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Detecting Fake Products Using Blockchain

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***Abstract*:** In today's world, counterfeit products are a serious issue affecting both consumers and businesses. Counterfeit goods harm supply chains, economies, Legitimate manufacturers lose revenue and consumer trust, consumers face health risks and as well as financial loss. In the past, a number of technologies have been put forth to resolve this problem such as QR Codes, RFID Tags, and machine learning, but each one came with some drawbacks, such as RFID Tags and QR Codes susceptibility to cloning and requirement of huge amount of dataset for machine learning algorithms. The idea of this project is to use Blockchain to fight counterfeit products, through the use of decentralized and transparent ledgers, we aim to provide a reliable solution for verifying the authenticity of products, ensuring that consumers receive genuine items. Blockchain's decentralized structure provides an additional degree of protection, making it a strong contender in the continuing war against fake goods.

1 Introduction

Counterfeit products are fake versions of real items, and they cause a lot of problems. When these fake products enter the market, they can hurt both the companies that make real products and the people who buy them. As of 2020, annual sales losses from counterfeiting in the clothing sector amounted to 26.3 billion euros. This figure was 4.7 billion euros for cosmetics and personal care products. Counterfeit beauty and health products, mimicking popular brands, pose severe risks. A number of factors come together to increase the likelihood of counterfeit items emerging especially during pandemic. The increase in demand for necessities like medications and medical supplies gives counterfeiters a chance to take advantage of shortages. Global supply chain disruptions cause delays and shortages of genuine goods, giving counterfeiters opportunities to provide subpar alternatives. Counterfeiters earn greatly by charging excessive prices for their imitation items by preying on people's fear and sense of urgency. When fraudulent vendors take advantage of online platforms, the surge in e-commerce during lockdowns becomes a breeding ground for counterfeit transactions. Some news during pandemic has reported that “Fake hand sanitiser racket busted in Hyderabad after 1 lakh bottles sold for Rs 1.4 crore”.

From a financial perspective, counterfeiting is a massive source of competition on a global scale. Brands have to worry about both legitimate competitors eating up market share and counterfeiters who destroy trust. Beyond taking revenue away from a business, counterfeiting also affects the consumer's ability to trust their goods in an open marketplace. Without proper security and tracking measures, consumers rapidly lose trust in brands to protect their customers from theft. IP and brand protection company Incorp found that 52% of consumers lost trust in a brand after purchasing a fake good online, while 64% lost trust in online marketplaces. This actually led Nike to stop selling its products on Amazon.

The paper is organized as follows: The detail explanation of Blockchain with its working and features is mentioned in section 2. The section 3 orders a comprehensive review of the literature. The proposed System in Section 4 includes the system model and the flow of the system. The simulation results for the proposed method are presented in Section 5. Section 6 is where the paper comes to a close with the conclusion.

2 Blockchain

A blockchain is a constantly growing ledger which keeps a permanent record of all the transactions that have taken place in a secure, chronological, and immutable way.

These blocks are linked using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data. A blockchain is a decentralized, distributed and public digital ledger that is used to record transactions across many computers so that the record cannot be altered retroactively without the alteration of all subsequent blocks and the consensus of the network

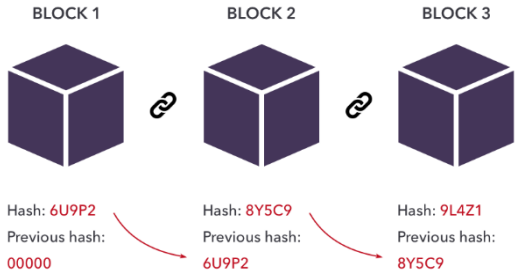

Fig. 1 Representation of Blocks in Blockchain

2.1 Working of Blockchain

When a new transaction is initiated, it is broadcast to the network of computers. Each computer on the network then verifies the transaction using mining, which is the process of adding and verifying new blocks to the blockchain. This is done by miners, who use specialized hardware and software to solve complex mathematical problems. When a new block is added to the blockchain, the miner who found the solution to the problem is rewarded with a certain amount of cryptocurrency. Once the transaction has been added to the blockchain, it is considered immutable, meaning it cannot be changed or reversed. This is because each subsequent block builds upon the previous one, and changing a single block would require changing all subsequent blocks.

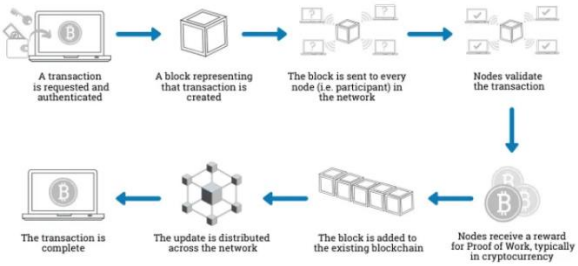

Fig. 2 How Transactions takes place in Blockchain

2.2 Key elements of a blockchain

Distributed ledger technology

All network participants have access to the distributed ledger and its immutable record of transactions. With this shared ledger, transactions are recorded only once, eliminating the duplication of effort that's typical of traditional business networks.

Immutable records

No participant can change or tamper with a transaction after it's been recorded to the shared ledger. If a transaction record includes an error, a new transaction must be added to reverse the error, and both transactions are then visible.

Smart contracts

To speed transactions, a set of rules called a smart contract is stored on the blockchain and executed automatically. A smart contract can define as a program which executes automatically when some certain conditions met.

2.3 Need of blockchain

Operations often waste effort on duplicate record keeping and third-party validations. Record-keeping systems can be vulnerable to fraud and cyberattacks. Limited transparency can slow data verification. And with the arrival of IoT, transaction volumes have

exploded and to resolve all these efficiency, transparency and security issues , Blockchain is the solution.

Greater trust

With blockchain, as a member of a members-only network, you can rest assured that you are receiving accurate and timely data, and that your confidential blockchain records will be shared only with network members to whom you have specifically granted access.

Greater security

Consensus on data accuracy is required from all network members, and all validated transactions are immutable because they are recorded permanently. No one, not even a system administrator, can delete a transaction.

Transparency

One of the most critical aspects of decentralization is transparency. All employees have access to information and decision-making processes in a decentralized organization. This transparency fosters a greater sense of trust and cooperation among the involving members.

3 Literature Survey

By leveraging blockchain's inherent properties of decentralization, immutability, and transparency, researchers and industry practitioners have proposed innovative approaches to enhance supply chain traceability, automate verification processes through smart contracts, and tokenize physical assets for seamless authentication. The importance of continued research and collaboration to realize the full potential of blockchain in safeguarding consumers, preserving brand integrity, and fostering trust in global supply chains is of massive Use.

4 Proposed System

The production and trafficking of counterfeit goods poses a significant health and safety threat to consumers. It also impacts the economic growth of legitimate businesses and consumers through lost revenue, downtime, and replacement costs. These counterfeit goods usually bear the trademark of a legitimate and trusted brand, but they were produced by another party and are not made to the specifications of the original manufacturer. They're often produced illegally and sold at a profit to fund other criminal activities. They defame brand’s name as well as made costumers to loose their trust in brand unknowingly. This Blockchain based Counterfeit product detection system helps you to trace all history from manufacturer to customer in order to catch counterfeit products.

4.1 Proposed System

The proposed system will be a decentralized application (Dapp) which will be implemented using the Ethereum
Network as the main blockchain for keeping all the records and managing the transactions regarding the products of
the companies listed on Dapp.

Ethereum

Ethereum is a decentralized blockchain platform that establishes a peer-to-peer network that securely executes and verifies application code, called smart contracts. Smart contracts allow participants to transact with each other without a trusted central

authority. Transaction records are immutable, verifiable, and securely distributed across the network, giving participants full ownership and visibility into transaction data. Transactions are sent from and received by user-created Ethereum accounts. A sender must sign transactions and spend Ether, Ethereum's native cryptocurrency, as a cost of processing transactions on the network.

Benefits of building on Ethereum

Ethereum offers an extremely flexible platform on which to build decentralized applications using the native Solidity scripting language and Ethereum Virtual Machine. Decentralized application developers who deploy smart contracts on Ethereum benefit from the rich ecosystem of developer tooling and established best practices that have come with the maturity of the protocol. This maturity also extends into the quality of user-experience for the average user of Ethereum applications, with wallets like MetaMask, Argent, Rainbow and more offering simple interfaces through which to interact with the Ethereum blockchain and smart contracts deployed there. Ethereum's large user base encourages developers to deploy their applications on this network.

Smart Contract

Smart contracts are simply programs stored on a blockchain that run when predetermined conditions are met. They typically are used to automate the execution of an agreement so that all participants can be immediately certain of the outcome, without any intermediary's involvement or time loss. They can also automate a workflow, triggering the next action when conditions are met.

Benefits of smart contracts

Speed, efficiency and accuracy

Once a condition is met, the contract is executed immediately. Because smart contracts are digital and automated, there's no paperwork to process and no time spent reconciling errors that often result from manually filling in documents.

Trust and transparency

Because there's no third party involved, and because encrypted records of transactions are shared across participants, there's no need to question whether information has been altered for personal benefit.

Security

Blockchain transaction records are encrypted, which makes them very hard to hack. Moreover, because each record is connected to the previous and subsequent records on a distributed ledger, hackers would have to alter the entire chain to change a single record.

The Gas fees required in all of these smart Contract's functions is given below:

GAS COST OF FUNCTION IN THE SMART CONTRACT
(GAS PRICE = 21 GWEI, 1 ETH = $2301)

Algorithm	Gas Used	ETH	USD
addManufacture	24916	0.000523236	1.203
addSeller	24938	0.000523698	1.205
addProduct	262281	0.005507901	12.671
productSeller	259524	0.005450004	12.540
getProduct	0	0.0	0.0
viewSellerProduct	0	0.0	0.0
viewAllProduct	0	0.0	0.0

4.2 Flow of Proposed Model

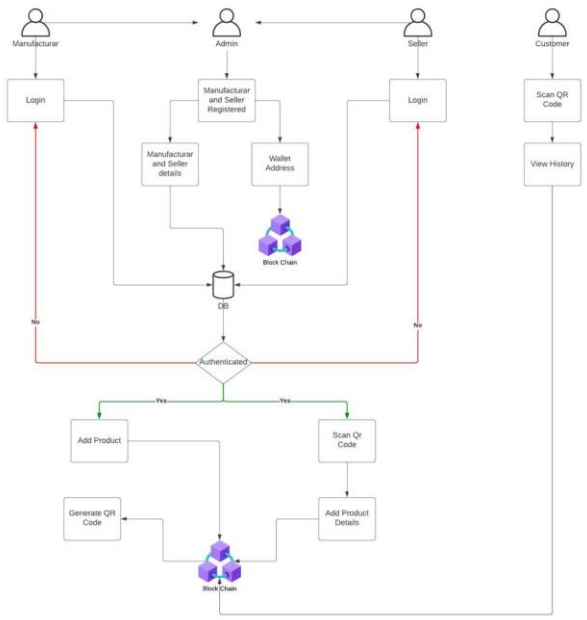

Fig. 3 Workflow Diagram of the System

Step 1: Access Manufacturer Account:
The manufacturer logs into their dedicated manufacturer account using their Login Details.

Step 2: Product Registration and QR Code Generation

- After successful login, the manufacturer navigates to the product registration section within their account.

- The manufacturer inputs essential details of the product, such as product name, production date, and other relevant information and can push those details onto the Blockchain using his MetaMask Wallet.

Generate QR Code:

- The system provides an option for the manufacturer to generate a QR code for the registered product. This QR code serves as a unique identifier linked to the product details.

Step 3: Interaction with Ethereum Blockchain

Use Ethereum Wallet:

- The manufacturer utilizes their Ethereum wallet, a digital wallet on the Ethereum blockchain, to interact with the decentralized network.

Initiate Blockchain Transaction:

- their Ethereum wallet, the manufacturer initiates a transaction to add a new block to the Ethereum blockchain. This transaction includes the product details and potentially a reference to the generated QR code.

Step 4: Database Mapping for Authentication

Database Mapping:

- The system maps the manufacturer's user ID in the local database with their Ethereum wallet address. This mapping is crucial for authentication purposes.

Authentication Check:

- Before adding a block to the blockchain, the system checks if the manufacturer is logged in from their own account and is using their own Ethereum wallet.
Conditional Block Addition:
- If the authentication check is successful, meaning the manufacturer is indeed logged in from their account and using their Ethereum wallet, the system proceeds to add the block to the Ethereum blockchain.

Workflow (Seller Login):
Step 1: Seller Login

Access Seller Account:

- The seller logs into their dedicated manufacturer account using an authentication email account and is secure with password.so that we access the details with a security.

Step 2: Product Information Retrieval and QR Code Scanning

Navigate to Product Information:

- After successful login, the seller navigates to the section where product information is accessible.

Scan QR Code:

- Using a QR code scanning feature, the seller scans the QR code on the product. This action retrieves the product details entered by the manufacturer.

Step 3: Product Details Addition and Blockchain Interaction

Add Seller Details:

- The seller adds their own details to the product information, such as the shop destination or any relevant details specific to their selling process.

Initiate Blockchain Transaction:

- Utilizing their own Ethereum wallet, the seller initiates a blockchain transaction to add a new block to the blockchain. This transaction includes the updated product information.

Step 4: Buyer Access to Information

Buyer Access:

- Once the seller has successfully added their details to the blockchain, a buyer can access the information associated with the product.

Transparent Product Information:

- The buyer gains transparency into the product's journey, viewing not only the original manufacturer's details but also the additional information added by the seller.

Workflow (Product Serial Number Entry):

Manufacturer Adds a New Product:

- The manufacturer logs into their account, navigates to the product registration section, and adds a new product by providing details such as product name, production date, and additional information.

Generate QR Code:

- As part of the product registration process, the manufacturer generates a QR code associated with the newly added product. This QR code serves as a unique identifier.

Blockchain Transaction Initiation:

- Using their Ethereum wallet, the manufacturer initiates a blockchain transaction to add a new block to the Ethereum blockchain. This transaction includes the product details and the reference to the generated QR code.

Database Mapping for Authentication:

- The system maps the manufacturer's user ID in the local database with their Ethereum wallet address for authentication purposes. This ensures that only authorized manufacturers can contribute to the blockchain.

Authentication Check:

- Before adding a block to the blockchain, the system checks if the manufacturer is logged in from their own account and is using their own Ethereum wallet.

Conditional Block Addition:

- If the authentication check is successful, the system proceeds to add the block to the Ethereum blockchain, registering the newly added product.

Seller Updates Product Information Workflow:

Seller Logs into Seller Account:

- The seller logs into their seller account through a secure authentication process.

Retrieve Product Information:

- The seller navigates to the product information section and scans the QR code on the product, retrieving details entered by the manufacturer.

Add Seller Details:

- The seller adds their own details to the product information, including shop destination or any relevant details specific to their selling process.

Initiate Blockchain Transaction:

- Using their Ethereum wallet, the seller initiates a blockchain transaction to add a new block to the blockchain. This transaction includes the updated product information, which now includes the seller's details.

Buyer Accesses Product Information Workflow:

Buyer Accesses Product Information:

- The buyer, either through an app or a web interface, accesses information about a specific product of interest.

QR Code Scanning:

- The buyer can scan the QR code on the product using their device's camera or a dedicated scanning feature in the application.

Retrieve Information from Blockchain:

- The application retrieves information associated with the QR code from the Ethereum blockchain. This information includes details added by both the manufacturer and the seller.

Transparent Product Information:

- The buyer gains transparency into the product's journey, viewing details provided by both the manufacturer and the seller. This includes production information, seller details, and any other relevant data recorded on the blockchain.

5 Result and Discussion

The suggested solution enables interaction between suppliers and manufacturers so that each can contribute a block to the blockchain with transaction details without altering the other's block. Solidity is used in the writing of the contracts for the supplier and manufacturer block.

React is used to design the interface. to enable communication via the Ethereum blockchain's ether. To carry out operations like transmitting ether, validating transactions, and reading and writing data from smart contracts, the ether.js library is needed. Installing MetaMask on a browser makes it possible to access an Ethereum wallet via a browser and interact with the Ethereum blockchain.

They must validate the transactions with their account using the MetaMask wallet, which is connected via ether.js, in order to add blocks for suppliers and manufacturers. After that, the end-user can verify the product integrity and supply chain by scanning the QR code. Figure 4 illustrates how accounts can be divided into manufacturer, supplier, and customer categories.

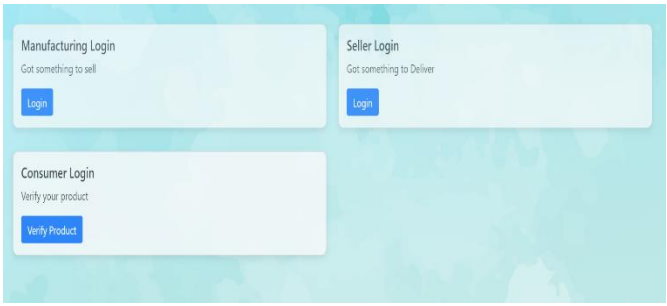

Fig. 4 Manufacturer, seller and consumer panel

The credentials are stored in MongoDB server .
MongoDB database is used for storing manufacturer and supplier login details and their address.
after logging into his account, the manufacturer assigns unique serial number for the product and generates its QR Code. This QR code is placed on the product when it is transported to other places. Along with this the manufacturer fills other details of product like its name, current address that is the source and destination where it is currently headed. Once all the details are filled the manufacturer clicks add block button which is used to add all the filled details to blockchain.

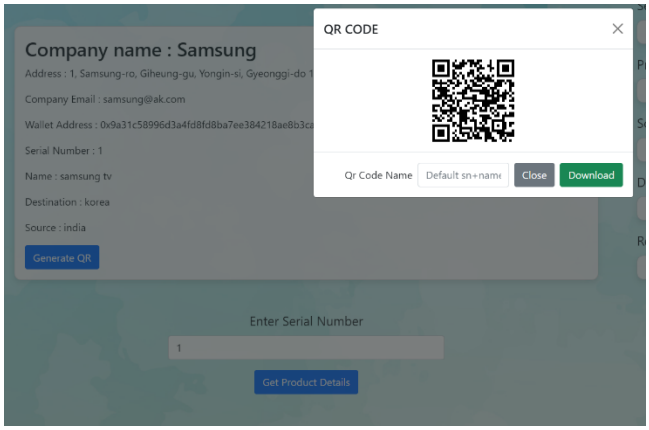

Fig. 5 QR Code Generation of the Product

A MetaMask confirmation popup is displayed which asks for the confirmation as in Figure 5.

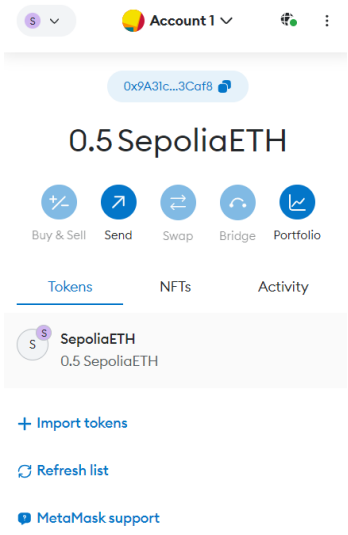

Fig. 6 MetaMask Wallet confirming the Transaction

Once confirmed the block containing all details are added to blockchain

Once the product reaches the supplier destination, the supplied needs to login into his account shown in Figure 7 and connect his MetaMask wallet.

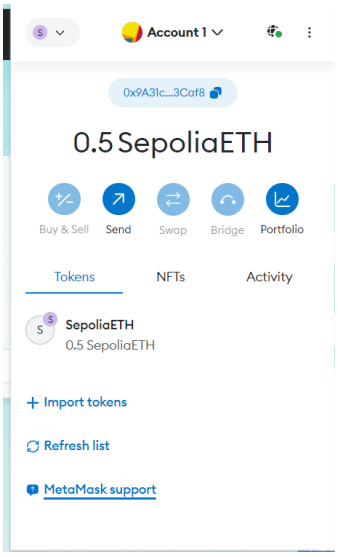

Fig. 7 Seller's MetaMask Wallet

Once done the supplies is presented with screen to fill in the required details of product. This time the supplier doesn't generate the QR code, the supplier clicks on scan QR and scans the QR code. The supplier enters the required details for the product and clicks on add block .The block gets added after the supplier confirms his transaction through the MetaMask wallet and logs out.

Other supplier involved similarly log into their account and adds their respective blocks to the blockchain. After the product reaches the customer he can visit the customer page, scan the QR code and check the complete supply chain history of product as shown in Fig. 8.

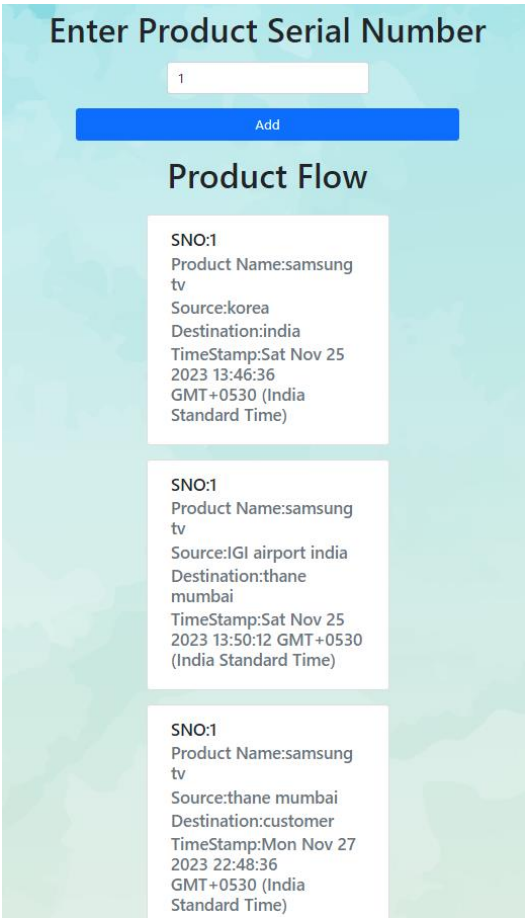

Fig. 8 Supply Chain History of the Product

The supply chain history as shown in Figure 8 shows various information of like the product id, its name, source, destination address related to the entities involved, their Ethereum account address, timestamp of when the block was added, and any additional remarks if added.

At the time of customer purchasing the product after the QR scan in supply chain history, if the last location is not matched with the purchase location, the customer will know that the product is not genuine. It concludes that the QR code was copied and the customer becomes aware of counterfeiting.

6 Conclusion

Since blockchain is a decentralized system and anyone connected to the network can view the block data, it makes counterfeiting much more difficult. The technology allows manufacturers and suppliers to record product details in Blockchain, which provides tamper resistance, data consistency, and confidentiality—properties that ensure the security and privacy of data on the network. The buyer checks to see if the goods is authentic by looking at its supply chain history. Consumers can feel secure in the quality of the products they buy. The suggested solution can significantly reduce the percentage of branded items being counterfeited and give businesses a simpler way to give customers the assurance that they won't buy counterfeit goods. This system will actually aid in strengthening the bonds of trust and goodwill between the maker and the client as well as in enhancing the economy and decreasing corruption. Additional systems can be implemented to prevent fraud in the banking, healthcare, voting, internet shopping, and other sectors.

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