or modifications in printing equipment to implement. Related product authentication and traceability of data can be stored in a blockchain.

Comparison of Anti-Counterfeiting Technologies & Gaps:

Analysis of various ANTI-COUNTERFEITING Technologies.

Different anti-counterfeiting technologies are displayed in the following table along with comparisons between them:

Technology	Description	Advantages	Limitations
RFID (Radio Frequency Identification)	Uses radio waves to track. Verify Product with embedded RFID chips.	1.Fast Scanning. 2.Can store data. 3.Used logistics and supply chain.	1.Costly 2.Can be cloned. 3.Requires special Scanners.
Magnetic Chips	Encodes products data on a magnetic strips.	1.Cost Effective 2.Easy to upgrade	1.Can be damaged. 2.Easy to clone.
Security Hologram	Optical hologram printed on packaging to verify authority.	1.Virtually verifiable 2.Difficult to replicate	1.Can be duplicated. 2.No real time verification
Barcode and QR code	Printed QR code or QR code that store product information for authenticate	1.Cost Effective 2.Easy to implement. 3.Scanable via mobile apps	1.QR code can be copied. 2.No real time tracking. 3.Static Cards may not updated supply chain changes.
Biometric (Fingerprint)	Uses unique biometric or material fingerprints for product authenticate	1.Extremly severe 2.Hard to duplicate.	1.Costly 2.Require specialized scanner.
Blockchain-Based Authenticator	Stores product information on a blockchain and links it to QR or RFID.	1.Tamper proof data. 2.De-Centralized Security. 3.Real time tracking.	1.High setup cost. 2.Requires internet access. 3.Adoption barrier in industries.’

III. METHODOLOGY

Methodology of Fake Product Identification Using Blockchain and QR Code:

A. PROBLEM STATEMENT:

Counterfeit products harm businesses, consumers, and brand reputations. Traditional anti-counterfeiting methods (e.g., holograms, and serial numbers) are vulnerable to replication. Blockchain and QR codes offer a decentralized, tamper-proof solution to verify product authenticity.

Objectives

a)Create a unique digital identity for products using QR codes.
b)Store product lifecycle data immutably on a blockchain.
c)Enable real-time verification by consumers/supply chain stakeholders.
d)Ensure scalability, security, and user-friendliness thus we introduced TRUSTSEAL.

B. SYSTEM MODEL:

A piece of personal software named Ganache is used for blockchain integration in the proposed system. Ganache makes it easier to set up and maintain a blockchain network. Metamask is an add-on for web browsers that acts as a bridge between online pages and blockchains.Node.js is used for web page development, and the Solidity programming language is used for creating blockchain smart contracts.
For the purpose of archiving frequently accessed data and for optimizing query operations, a database can be used. Depending on the system requirements, it is possible to use widely available databases such as MYSQL, PostgreSQL or MongoDB. The system has capabilities to analyze data analytics tools or frameworks, such as Apache Spark or Tableau, which can be integrated to process and visualize the data.

C.TOOLS REQUIREMENT:

1. Ganache: It is a personal software that facilitates the integration of the Ethereum blockchain into the system.

2. Metamask: Metamask is a browser add-on that acts as a bridge between web pages and blockchain.

3.Node.js: Node.js allows developers to build scalable and efficient web applications in a system model.

4. Solidity: A programming language that is specially designed for the creation of cryptographically based contracts on an Ethereum blockchain.

5.Web3.js: This is a JavaScript library that allows you to interact with Ethereum or any of the supported blockchains.

6. Security Auditing Tools: Contacts are susceptible to vulnerabilities and security risks. Tools like MythX help with security analysis.

7. Testing Frameworks: To ensure the quality and reliability of smart contracts, testing frameworks like Mocha and Chai can be used.

Blockchain Network:

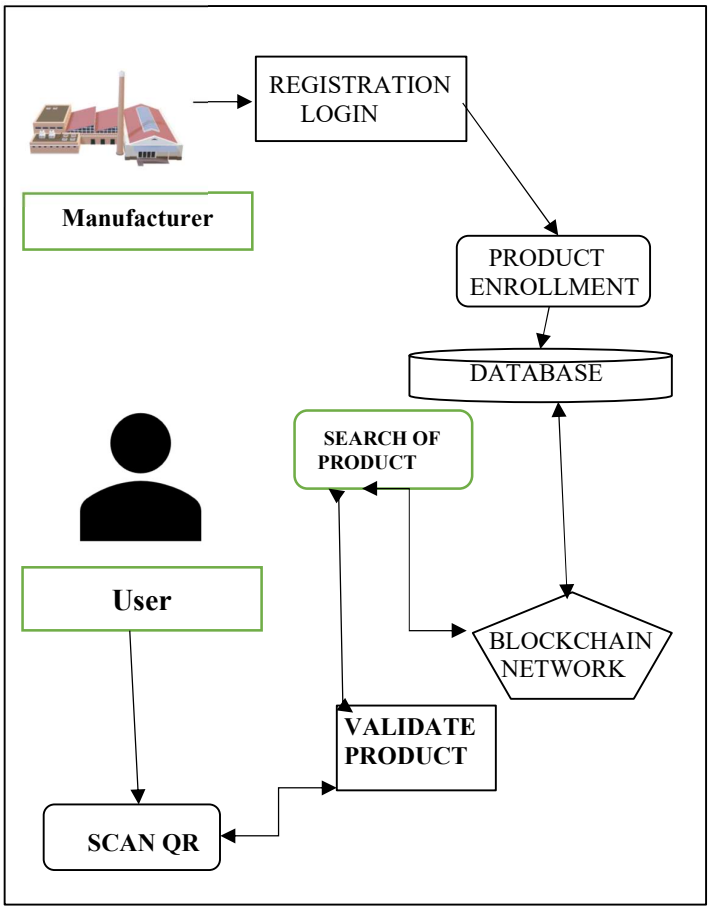
-Use a permissioned blockchain (e.g., Hyperledger Fabric) or public blockchain (e.g., Ethereum) for transparency and immutability.
-Smart contracts automate product registration and ownership transfers.
QR Code Generation:
-Generate unique, cryptographically secure QR codes for each product.
-Encode product ID, manufacturing details, and blockchain transaction hash.

Database:

Off-chain storage (e.g., IPFS or cloud) for high-resolution product images, manuals, and certifications.

User Interface:
-Mobile/web app for consumers to scan QR codes and verify authenticity.
-Admin dashboard for manufacturers/retailers to register products and update supply chain data.

4.Workflow Diagram:



WORKFLOW:

Step 1: Product Registration
-Manufacturer assigns a unique Product ID (UID) and generates a QR code.
-Product details (manufacturing date, batch, location) and -UID are hashed and stored on the blockchain.

Step 2: Supply Chain Updates
Distributors/retailers scan QR codes and update the blockchain with timestamps (e.g., shipping, delivery).

Step 3: Consumer Verification
-Consumer scans QR code via mobile app.
The app fetches blockchain data to verify UID, transaction history, and product authenticity.
-Alerts user if the product is flagged as counterfeit (e.g., duplicate QR code scans).

Key Technologies
1. Blockchain: Smart contracts, consensus mechanisms (PoA/PoS), and cryptographic hashing (SHA-256).
2. QR Code: Dynamic QR codes with encryption (AES-256) to prevent replication.
3.APIs: REST APIs to connect the app with blockchain nodes and databases.
4. Security: SSL/TLS encryption for data transmission; role-based access control (RBAC).

Implementation Steps
Blockchain Setup:
Deploy a private or consortium blockchain network.
Develop smart contracts for product registration, ownership transfer, and alerts.

QR Code Integration:

a) Use libraries like qrcode.js or ZXing to generate and scan codes.
b) Link QR codes to blockchain UIDs via metadata.

App Development:

-Build cross-platform apps (React Native/Flutter) with QR scanning and blockchain interaction.

Testing:

Unit testing for smart contracts (Truffle/Waffle).
Stress testing for scalability (1000+ simultaneous scans).

Security Measures

a) Immutable Records: Blockchain ensures data cannot be altered retroactively.

b) QR Code Security: Encrypted QR codes with time-based OTP for added protection.

c) Fraud Detection: Machine learning algorithms flag suspicious patterns (e.g., repeated UID scans).

Challenges & Mitigation
a) Supply Chain Participation: Incentivize stakeholders with tokens or reduced fees.

b) Scalability: Use sidechains or Layer-2 solutions (e.g., Polygon) for high transaction throughput.

c) User Adoption: Simplify UI/UX and provide multilingual support.

Case Study Example:

a) Pharmaceuticals: Track drug batches from factory to patient, ensuring no tampering.

b) Luxury Goods: Verify the authenticity of high-end products (e.g., handbags, watches).

Future Scope

-Integrate IoT sensors for real-time tracking (temperature, location).
-Use NFTs to represent ownership of limited-edition products.
-Expand to cross-industry anti-counterfeiting ecosystems.

This methodology combines blockchain's immutability with QR codes' accessibility to create a robust anti-counterfeiting system. It enhances transparency across supply chains and empowers consumers to verify products instantly, reducing economic losses and improving trust.

IV.CONCLUSION

In the end, we can say the following from this discussion: 100% functioning application that can be used to determine whether. The retail market is really benefiting from products that are fake or genuine growth and provide security for the end consumer of that product buying is real, it's branded and that helps too.

Manufacturers who will do everything they can to ensure that their businesses are recognized and valued.

To this end, the use of blockchain involves an important contribution from all customers and manufacturers. In this paper, a proposal has been tabled for the full functionality of an application that would allow users to distinguish between fake and genuine products.

At last, a customer is allowed to scan. The QR code will let you check the history of your product to determine whether it's real or not.

V.ACKNOWLEDGMENT

We would like to extend our sincere gratitude to everyone who has worked to create and implement the "Trust Seal" (Recognizing Untrusted Materials using blockchain technology). This cutting-edge method attempts to address

the urgent problem of counterfeit goods and gives customers a trustworthy way to confirm the legitimacy of their purchases.

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