

BLOCKCHAIN-DRIVEN FRAMEWORK FOR AUTHENTIC PRODUCT VERIFICATION

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Abstract: The spread of fake products has turned into one of the main issues in the world, causing consumer uncertainty and brand insecurity. Lack of effective verification systems makes many buyers to buy fake products without realizing. The solution to this issue can be provided with the help of blockchain technology, which has been characterized as decentralized and impossible to tamper with. This paper presents a blockchain-based system that will enable product authentication and stop counterfeiting. With the proposed model, manufacturers will write actual identifiers of the product on a distributed ledger and consumers will be able to confirm authenticity thus they can purchase the product. The fixed and transparent attribute of blockchain also guarantees safe and sound data. It has you verifying your accounts automatically via Ethereum-based smart contracts and limiting usage of intermediaries and increasing integrity on transactions. This is not only a way of limiting the proliferation of counterfeit products but also a way of boosting consumer confidence by ensuring that the products are authentic through decentralized checking systems.

“Keywords: Blockchain, Counterfeit Detection, Product Authentication, Smart Contracts”.

1. INTRODUCTION

The problem of fake products is a widespread and multifaceted one in the contemporary market, which risks consumer safety, undermines brand integrity, and reduces online shopping credibility. Counterfeits refer to the inferior imitations of original products whose aim is to copy luxury goods at a much lower price thus attracting a consumer with the promise of saving money. The counterfeit products have become so good that they closely replicate their original counterparts and it has become difficult to be able to identify a real product and a fake product. There has been a steady rise in the trade of fake goods around the world, according to the “Organization for Economic Co-operation and Development (OECD)”. with the trade constituting 3.3 percent of the total world trade. This booming illicit trade deprives

legitimate companies of money and puts the health of the consumers at risk particularly in the pharmaceutical and cosmetic industry.

Online merchants are increasing efforts to combat counterfeits as a response to the increasing levels of counterfeit products all in a bid to safeguard their customers. Amazon, a major e-commerce player has implemented initiatives such as Project Zero which involves machine learning technology in detecting and removing fraudulent sellers in its market. Amazon invests large resources and human resources into working to protect the integrity of the marketplace and protect consumers against counterfeit products. Despite these measures, counterfeit goods continue to affect the global marketplace causing a lack of consumer trust and undermining the ability of honest enterprises to compete.

A lot of people in the European Union have bought fake goods without meaning to because they think they are real [3]. This is a worrying trend that affects customer loyalty and generates the risk of losing authentic brands because dissatisfied customers abandon online purchases. In addition, the uncontrolled distribution of fake goods destroys profitability of legitimate businesses and at the same time makes counterfeiters richer at the expense of original manufacturers.

At this situation, it is a matter of urgency to have a powerful and reliable mechanism of checking the items and restoring customer confidence in online transactions. An alternative opportunity is blockchain technology that has a decentralized trust system that will enable customers to easily verify the legitimacy of a product. Through the inherent characteristics of blockchain, namely, consensus, provenance, immutability, and finality, the involved parties will be able to establish an immutable and open system of the information about the product, which will minimize the chances of product duplication.

This background sets the context under which the in-depth analysis of the impact of counterfeit goods on

consumer confidence and brand loyalty in the digital era is to be analyzed. This paper aims to explain why blockchain technology has potential to fight counterfeits by analyzing the market trends, legal framework, and technological development. To inform the consumers, business people, and politicians on how to minimize the risks of fake products and establish a safer and more reliable business environment, this paper will discuss the opportunities and challenges of blockchain-based authentication measures.

2. LITERATURE SURVEY

The problem of counterfeit products is an expanding and very common concern in the global market causing intense research and development to deal with this illegal commerce. The close examination of the literature demonstrates a complex system of economic, social, technical aspects of the counterfeit detection and prevention.

“Organization for Economic Co-operation and Development (OECD)” clarifies the magnitude and importance of the business of fake goods, and that it affects the global trade enormously and indeed rapidly [1]. It is shown that fake products represent 3.3 percent of international trade; hence, there is an urgent need to implement the proper solutions to counterfeit goods. The paper is a landmark work serving as a baseline to understanding the magnitude and effects of forged products to the global economy. With this flood of counterfeit products, internet sellers eBay counterfeits have intensified their fight against counterfeit listings eBay counterfeits have intensified their fight against counterfeit listings such as Amazon have bolstered the fight against counterfeit listings. Segrán (2021) has critically examined the activities of Amazon, which has established Project Zero that is implemented with machine learning technology to identify and delete counterfeited products in its platform [2]. Even with these attempts, there have still been challenges and this has led to the question arising whether the current methods are effective in stopping proliferation of fake goods.

The perception and the attitude of consumers are influential factors to take into consideration in the discussion of counterfeit goods. According to TFL (2021), it is estimated that about 10 percent of The fact that customers in the European Union have purchased fake products without realizing it

emphasizes the fact that the issue of counterfeit products remains persistent and is having an adverse impact on the consumer confidence [3]. This is why it is necessary to know the behavior and preferences of the consumers in order to establish successful anti-counterfeiting strategies.

There has been an emergence of a new technology known as blockchain which can be used as a potential method of product authentication and minimization of product faking within the industries. The article by Hedao et al. (2021) provides a comprehensive explanation of the blockchain-based solutions in fake products detection and demonstrates the applicability of the implemented distributed ledger technology in creating an unaltered and transparent list of provenance of products [6]. Those solutions make use of the cryptographic features of the blockchain and the decentralized structure to increase the supply chain visibility and trust that reduces the risk of counterfeit products.

Gupta, et al. (2021) introduce a product identification system that relies on Ethereum and is based on smart contracts to make the process of product authentication automatic [7]. It is a new strategy rooted in the programmability and security possibilities of the Ethereum blockchain to ensure supply chains integrity and to authenticate products. In Shahariari, Sahle, and Sandi (2018), the authors describe the opportunities presented by the solutions that blockchains provide to avoid frauds and compare the application of smart tags to secure the brand and fight counterfeiting in the wine market [8].

Supply chain management with the blockchain technology has its peculiarities to ensure a certain traceability and identify fake products. Another method of counterfeit detection of supply chain management suggested by Prathipa et al. (2020) is based on the use of blockchain to track and validate products throughout the supply chain with the assistance of distributed ledger technology [9]. Blockchain also promotes transparency and accountability since the history of product movement and ownership is built and is immutable; hence, the reduction in the occurrence of fake products.

Kumar and Tripathi (2019) discuss the adoption of the blockchain technology as a tracing tool in the supply chain of counterfeit drugs, stating that a safe and transparent data management system is needed to prove the integrity of the medicinal product supply

chains [10]. It is also possible that the stakeholders can successfully verify and authenticate the provenance of the pharmaceuticals with the help of traceability systems that use blockchains, thus reducing the possibility of fake products coming to the market.

The literature review touches upon the complex nature of the issue of fake goods and the variety of methods that are being reviewed to solve the problem. Stakeholders in different industries such as government and technological solutions are fighting the battle of counterfeit products and protecting consumer interests. Sharing of knowledge and cross-disciplinary cooperation will be significant in the future in terms of coming up with comprehensive plans to end this common crisis.

3. METHODOLOGY

a) Proposed Work: The counterfeiting system is an amalgamation of automation, transparency, and decentralization with an attempt to fight the weaknesses of the existing systems.

Moreover, it involves both partners in their supply chain, provides an advanced system to solve the issue of selling fake goods, and can make customers make a well-informed choice to purchase.

Blockchain is an e-record that catalogs transactions in a safe yet open manner. It is used to document information on provenance of products, authentication processes and authentication of authenticity. Instead of having all the information in one place, blockchain assists in structuring the records in blocks of information each of which is marked with a particular code referred to as a hash.

The fact that the manufacturers use separate serial numbers that are stored in the blockchain makes it highly challenging to enable product identifiers to be copied or reused by counterfeiters.

b) System Architecture:

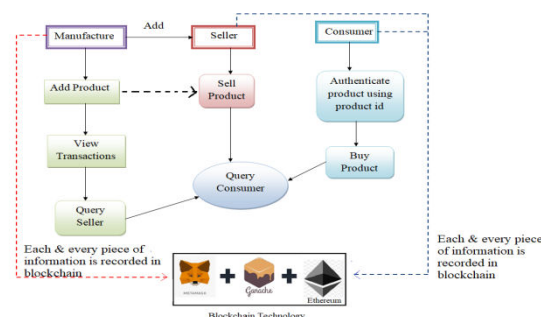


Fig 1 Proposed Architecture

The system design facilitates the decentralized system of producers, dealers, and consumers, the blockchain technology. Manufacturers post product details, check transactions and interrogate participants. The product is made with the help of sellers. transactions, and the customers are the ones who validate products, make purchases, and make inquiries with relevant parties. All activities and information have been safely recorded on the proposed anti-d platform based on blockchain, which ensures that there is transparency, immutability, and traceability of the activities and information throughout the supply chain. The architecture enables smooth interaction, validation, and exchange of real commodities by smart contracts and cryptographic processes, therefore leading to trust and confidence between all members of the process.

c) Modules:

The following modules were used in implementing this project; Manufacturer, Seller, and Consumer. The following are the descriptions of these modules:

i) Manufacturer Modules

“Manufacturer Login”: The system has secure credentials that manufacturers can use to ensure that they manage their operations in the platform.

Add Seller: Manufacturers are able to integrate approved vendors into their infrastructure thereby improving distribution of the products.

Add Product: Manufacturers are able to integrate their goods into the system, providing detailed information about the individual goods, including their validity.

“View Transactions”: The technology provides manufacturers with data on the distribution and sale of their products hence they can monitor and evaluate products related transactions.

“Query Seller”: Manufacturers may request their approved vendors to answer questions to learn more about their performance and products distribution.

“Query Customer”: Probably, to seek feedback and marketing goals, manufacturers are able to query consumers who have interacted with their products.

ii) Seller Modules

“Seller Login”: The sellers are able to access the system which allows them to control the sales and interactions of their products.

Sell Product: Vendors can list their products online, explain their specifications and validity, thus making these available to a consumer. Before that, businesses have to purchase items with the manufactures.

Query Consumer: Vendors will be able to gain information about the buyers of their products, who may be used to achieve marketing or CRM goals.

iii) Consumer Modules

“Consumer Signup & Login”: Consumers are able to interact with the platform by creating an account or logging in and do so in a secure manner.

Authenticate Product: The system allows consumers to verify products before purchases which ensures one acquires authentic things.

Buy Product: The platform also enables consumers to do product research, make purchases and close deals safely.

Query Consumer: This is a consumer tool that allows the consumer to have a record of their transactions.

d) Blockchain Integration:

Blockchain describes an immutable database that contains an exhaustive and unalterable product information. This includes details about the manufacturing process of a product, distribution and other important facts about the lifecycle of a product. This will also give the transparency and confidence in the origins of the product as it will ensure that the data maintained is accurate and reliable.

Product verification can be done safely with the use of the blockchain. Some of the stakeholders include customers, producers, and authorities who can establish the authenticity of a product by checking its history on the blockchain ledger. This transparency can also ensure a credible authenticity check, which is necessary in ensuring authentic products and counterfeiting the fake ones.

The decentralization of the blockchain does away with the central organization since it improves the

exchange of information among a network of nodes. Such a construction increases the overall safety of the system significantly as the possibility of fraud and data distortion is significantly reduced. It enhances its greatness and hard-to-crack platform by eliminating the point of failure vulnerability.

According to protocols developed prior, smart contracts enhance efficiency and instill trust in product identification and tracking through information updating on products status and initiating the verification process.

The openness and consensus mechanism of blockchain ensures that every one of the network participants can access the same data and trust it to be accurate. It is a crucial trust that will enhance transparency in the supply chain and help in fighting counterfeit products. It facilitates cooperation and ensures that any information stored in the blockchain registry is accurate.

e) Ganache:

Ganache is a convenient interface that can be used to monitor the activity of the Ethereum blockchain. It renders account and transaction tracking as well as smart contract tracking achievable and available even to consumers who do not have many. knowledge of blockchain. Ganache also displays detailed information on transactions that includes the sender, receiver, amounts, gas used, and the success state, which makes it easier to debug and guarantee precision of transactions. It also tracks the deployments of smart contracts and ensures that the deployments have been done correctly and perform their tasks. This transparency eases the process of monitoring and verification.

With the help of Ganache, we can trace the details of each block of the Ethereum blockchain. The number of transactions that have been finalized, the time in which a particular block is included, and the quantity of computation resources (gas) are all put into consideration. Also, the developer can read and research a particular block with the help of Ganache to make the data of stored blocks easy to access.

f) Metamask:

Metamask is an extension on the Ethereum browser and a wallet. It simplifies the administration of cryptocurrency and allows direct access to DApps, therefore, improving the interaction with blockchain apps.

Metamask ensures secure Ethereum transactions in the project, which makes the project more transparent through the deduction of ETH in the form of fees. Such openness ensures accuracy and ensures that there is confidence and reliability in financial transactions in the system.

4. EXPERIMENTAL RESULTS

The proposed blockchain-authorized product check system was implemented and tested to verify its effectiveness and ability to detect falsified products. The tests were focused on the fluid interaction of the three main stakeholders including manufacturers, sellers, and consumers using the integrated blockchain ecosystem enabled by Ganache and MetaMask.

The interface of the system was designed in a manner that is simple to use and easy to navigate and thus facilitating users at all levels of the supply chain to perform their duties successfully. The workflow and data flow in the system are shown in the screenshots of various stages of the implementation, as depicted below.

User Interface Overview

- **Fig. 2: Main Page**
Shows the homepage, in which users are able to select their roles (Manufacturer, Seller or Consumer) and access to the respective system modules.
- **Fig. 3: Manufacturer Login Screen**
Allows manufacturers to securely log in using unique credentials before adding or managing product-related information.
- **Fig. 4: Add Seller Details Screen**
Enables manufacturers to register verified sellers authorized to distribute genuine products.
- **Fig. 5: Add Product Details Screen**
Provides a platform that allows manufacturers to post product information, including serial numbers, categories and authentication information, which are recorded in the blockchain.
- **Fig. 6: Ganache Dashboard**
Shows detailed blockchain operation, such as registering products, authorizing the sellers, and confirmation of the operations, as well as gas usage and confirmation of the block.

- **Fig. 7: MetaMask Interface**
Shows the wallet interface that is used in validating the transactions and managing of fees when engaging in blockchain activities.
- **Fig. 8: Seller Login Screen**
Allows vendors to log in safely, place authenticated merchandise in the market, and interact with the clients through the marketplace that is supported by the blockchain.
- **Fig. 9: Product Purchase Screen**
Demonstrates the interface to the customer of navigating, choosing, and purchasing authenticated products within the decentralized platform.
- **Fig. 10: Purchase Successful Screen**
Confirms the end of a transaction, which means that all the relevant data are stored in a blockchain ledger in a safe manner.
- **Fig. 11: Customer Signup Screen**
Enables online registration of new users into the system and creates a verified digital identity to identify a user and carry out any transaction.
- **Fig. 12: Product Authentication Screen**
Admits consumers to ensure the validity of a product through verifying its serial number and blockchain write-up before sealing a deal.
- **Fig. 13: Output Verification Screen**
Exhibits confirm validation results that determine the legitimacy of the product as either original or fake based on its blockchain history.
- **Fig. 14: Ganache Transaction Log**
Shows the records of transactions of the product verification and points out the decentralized nature of the verification.

Result Analysis

The system was able to reveal how blockchain technology can be incorporated into a realistic anti-counterfeiting system. Key observations include:

- **Enhanced Transparency:**
All transactions of products, including their creation and purchase, were registered in the blockchain permanently, which ensured complete transparency within the supply chain.

- Decentralized Verification:**
Product authentication was done without any central databases or agents and, therefore, the risk of data manipulation was reduced.
- Improved Security and Trust:**
The use of cryptographic authentication and automation of smart contracts ensured that products could only be registered and validated by approved users.
- Ease of Use:**
The combination of Ganache and MetaMask provided a clear and straightforward system to manage blockchain transactions, which makes the system user-friendly to non-technical consumers.

The results of the conducted experiment denote that the proposed method is a legitimate, scalable, and harmless means of fighting the scams in the virtual and off-line trading centres.

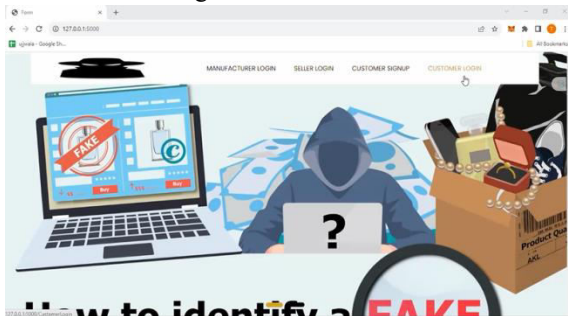


Fig 2 Main Page

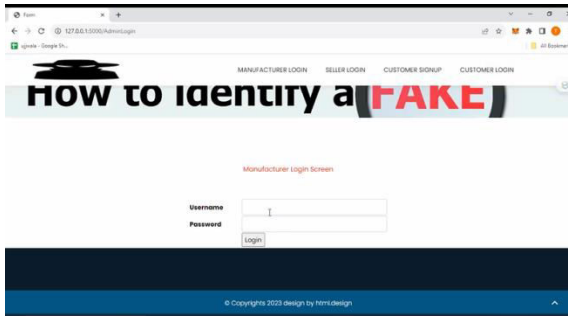
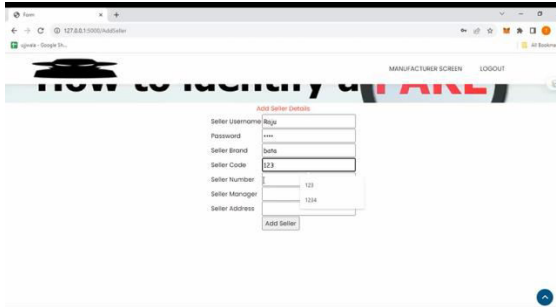
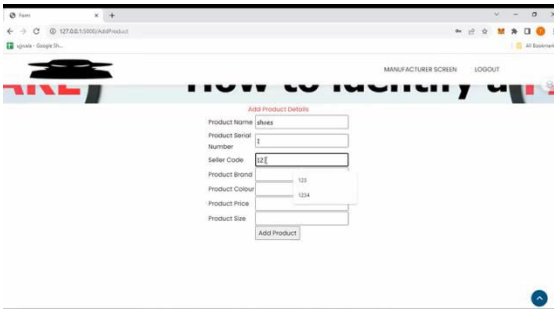


Fig 3 Manufacturer Login Screen



“Fig 4 Add Seller Details Screen”



“Fig 5 Add Product Details Screen”

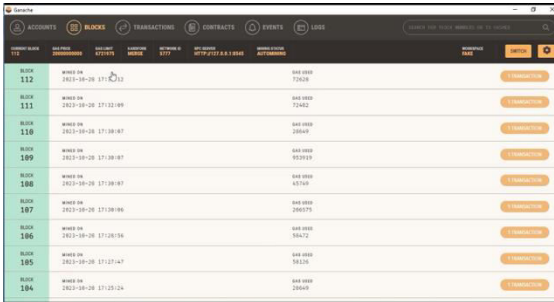
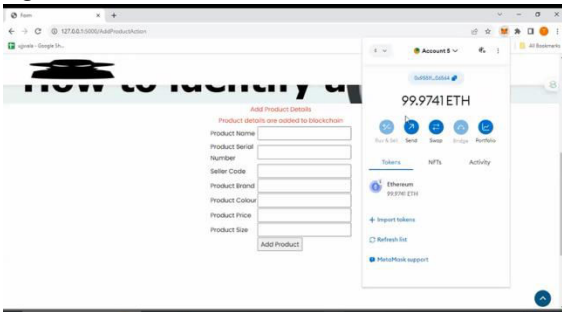
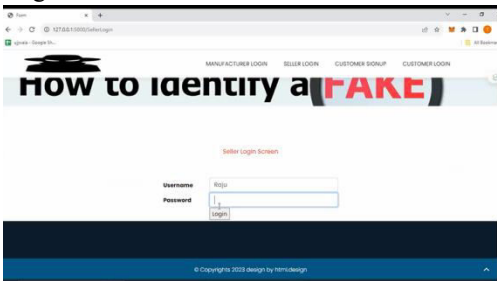


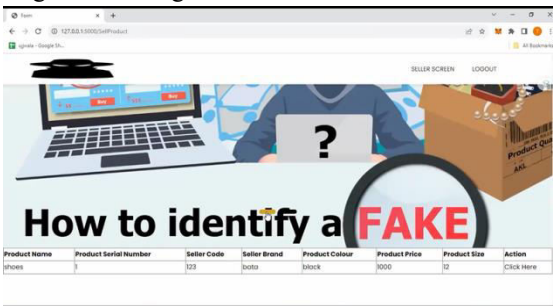
Fig 6 Ganache Screen



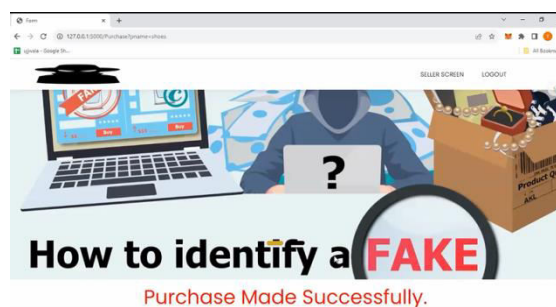
“Fig 7 Metamask Screen”



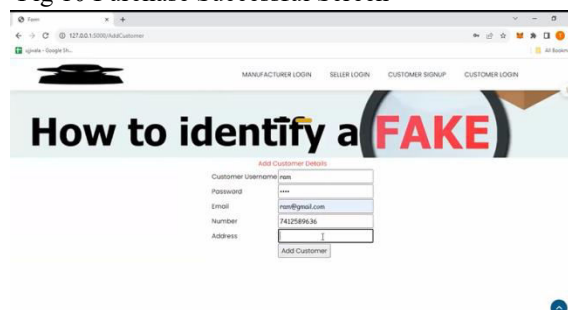
“Fig 8 Seller Login Screen”



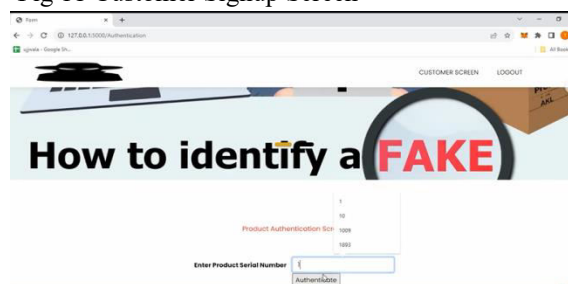
“Fig 9 Product Purchase Screen”



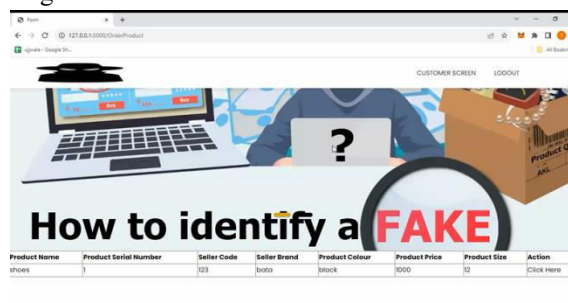
“Fig 10 Purchase Successful Screen”



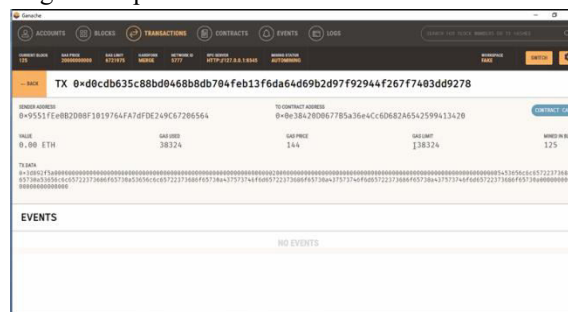
“Fig 11 Customer Signup Screen”



“Fig 12 Product Authentication Screen”



“Fig 13 Output Screen”



“Fig 14 Ganache Screen”

5. CONCLUSION

This paper proposes a blockchain-based solution that will be applied to address the existing issue of counterfeit products in the international markets. The proposed architecture will use the blockchain-based technology in its supply chain operations, which will deliver a decentralized, transparent, and secure method of product validation.

It will be solved by applying smart contracts and immutable ledgers to make sure that all the phases of the product lifecycle, including manufacturing to purchase, are properly documented and verifiable. This is also a way of ensuring that the consumers are not exposed to counterfeit products; brand integrity and consumer confidence are also enhanced.

The system allows the consumers to be able to check products independently and purchase them without the need to depend on the centralized control or mediators. It increases accountability and transparency through channels of distributing manufacturers and sellers, hence limiting the possibility of a counterfeiter breaking into the supply chain.

The blockchain architecture will motivate the stakeholders to cooperate because it introduces a single source of truth that is impossible to manipulate. The system is decentralized hence it has avoided the unauthorised alterations hence making data integrity and traceable.

The paper brings into focus the opportunities of blockchain technology as a tool of relevance in combating counterfeit. The effective development of the offered system proves that it will be capable of changing the traditional approaches towards the verification of products and contribute to the safer, more reliable and transparent marketplace.

FUTURE SCOPE

The future of the system and how the system can transform other industries beyond the initial success in the industry such as the pharmaceutical, electronic and luxury products. The relation to more recent technologies such as Internet of things (IoT) devices will allow following and managing the supply chain in real-time, which will make it more efficient. Furthermore, it is possible to apply AI and ML, which will enable a more precise examination of the patterns and the identification of the anomalies in counterfeiting. The comprehensive nature of this approach does not only increase the deterrence of

counterfeits but also increases the innovative ability and efficiency in many areas thereby making the international market safer and more transparent.

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