Identifying Fake Products using Blockchain Technology in Supply Chain System

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*Abstract*— The volume of production and ease of obtaining counterfeit goods has increased to unprecedented levels with the advent of globalization and the rapidly advancing pace of technology. All types of industrial manufacturers and distributors are currently working to increase supply chain operations' openness to prevent counterfeiting, whether it be for food, medicine, or luxury goods. To detect fake goods in the supply chain system, this paper proposes a decentralized Blockchain-based application system (DApp) to authenticate products and detect counterfeit products. With the quick development of Blockchain technology, it is already well known that data stored there is secure and unchangeable. As a result, this idea is used in the proposed system to handle the transfer of ownership of goods. A Quick Response (QR) code issued by the DApp for each product connected to the Blockchain can be scanned by a customer to confirm the distribution and ownership information of the goods.

Keywords—Blockchain, Counterfeit, Ethereum, QR Code, Supply Chain, Decentralized, Keccak256

# Introduction

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Description automatically generatedFor all parties involved in the supply chain, spotting fake goods in the market has proven to be difficult over the years. According to the most recent assessment by the Organization for Economic Cooperation and Development (OECD) and the EU Intellectual Property Office (EUIPO), counterfeit and pirated items are now sold globally for 460 billion euros, or around 3.3% of all trade. This phenomenon has an impact on the sales and earnings of businesses everywhere. Sales losses in the apparel and pharmaceutical industries totaled roughly 26.3 billion euros and 10.2 billion euros, respectively [1].

Furthermore, the market for counterfeit goods has blossomed on social media platforms with the introduction of current technology and E-commerce. For counterfeiters, social media and e-commerce's anonymity, reach, and segmentation tools have made life easier. Therefore, counterfeiting—the act of creating twins or imitations of genuine goods—poses a serious danger to innovation and economic development [2].

Quick Response (QR) code will be used in the proposed system to provide a reliable way to try and halt the practice of product counterfeiting. A Quick Response scanner can identify fake products by scanning a QR code that connects the item to the Blockchain network. Once the user submits the special code, which is then checked against the Blockchain database. If the code matches the code generated by the manufacturer, the client will be notified that the QR code is matched [3].

Blockchain technology is a secure and decentralized system that provides a transparent way of storing and transmitting data. It is a distributed database that is maintained by a network of nodes, each of which contains a copy of the entire blockchain. The key features of a blockchain system include decentralization, transparency, security, immutability, and consensus. These features ensure that the data stored on the blockchain is secure, transparent, and consistent across the network. Therefore, any application that uses Blockchain as its foundational technology guarantees that the data is impenetrable [4].

Although it is unlawful to trade goods that violate international intellectual property regulations, the corresponding industry has been booming over the past few years. Examples include shoes, apparel, purses, and gadgets. Data from the OECD and EUIPO's Global Trade in Fakes study indicates that $449 billion or so worth of counterfeit goods were traded in 2019 as shown in Fig. 1. Selling imitation trainers, watches and clothing is roughly as profitable as running a mid-sized European country, as shown in our graphic comparing this amount to the 2019 GDP numbers of chosen OECD countries and regions [5].

**Fig 1**: Sales Losses Due To Fake Products

For instance, the OECD estimates that Ireland's economy generated about $431 billion, while Portugal ranked seventh among the organization's member states with $372 billion. It's interesting to note that the market for fake products is nearly the same size as Hong Kong's GDP, which accounts for 20% of the value of goods seized between 2017 and 2019. Hong Kong's GDP is $466 billion [6].

A screenshot of a cellphone

Description automatically generated with low confidenceThe article claims that in 2019 the trade in fake or stolen goods accounted for around 6% of imports into the European Union and 2.5% of global trade illustrated in Fig. 2. Despite the lack of precise data in the report, the global pandemic had an effect on this particular industry as well, with border closures and constrained production leading to an increase in the importation of fake medications and personal protective equipment including masks, gloves, and sanitizers [6].

**Fig 2**: Fake Goods Origins By Country Percentage

The rest of this paper is organized as follows: Section II reviews the related works. Section III describes the proposed DApp system architecture and its characteristics. In Section IV, the methodology of the proposed system is illustrated. Then Section V talks conclusions and future research directions

# Related Work

Various researchers have proposed different methods for establishing a blockchain-based supply chain management system.

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Description automatically generatedFariha Jahan et. al [7] displayed a fake product detection system using blockchain where SHA-256 Algorithm was used to identify a product. A fully functional anti-product forgery system was designed by a group of researchers that uses digital signature for verification. Product Ownership Management System was proposed. It displayed the use of blockchain-based system over traditional RFID based system. Blockchain was used to remove the limitation in post supply chain. To improve the current supply chain method a paper used blockchain combined with IoT to track product origin.

Abhinav Sangha et al. [8] proposed a blockchain-based system to help in tracking the movement of drugs from the industry to the patient. Mainly, the Hyperledger fabric is used for implementing the entire model. In this model, the manufacturer must upload the details of a drug to a website which is sent further to the government for approval. Once the government approval is done, the pharmacies can request the approved drugs with the help of blockchain technology. Further, if any patient needs to get some medicine or drugs, then a request is made to the blockchain network. After that, a medical officer or doctor will approve or reject the request. Because the entire model is implemented in a blockchain network, it can help in preventing the counterfeiting of drugs and the movement of drugs can be tracked from the manufacturer up to the patient.

G. Vidhya Lakshmi et al. [9] utilized blockchain technology and Python to generate QR codes. In other words, they used the features of blockchain and QR codes to create a reliable and transparent inventory management system. Using Python, they can create QR codes that are customized for different products. The details of the sold products are then broadcasted through the P2P network. A manufacturer can quickly compute inventory by retrieving product details from the blockchain database.

# Proposed System

Product authenticity is essential for preventing counterfeiting. Regrettably, counterfeit goods are offered for sale in markets, other product distribution centers, and retail centers. Retailers willfully sell bogus items on occasion in order to make a considerable profit. Identifying whether the goods is real or fraud is difficult in this situation. Hearing that this is happening with medications and children's toys is really unsettling. As the products' value is questioned, the problem is getting worse. The product is not just judged according to its physical attributes; it may also be sold in a virtual environment, and its past can be examined. The relationship between a customer and a store or business may be impacted by this. The local region's trade may also be impacted [10].

Transparency and untraceable products are two of blockchain's most significant characteristics. Companies don't have to spend additional money to protect the product's data. This technique is secure and much faster thanks to the Quick Response codes that are created. The data is error-free due to the quick system. Chain system regulations can access it. Successful Blockchain system administration in any organization depends on secure system handling [11].

## System Architecture

Every user of the DApp must be authenticated before logging in. This authentication system has been implemented using the solidity code. After successful authentication, the company can add their product to the DApp and enroll products of the company. The data of the company is provided to the website and stored in the blockchain network. After a product has been included in the blockchain, it is assigned a QR code for verification. The users can verify products from the manufacturer after registration. The ownership transfer of the product can be tracked through the QR code. This process is show in the system architecture in Fig. 3

**Fig 3**: System Architecture

The methodology used to create this system includes the use of a high-end development tool called Ganache to run our own local Ethereum blockchain, a cryptocurrency wallet called MetaMask to interact with the Ethereum blockchain, the Remix IDE tool used to debug the Smart Contract Program..

## Blockchain Implementation

To implement the blockchain technology for identifying fake products in the supply chain, **Ethereum** was selected as the blockchain platform due to its robust smart contract capabilities and widespread adoption in various industries. The Ethereum blockchain offers a decentralized and transparent network, making it suitable for enhancing supply chain traceability and trust. Smart contracts were developed using the Solidity programming language to automate the verification and tracking processes. The smart contracts were deployed on the Ethereum blockchain network using the Remix IDE and the Truffle development framework. Additionally, to address the scalability challenges associated with Ethereum. Through this blockchain implementation, the aim was to establish an immutable and auditable ledger to securely record product information, transactions, and supply chain events, thereby enhancing transparency, traceability, and trustworthiness within the supply chain ecosystem [12].

The **Hyperledger Fabric** framework was chosen as the blockchain technology for implementing the solution to identify fake products in the supply chain. Hyperledger Fabric provides a permission and modular blockchain platform with a strong emphasis on privacy, scalability, and flexibility. The network was set up using a consortium model, involving multiple trusted participants, such as manufacturers, distributors, and retailers. Chain code, written in the Go language, was developed to define the business logic and rules governing the supply chain processes. Each participant had their designated roles and permissions within the network, ensuring controlled access to sensitive information. Privacy features such as channels and private data collections were utilized to restrict data visibility to authorized parties only [13].

To develop and deploy the smart contracts for identifying fake products, the **Solidity** programming language and the Truffle framework were utilized. Solidity, specifically designed for smart contract development on the Ethereum blockchain, provided the necessary tools and syntax to define the logic and behavior of the contracts. The contracts were written in Solidity, leveraging its object-oriented features to model the various entities and interactions within the supply chain system. Truffle, an industry-standard development framework, was employed for the compilation, testing, and deployment of the smart contracts. Truffle's suite of tools, including Ganache for local development, helped in simulating the blockchain environment and conducting thorough testing of the smart contracts before deployment to the main network. Truffle's deployment pipeline streamlined the process of deploying the contracts to the Ethereum blockchain, ensuring proper migration and version control. By utilizing Solidity and the Truffle framework, the aim was to create robust and reliable smart contracts that enforce the business rules, enhance supply chain transparency, and facilitate the identification of counterfeit products in the supply chain system [14].

The supply chain management paradigm offers promising potential thanks to blockchain technology. On nodes, where each node has a full copy of the blockchain database, blockchain data is kept. Using a blockchain network, orders, payments, accounts, product prices, and other data may be monitored, shared, and safeguarded. The following are some crucial characteristics of blockchain technology for supply chain management:

1) **Security and Privacy**: Public key cryptography is a technique used by blockchain to secure data. Users have a public and private key pair that is used to validate transactions, which are unchangeable and irreversible.

2) **Decentralization**: Because blockchain uses a distributed ledger, it is not dependent on a centralized authority or third party.

3) **Transparency**: Blockchain data is public and anyone can check its transactions. A set of guidelines known as a smart contract may be used to control the transactions. The solution that is being presented here uses the Ethereum blockchain's Ganache Test Network and the MetaMask cryptocurrency wallet for all transactions. The Manufacturer, the Seller, and the Consumer are the three main stakeholders in the Decentralized Application [15].

## Operation Flow

The operational flow for identifying fake products using blockchain in the supply chain system involves a series of interconnected steps to ensure transparency, traceability, and authenticity. First, the product information, including unique identifiers and manufacturing details is recorded on the blockchain starting from the company. This information is stored in a decentralized and immutable manner, providing an auditable trail of the product's journey. As the product moves along the supply chain, smart contracts embedded within the blockchain network automatically verify and validate its authenticity at key checkpoints. These smart contracts employ predefined rules and algorithms to compare the recorded product information with the expected characteristics of a genuine product. This verification process helps identify any discrepancies or red flags that may indicate the presence of counterfeit items [16].

In case a potential counterfeit product is detected, an alert is triggered, notifying the relevant stakeholders, such as manufacturers, distributors, and retailers. This real-time notification enables swift action to be taken to investigate further and mitigate the risks associated with the presence of fake products within the supply chain. To enhance the identification process, additional mechanisms can be implemented, such as integrating anti-counterfeiting technologies like QR codes are being used. These technologies allow for seamless scanning and verification of product information, further strengthening the accuracy and efficiency of the identification process [17].

Ultimately, the combination of blockchain technology, smart contracts, and anti-counterfeiting technologies forms an integrated system that empowers supply chain participants to identify fake products, minimizing their impact quickly and reliably on consumer safety, brand reputation, and economic losses.

## Product Verification Algorithm

Input: Product Information (recorded on the blockchain)

Output: Verification Result (Genuine or Counterfeit)

1. Initialize the Verification Result as "Genuine."
2. Retrieve the product info from the blockchain.
3. Extract the unique identifiers, manufacturing details, associated with the product.
4. Compare the extracted information against predefined criteria for a genuine product.
5. Perform data validation to ensure the completeness and integrity of the recorded information.
6. Conduct detection process using the product information to identify discrepancies or red flags.
7. Analyze manufacturing details, such as *hash id*, for consistency and plausibility.
8. Validate supply chain events to verify the authenticity and accuracy of transfers between entities.
9. Check for any suspicious or abnormal patterns in the recorded data.
10. If any discrepancies or red flags are identified:
    * 1. Update the Verification Result to "Counterfeit."
      2. Trigger an alert or notification to companies
11. If no discrepancies or red flags are found:
    * 1. Keep the Verification Result as "Genuine."
12. Return the Verification Result as the output.

## Tool Requirements

We can execute blockchain on our machine using Ganache, a local blockchain simulator. Without purchasing Ether, we can create, implement, and test our decentralized application. Numerous virtual ether addresses and balances are present on the Ganache interface. Our smart contract may be created, implemented, and tested using this virtual ether. Additional details are provided to us regarding Blocks, Transactions, Contracts, Events, and Logs.

A browser addon called MetaMask makes working with any blockchain much simpler. In essence, MetaMask automates all the coding that we had to do. Both a security and an accessibility layer are provided by MetaMask. Nothing from our MetaMask wallet can be sent to that website without our consent. Using Remix IDE, we can deploy Smart contracts in Solidity. Remix IDE is an online tool where we must create our solidity-based smart contract.

We can quickly deploy our smart contracts to the test nets or the main nets, where we can then use this environment to test and validate the smart contracts. For a decentralized e-commerce website, smart contract code is written.

The primary JavaScript library for dealing with the Ethereum blockchain is called Web3.js. The web3.js package is useful for creating a website or other kind of client that can really communicate with the blockchain. Website communicates with the blockchain via web3, and a technology known as JSON RPC. RPC, or remote procedure call protocol, is the technique that enables communication with the Ethereum blockchain.

# Conclusion & Future Direction

Blockchain technology could help e-commerce businesses and customers by preventing product counterfeiting. From the time the product is manufactured until it reaches the customer, the manufacturer, distributor, and the customer will have access to the product's information. A third party or hacker can't alter the product's information between any of the links in the blockchain. Blockchain systems are governed by smart contract codes. When a product is delivered to the consumer and the created QR code is compared, the QR code is confirmed. The user may have faith in this Blockchain-based application because the code is so straightforward. The code may be made simpler in the next work. Customers won't be familiar with Blockchain-based E-Commerce websites, thus to persuade them to purchase a product from this website, they must understand how this website differs from other shopping websites and the benefits this website offers. This website's promotion will be difficult.

In the future, upscaling and improving our system will be possible, as our system is still a small-scale system and still relies on manual inputs. Automation can also be applied to ease the manual input process and reduce human errors that may occur. Another factor that limits our system is the price of Ethereum. Our system is dependent on the price of Ethereum and if it fluctuates too high, the cost of using our system will automatically be more expensive. Therefore, in the future, developers can fork and create a specialized blockchain architecture from current open source blockchains, to reduce the dependencies towards Ethereum.

Despite its shortcomings, the blockchain is still underutilized heedless of its amount of unrealized potential. This model has shown that an anti-counterfeit system can be built using blockchain, and that opens a whole world of possibilities for the utilization of blockchain technologies that can truly advance technology. Blockchain has proven to be effective in building a system that deters counterfeiting activities and there are so many fields that are still untouched by blockchain that can adopt this technology to make systems that would benefit them.

In terms of future research directions, exploring the integration of emerging technologies, such as Internet of Things (IoT) devices and artificial intelligence (AI), with blockchain can further enhance the detection and prevention of counterfeit products. Moreover, investigating the applicability of blockchain beyond product identification, such as tackling supply chain sustainability, and fair trade, presents exciting avenues for future exploration [18].

Our plans are to make a mobile application version of the application to ease up the verification process for the user in a portable manner. Also to imply an Identity management API to protect the personality of the companies when logging in to our application. Expand the blockchain application to cover the entire supply chain, enabling transparent tracking of products from their origin to the end consumer. This would help identify and eliminate counterfeit products at various stages of the supply chain.

We can consider integrating your product identification system with e-commerce platforms such as Amazon, eBay, and Shopify. This will enable users to verify the authenticity of products before making a purchase. Also incentivize users to report fake products by implementing a reward system. Users can earn tokens or other rewards for reporting fake products, which can be used to purchase products on the platform or traded on cryptocurrency exchanges.

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