Blockchain-Enhanced Counterfeit Detection System for Secure Product Authentication and Transparent Verification of Genuine Goods

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Abstract- ***Counterfeit or replicate goods and commodities production and selling risk customers' finances, safety, and health. It further impacts the original manufacturer's economic growth through such things as loss of revenue, defamation of product, downtime, replacement cost, compelling brands to incur funds to fight fakes, compromising business partners' trust, robbery of sales, etc. In response to this, we outline an SHA-256 algorithm-secured blockchain system that verifies products with QR codes and barcodes. The method uses a camera scanner to verify the product's serial code, which is on a tamper-proof blockchain, authenticating every item's authenticity by the cryptographic strength of SHA-256. If the code in a scanned product is identical with the blockchain entry, the customer is notified of its authenticity; inconsistencies notify the customer and, with permission, the manufacturer of the counterfeit state. This method greatly minimizes reliance on merchant guarantees, offering customers direct validation powers while ensuring manufacturers' interests with an open, secure, and impenetrable confirmation process against forged products.***

Indexed Terms- Blockchain, Smart Contracts, QR (Quick Response), Anticounterfeit

I. INTRODUCTION

In an era of widespread digital transactions and markets, one of the most important questions to answer is the authenticity of things. The increase in the production of counterfeit goods is rapidly becoming a serious problem for both consumers and businesses, as its effect is reflected in financial losses, spoiling one's reputation, and even health problems. The methods that have been used for product authentication until the invention of blockchain technology are not effective because of the development of the chemical industry and counterfeiters' ability to use the latest technology. However, blockchain technology can solve this problem once and for all. By using the properties of an immutable and transparent blockchain ledger, you can create a decentralized system of certifying the authenticity of the product at all stages of the supply chain. This introduction examines the problem of false product identification using blockchain technology and shows how it can change and increase the credibility of the consumer in the market.

Blockchain, which was originally intended to be the native technology for a trendy cryptocurrency like Bitcoin, has escalated into being a transformative force for the whole range of industries. Basically, blockchain is a digital ledger that is decentralized and secure from tampering and that records transactions safely across a network of computers. Blockchain's main idea is to create a transparent, secure, and trustworthy data exchange system with no interference from intermediaries. As the number of blockchain users continues to increase, so does its potential to become the backbone of the supply chain management sector by improving healthcare systems and voting processes, among others. With technology, we will reframe the way we trade, deal, and trust within the digital era.

Mighty fine things, those smart contracts! They are named so because they are the laws that take care of themselves. They reside on the blockchain and verify the terms of the agreement automatically if the precise

terms are met. Standard contracts are different as they depend on third parties for the execution and enforcement of chap transactions. Contracts are now written in a fully automated manner, thus speeding up and ensuring that all steps are precisely followed. By eliminating the need for the middlemen, smart contracts bring in a new age of trustless and automated processes, which in turn offer great opportunities to redefine how the agreements are made and enforced not only in different sectors but also across industries.

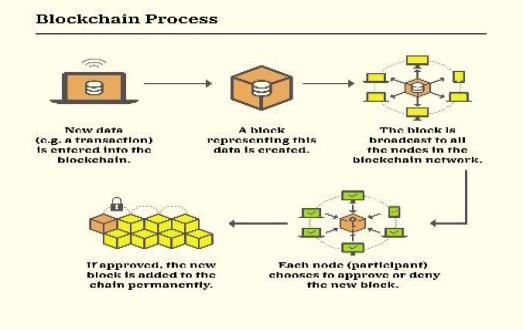

Figure 1 Blockchain

Smart contracts are digital contracts that execute and enforce the conditions of the agreement automatically once specific conditions are met, the need for which is to replace intermediaries or third-party trust. The blockchain technology, which is smart contracts, the self-executing contracts, not to mention, enhances transparency, security, and efficiency in transactions, is the very best means to execute them. This passage gives a narrower view of smart contracts and their ability to overhaul the banking, supply chain, and real estate industries as we have previously done. The solution of the smart contract, one would get from it lowering the operational costs, enhancing trust between the parties, and thus the digital economy being more efficient and reliable.

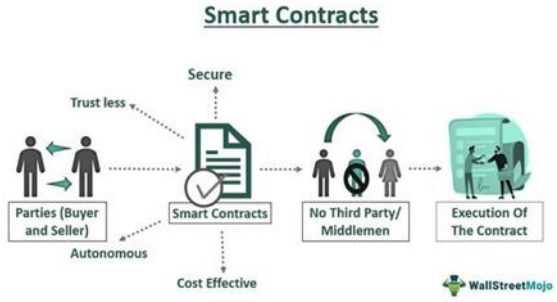

Figure 2 Smart Contrast

Quick Response QR codes have become the lifeblood of today's digital world, serving as information channels and carriers of business across the globe. Initially, QR (Quick Response) codes were created in order to keep track of vehicle components in Japan in the mid-1990s. Ironically, then, QR codes have come a long way and they have emerged as a multilateral tool in almost every area from which they arose. Uniform Resource Locators (URLs) and contact information are two of the many types of data these two-dimensional codes can contain in addition to other data types like direct payment reference and login tokens. Together with the ever-growing number of smartphones having QR scanners built in, these codes are now mostly employed in the marketing, retail, and ticketing sectors. This piece makes an inquiry that is concerned with the process, uses, and influence of QR codes in the sphere of modern business and communication.

Fake or imitated goods are the biggest threats to the consumers' safe lives, brand names, and the progress of world financial stability. Counterfeit products have become a real threat to the safety and the reputation of the brands because the competition from other countries is growing. There are plenty of anti-counterfeiting solutions that are designed to prevent counterfeit products from being sold and, thus, to protect the image and the economic interests of both consumers and legitimate businesses. One of the newest strategies is the use of RFID (radio frequency ID), which is thought to have become a better authentication method. Blockchain technology, RFID, and biometrics are some of the technologies that will be adopted in the coming years. As a result of their experiments, anti-counterfeiting initiatives do not only teach but also learn together with the consumers, enabling them to prove and track the origin of the merchandise. This creative article narrates how new anti-counterfeit technologies are developing, linking to their function of safeguarding consumers and keeping global transactions secure

II. LITERATURE REVIEW

Eduard Daoud, Dang Vu, and others introduced this method in research made available by Research and

Markets on May 15, 2018. Based on the report, an estimated 1.2 trillion USD of products were counterfeit in 2017. Based on the estimate, global losses are projected to be worth $1.82 trillion USD in 2020. This study does not consider copyrights, online piracy, counterfeiting, or counterfeit documents but technical measures for preventing counterfeiting. The availability of fake products in the European market is increasing; therefore, the participation of inspection teams and authorities alone is not enough; consumers might assist and support this process. In this research, we consider the potential for reducing fake products through machine learning-based technology. Image and text recognition and classification through machine learning can potentially become a key tool in combating counterfeiting.

JINHUA MA et al. put forward this system. Blockchain technology has been paid greater attention to in recent years, leading to the creation of a broad spectrum of applications. Bitcoin, a famous application of blockchain technology, not only efficiently solves the double-spending issue but can also authenticate the validity of transactional information without a central agency. Therefore, any application based on blockchain technology guarantees its data to be tamper-proof. This study employs a decentralized blockchain technology method to make it impossible for customers to solely depend on merchants to ascertain whether products are original or not. We outline a decentralized blockchain system with product anti-counterfeiting functionality that enables manufacturers to utilize the system to provide original things without the necessity of directly operated stores, reducing the cost of product quality control. The trade in counterfeit goods is increasing, reducing sales and profitability for firms affected by the problem.

Naif Alzahrani et al. introduced this system. The global community has been trying to combat the spread of counterfeit products for decades. Counterfeiting remains a major challenge today. The majority of contemporary anti-counterfeiting systems are centralized. Inspired by the development of blockchain technology, we introduce Block-Supply, a decentralized anti-counterfeit supply chain that utilizes both NFC and blockchain technologies. This paper further suggests a groundbreaking, fully decentralized consensus process that, in contrast to the majority of current protocols, does not require PoW and uses instead a random subset of validators of different sizes on every occasion that a new block is assigned. Our method involves the use of a game theory model to select the riskiness of the nodes proposed for the block. The probability of the risk affects the number of validators that are engaged in the consensus process.

Neo C. K.et al. advocated for this system. One fascinating research problem within the supply chain sector is analyzing and authenticating the origin of physical objects that confirm the validity of luxury items such as packaged wine. But most supply chain networks and systems have been developed and deployed with centralized system design, depending on centralized authorities or any type of intermediary, leading to problems like single-point processing, storage, and failure, which can be susceptible to malicious alterations to product records or other possible attacks on system elements by unscrupulous participant nodes passing through the supply chain. Blockchain technology has come a long way from being a distributed, decentralized, and unalterable record of bitcoin transactions to a programmable, interactive platform for building decentralized and trustworthy apps that solve many different problems in the real world. In this research, with a selected research approach of proof-by-demonstration, the Decentralized NFC-Enabled Anti-Counterfeiting System (DNAS) is designed and developed, decentralizing a traditional anti-counterfeiting system of the supply chain sector through blockchain technology to enable reliable data provenance retrieval, verification, and management and enhance the ability of the product's anti-counterfeiting and traceability attributes in the wine sector.

This system was proposed by Neo C. K. et al. Current product anti-counterfeiting and traceability solutions for today's global supply chain networks are designed and implemented using a centralized system architecture with centralized authority or intermediates. System weakness or failure caused by centralized product anti-counterfeiting systems could result in product record susceptibility to malicious adjustment as well as to other system-component attacks from mischievous participant nodes

transversing the supply chain. Blockchain technology has evolved from a basic application of an unalterable record for bitcoin transactions to a programmable, interactive platform for building decentralized and trustworthy apps for a variety of global use cases. This research determines the major areas of decentralization, essential system requirements, and viable mechanisms for building decentralized product anti-counterfeiting and traceability ecosystems based on blockchain technology by performing a series of security analyses against solutions already deployed in the supply chain sector with centralized architecture.

III. PROBLEM STATEMENT

Counterfeiting is a ubiquitous threat to multiple industries, compromising consumer safety, brand image, and supply chain authenticity. The penetration of counterfeit products, including consumer goods such as apparel, electronics, and pharmaceuticals, has reached alarming proportions, and stakeholders throughout the supply chain have called for action. Conventional approaches to combating counterfeiting have been found wanting in the face of changing counterfeit methods and global supply chains. Consequently, it is imperative that shortcomings in current anti-counterfeiting efforts be met and innovative approaches to detect, prevent, and reduce the effects of counterfeits be developed. This definition of the problem highlights the necessity for effective solutions to be developed to protect supply chain operations, consumers, and the integrity of global trade.

IV. EXISTING SYSTEM

Counterfeiting is common in many industries and takes many forms, posing major challenges for supply chain operations. Counterfeiting may occur in a variety of consumer products, including fashion, food and beverages, accessories, pharmaceuticals, technology, and luxury items. Due to continuing supply chain breaches, all stakeholders must work together to tackle counterfeiting threats. Effective traceability appears to be the only way to address this phenomenon while ensuring safe and sustainable supply chain operations. This study presents a structured literature review on traceability approaches for countering product supply chain counterfeiting, which resulted in the creation of a structured classification method. The research aimed to discover trends and best practices that may be used as a reference for real-world supply chain counterfeiting activities. The findings show that traditional traceability measures are inadequate since they may be easily altered with today's technological advances. However, these same breakthroughs enable critical technologies like blockchain and the internet of things, which ensure safe and sustainable supply chain operations.

Drawbacks of the existing system:

Implementing advanced traceability technologies like blockchain and IoT can be complex and require significant financial investment, particularly for small and medium-sized enterprises.

Collecting and storing detailed supply chain data may raise privacy concerns among consumers and stakeholders, especially regarding sensitive information.

Encouraging widespread adoption of new traceability systems across the supply chain may face resistance from stakeholders reluctant to change established processes or invest in new technologies.

Advanced technologies such as blockchain and IoT may introduce new vulnerabilities to cyberattacks, potentially compromising the integrity of traceability data and undermining efforts to combat counterfeiting.

V. PROPOSED SYSTEM

The suggested method has been designed to deal with the common issue of counterfeiting products using a blockchain-based authentication system. With the strength of the SHA-256 algorithm and the openness of blockchain technology, the solution offers a complete platform for preventing counterfeit goods at every level of the supply chain. The system consists of separate modules created for different user types, such as administrators, manufacturers, and customers. The system provides administrators with privileged access to oversee user management and actions on the system, which are securely authenticated through a blockchain. Manufacturers can use the technology to add products to the blockchain ledger in a safe way,

like single-use QR codes for easy authentication. Consumers gain the advantage of rapid access to product information and authentication records on the blockchain, enabling them to rapidly check for product legality by scanning QR codes. The features of the suggested system are intended to generate customer confidence, stop income loss for original producers, and end the market transmission of counterfeit products

A. LOGIN MODULE

Blockchain technology is applied to secure admin and user logins. Admin Login enables admins to manage user accounts and manage system operations with enhanced security and auditability through a distributed ledger. User login enables registered users to access the system securely, while blockchain authentication secures user privacy and bars unauthorized access.

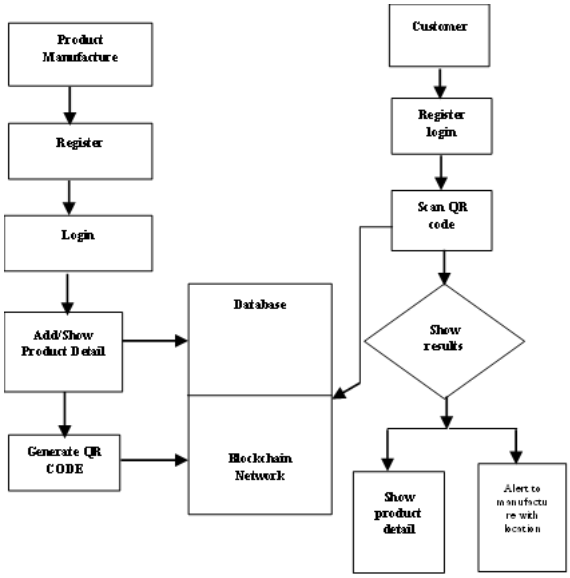

Figure 3 System Flow Diagram

B. USER REGISTRATION MODULE

Enables new users to securely register on the system. User registration data is kept and verified with blockchain technology, which guarantees data integrity and ensures unauthorized access.

C. MANUFACTURER MODULE

VGG16 utilizes 3x3 filter convolutional layers to process 224×224 images in RGB color, which are then processed using three fully connected layers. Convolutional layers can deal with input of any size, whereas fully connected layers need a fixed-size vector, confining adaptability. Our data are 1024×1024 images; thus, reducing to 224×224 results in loss of content and inaccurate data. To counter this, we insert a Spatial Pyramid Pooling (SPP) layer between the final convolutional layer and the first fully connected layer. The SPP layer aggregates features and provides a fixed-size output without scaling, thereby improving identification accuracy. Distributed Ledger (Blockchain): Provides manufacturers with a secure platform to store product information and authentication records. The blockchain ledger provides tamper-proof data storage while safeguarding the integrity and authenticity of product information. Adding items: Manufacturers can add new items to the system, each having a distinct QR code for instant authentication by the end users. QR code use is essential for seamless product verification.

D. CUSTOMER MODULE

The distributed ledger (blockchain) provides customers with the ability to safely view product details and authentication records, promoting transparency and trust. Customers can use the View Product Details feature to examine comprehensive product information and authenticate the product before reaching an informed choice. Customers can use the Scan QR Code function to verify a product's authenticity by scanning the QR code on the product and comparing it to blockchain data. In addition, the View QR Code feature offers a visual cue, enabling customers to see the QR code associated with a product for authentication. Through the use of blockchain technology, the process enhances product verification and prevents counterfeiting. The technique ensures that product information is secure and tamper-proof and enhances consumer trust.

E. ADVANTAGE OF PROPOSED SYSTEM

Uses the SHA-256 algorithm and tamper-resistant blockchain to provide strong authentication.

Empowers customers to authenticate products independently.

Lowers costs involved in revenue loss, product defaming, and replacement.

Protects original producers from financial dangers and maintains brand image.

VI. DETAILS OF THE ALGORITHM

The proposed system employs SHA-256 encryption for a cryptographic safety measure to ensure blockchain records are immune to tampering. Every item comes with an individual QR or barcode, which is hashed via SHA-256 and stored safely on the blockchain. When a consumer scans the item, the system retrieves the stored hash and recalculates it to verify. If the recalculated hash matches the record on the blockchain, then the item is authenticated; otherwise, an alert is sent. The authentication process is facilitated by a camera scanner for user convenience. The decentralization of the blockchain eliminates unauthorized tampering, which in turn increases trust. Finally, public-private key encryption is used to authenticate manufacturer data submission. This method makes the authentication process more reliable, and the counterfeiting possibility is next to impossible.

VII. RESULT ANALYSIS

The proposed SHA-256 secured blockchain system is efficient in combating counterfeit products due to its high evaluation metrics. With correctness of 0.87 and 0.9, it identifies correct objects well and eliminates false positives, thus maintaining customer trust. The recall of 0.9 and 0.87 suggests that it can identify correct products while minimizing non-classification errors. Consistently high F1 ranging from 0.89 to 0.88 provides some kind of balanced method. Moreover, the accuracy of 0.88 gives the overall reliability of the system in detecting product correctness. It delivers a secure and transparent method of authentication, taking advantage of SHA-256 cryptographic security and the anti-tamper technology of the blockchain. These high-performance metrics do reflect its potential to protect producers while enhancing confidence. Lastly, the strategy strengthens confidence, precision, and effectiveness in combating counterfeit products.

CONCLUSION

In conclusion, the use of a blockchain for authentication is very successful and practical by using a blockchain, SHA-256 algorithm, etc. It gives information on safety in terms of authentication and transparency in authentication, which generally provides a high level of user experience. Trust is also one of the key factors that reduces income loss and brand reputation and reduces counterfeit products by the system as well, which is an advantage for both parties. The system has many modules, including the admin, company, and customer modules. The system denies the same user experience with the same system, but these modules have different levels of user rights and different functions.

FUTURE WORK

The next study could focus on additional changes and additives to improve the efficiency and skill of the suggested blockchain authentication system. A possible option to analyze is the inclusion of sophisticated machine learning algorithms to amplify the counterfeit detection function of the system. This will result in a more accurate and quicker counterfeit identification.

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