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Detection of Counterfeit Products with QR Codes using Blockchain Technology

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Abstract*—Supply chain management commonly encounters challenges such as duplicate products and a lack of standardization due to insufficient transparency. This creates problem in the supply chain which takes up valuable time and resources. The presence of counterfeit products adds on to these issues, which are very difficult to distinguish visually from the real ones. This paper focuses on providing a solution to this already existing problem by implementing a QR based detection method which uses blockchain technology. The paper provides a thorough analysis of the current scenario of fake products present in the supply chain management system and proposes a novel method for robust detection. This is achieved using blockchain technology, which guarantees the traceability and identification of genuine products all the way through the supply chain. A Blockchain-based system decentralizes information, allowing multiple parties simultaneous access. Novel advantage of the proposed system is the difficulty of altering recorded data without the consensus of all concerned parties, providing a high level of security and protection against vulnerabilities. This system can be readily integrated into the supply chain to identify fake products that are often used for impersonation or fraud.

***Keywords:* Blockchain, Web3, MetaMask, QRCODE, Ethereum**

I. INTRODUCTION

Counterfeiting of a product occurs when it is deceitfully sold as another item, constituting consumer fraud. This involves deceptive business practices that result in financial losses and other adverse consequences for consumers. According to reports from the Authentication Solution Providers' Association, this illicit practice inflicts an annual cost of INR 1 trillion on the Indian economy. Between 2018 and 2020, incidents of counterfeiting increased by an average of 20%. Counterfeit goods span various categories, including handbags, clothing, cosmetics, and electronics. The repercussions extend beyond the economic realm, impacting citizens directly. For example, a duplicate cosmetic which is sold pretending to be an original one can cause serious damages to the person using it. A fake gadget may cause serious consequences upon its failure. The proposed system keeps these issues in hindsight and provides a solution.

Another consequence of distribution of fake product leads to damage the image of the brand which is imitated by the fake item. The fake product manages to convince many customers that it is a genuine product, leading them to hold the legitimate company accountable if the counterfeit product fails to meet expectations. This often results in customer demanding for compensation, directly from the legitimate company. Businesses affected by counterfeiting may find themselves in challenging situations, managing complaints about the poor quality of items without realizing that the products in question are counterfeit. This dilemma forces companies to navigate the delicate balance of avoiding wasted time and effort on dealing with poor imitations while striving to maintain customer satisfaction.

II. LITERATURE REVIEW

The study builds upon blockchain and NFC technologies to establish a decentralized supply chain, addressing product tracking, tampering detection, and consensus. It proposes a novel consensus protocol optimized for scalability in large networks. While acknowledging ongoing work, future enhancements include applying game theory for probabilistic validation and dynamically adjusting validator numbers based on hostility factors. A limitation is identified regarding biased validation by leader nodes, with some solutions

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involving game theory integration or proof of work.[1]

The study emphasizes the decentralization benefits of blockchain, which makes sure that any local vendor or supplier cannot make changes to product. The paper highlights blockchain's properties of tamper-resistance, data consistency, and confidentiality for secure data storage. The system assures customers of genuine products, reducing counterfeiting, fostering trust between manufacturers and consumers, and suggests broader applications across sectors like banking, healthcare, and online shopping.[2] The study introduces a novel machine learning-based approach for detecting counterfeit products, with an emphasis on deep learning and neural networks. The evaluation reveals limitations, particularly related to training data availability. The research aims to enhance anti-counterfeiting efforts by combining image recognition, faster machine learning algorithms, and web crawling to detect fake products, aiming to empower consumers for increased market transparency and safety.[3] The paper introduces a pioneering Blockchain-based anti-product forgery system, offering users protection against counterfeit products through low transaction fees. It emphasizes transparency in sales information stored on the Blockchain, enabling immediate vendor-side verification and identity authentication using digital signatures. The cost analysis highlights the system's cost-effectiveness compared to traditional methods, providing companies with limited resources a practical means to ensure consumer confidence against counterfeiting.[4] The suggested design introduces a novel approach to enhance user interaction with the Ethereum blockchain by integrating memes and gifs into transactions, aiming to make the process more engaging and enjoyable. Leveraging the MetaMask wallet, the design maintains security while adding a lighthearted touch to the transactional nature of blockchain. The incorporation of popular culture elements seeks to attract a wider audience and foster broader adoption, without compromising blockchain's core principles of decentralization and security [5].

The urgent requirement for anti-counterfeiting measures in supply chain is addressed by the suggested blockchain system based on smart contracts. It makes use of blockchain technology to offer safe and transparent product verification, making it simple for customers to recognize authentic products and reduce the risk of counterfeiting. The solution uses digitalized identity verification and serialized QR codes to guarantee authenticity without depending on other parties. This novel strategy offers an easy-to-use and affordable alternative for industry adoption, while also promising to drastically reduce counterfeit goods and foster customer trust. The research report emphasizes the revolutionary potential of blockchain technology in thwarting counterfeiting and augmenting the effectiveness and safety of transactions and acquisitions.[6] The suggested system makes use of Ethereum smart contracts and blockchain technology to improve supply chain transparency. A user-friendly and effective experience is ensured by the usage of Web3.js for Ethereum blockchain interaction and React for interface design. Through the user's Ethereum wallet, safe transaction confirmation is made possible through MetaMask integration. [7] This study examines how blockchain technology can revolutionize business and industry, emphasizing how it can improve security and transparency in the exchange of financial resources, data, and goods. With an emphasis on logistics, it covers uses for cryptocurrencies and financial services in addition to risk management, the Internet of Things, and public services. The paper demonstrates how blockchain technology allows for secure product monitoring and verification throughout the supply chain, improving efficiency and sustainability through case studies and ongoing implementation projects. The study focuses on how blockchain can help logistics operations save money, time, mistakes, and fraud. It calls for more study and development in its conclusion, underlining the enormous potential of blockchain technology in overcoming obstacles and fostering innovation in the logistics industry.[8]

The authors stress the need for a more robust legal framework and discuss important issues related to counterfeiting in a variety of industries. With its capacity to guarantee existence and enhance data management, they promote blockchain's potential to improve public administration, notary services, and governance. The authors emphasize blockchain technology's diverse possibilities for enhancing numerous industries and call for more research into how it might improve e-business performance and supply chain security.[9] The study offers a supply chain management architecture for traceable Cyber-Physical Systems (CPS), with a focus on improved product safety and quality using data analytics and supply chain monitoring. It presents a Multi-Agent System (MAS) simulation that estimates probability density functions throughout the supply chain operations to predict product conformance. The article proposes a novel association rule mining technique to identify anomalous product behavior, with a focus on the cosmetic supply chain. To address concerns about processing time, the authors suggest a MapReduce framework for parallelizing computing to address issues with frequently occurring pattern mining techniques. Through parallelized frequent pattern computation, this novel solution addresses scalability difficulties and promotes effective supply chain management [10].

This article performs a thorough analysis of blockchain privacy-preserving solutions, highlighting important issues including transaction link-ability and GDPR compliance. It examines current methods, such as homomorphic concealing, and talks about how they might be used in a variety of settings, including eGovernment, eHealth, and smart cities. To improve privacy usability and compliance, the paper emphasizes the shortcomings of present blockchain solutions in handling privacy issues comprehensively. Instead, it underscores the necessity for effective crypto-privacy algorithms and cutting-edge research projects. The study emphasizes how crucial it is to develop zero-knowledge methods and create quantum-resistant ledgers to improve privacy-preserving features, particularly in difficult situations like the Internet of Things.[11] This article discusses current platforms and provides an overview of Blockchain-based Online social media (BOSM),

emphasizing both social and technological aspects. It points up problems with the current BOSM platforms, especially regarding privacy and content visibility. [12]

The need of efficient traceability in addressing supply chain counterfeiting issues is emphasized in this study. It talks about how traditional approaches are insufficient and emphasizes how cutting-edge technology like blockchain and IoT may help fight counterfeiting. The study highlights the significance of heightened governmental oversight and measures to establish secure and enduring supply chains, with the policies of the European Union serving as a prime example. To reduce the danger of counterfeiting and boost competitiveness, supply chain stakeholders, legislators, and businesses should use the paper as a reference for implementing traceability solutions. Prospective research avenues encompass in-depth examination of product supply chains and more investigation of efficacious traceability methodologies, ultimately leading to the deployment of sophisticated traceability systems, as typified by the wine and spirits industry.[13] The paper examines the state of blockchain-powered sustainable manufacturing and assesses possible effects from the standpoints of manufacturing systems and product lifecycle management. The report contributes by outlining twelve evaluation measures for blockchain adoption in manufacturing and identifies technical, social, cultural, and regulatory concerns. It draws attention to how blockchain is still in its early stages of being used in sustainable manufacturing, highlighting the urgency of moving past proofs-of-concept and addressing pressing issues related to industrial energy saving. To ensure that energy-saving gains are realized, the article emphasizes the significance of identifying certain indicators and related costs before to deploying blockchain in sustainable manufacturing systems. It also promotes ongoing monitoring.[14]

This paper offers a comprehensive analysis of blockchain-based traceability solutions through a review of previous research, highlighting its potential to increase supply chain transparency through monitoring and tracing features. Although these solutions are becoming more and more popular in many supply chains, especially in the food and pharmaceutical industries, actual implementations are still uncommon. One major factor expected to propel the advancement of blockchain applications in supply chain management is integration with IoT and smart contracts. The bulk of documented applications, however, are conceptual, highlighting the necessity for empirical study to provide a quantitative analysis of their advantages.[15]

III. METHODOLOGY

Manufacturers are important system players who initiate the process. Manufacturers must create QR codes and include pertinent information for each product. Then, using Ethereum wallets for authentication, this vital data is safely added to the blockchain. The next step is for sellers, who are represented in the system as suppliers. Sellers’s use QR codes to obtain relevant information entered by manufacturers. They are essential in keeping the blockchain updated with new data, such the product's destination, which improves the supply chain's overall openness. As the end users who engage with the system, consumers are in the forefront of maintaining product integrity. Customers can check the legitimacy of products and view the transaction history by scanning QR codes. This gives businesses the ability to spot any counterfeit goods and alert authorities if they see any discrepancies. Customers' involvement in the system is essential to its effectiveness.

The foundation of the entire approach is the underlying blockchain interaction. Reliability and security are reinforced by data storage on every node, information sharing throughout the network, and thorough transaction verification prior to inclusion into new blocks. As the backend blockchain system that supplies the infrastructure required for deployment, Ethereum takes center stage.
Manufacturers and suppliers are governed by solidity contracts, which guarantee safe and uniform transactions on the blockchain. Thorough testing is done on local networks, ganache in particular, to confirm that the solution functions as intended in the Ethereum blockchain context. Important roles that are deeply woven into the system's structure are Manufacturers, Sellers, and Consumers. Each of these roles is given distinct responsibilities that enhance the system's overall effectiveness.

It is therefore crucial to validate the proposed system to guarantee exact and accurate transaction recording on the Ethereum blockchain, as well as safe interactions between stakeholders. The entire blockchain-based anti-counterfeiting system's efficacy and dependability are measured by this painstaking validation procedure. As a result, the technique emphasizes the significance of each phase in the flow, leading to a thorough and safe solution to stop supply chain counterfeiting. The flowchart (Fig. 1) is mapped to ensure proper flow for the proposed system.

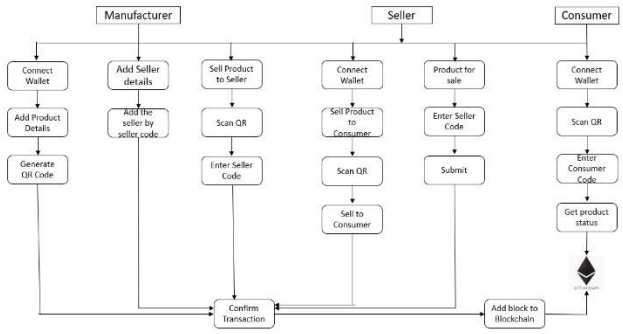

Fig 1: Flowchart

Manufacturer:
The manufacturer of the product will create a QR code for the product and will add the necessary information which is required using Ethereum wallet which will then add a block to the Ethereum blockchain.
The entity's wallet address and User ID from the local database will be mapped together.
Supplier:

The supplier will scan the product's QR code. The seller can access information that the manufacturer has entered about the products. It pushes the merchandise into the Blockchain and adds its own details, such as the seller code. The buyer has access to those facts.

Customer:

The customer can get history of transactions whenever he will scan the QR code. This is used to check whether the product is genuine or not. If the final code does not match the purchase code when the consumer purchases the product, the customer will become alert that the product is a fake one. The consumer will realize it is a fake product and refrain from buying it.

IV. Result And Discussion

In the proposed system only manufacturers and suppliers have the capacity to contribute their transaction details to the blockchain independently, preserving the integrity of each block without altering others.

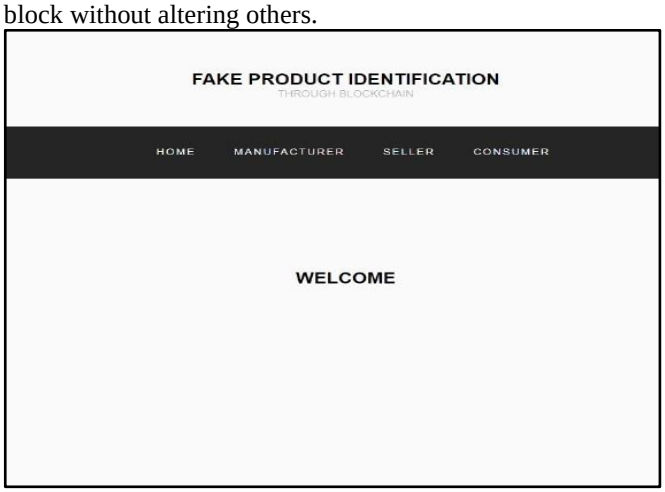

Fig 2: Homepage

Users can navigate options based on their roles as a manufacturer, seller, or consumer from the home screen (Fig. 2), which acts as a gateway to a secure and seamless ecosystem.

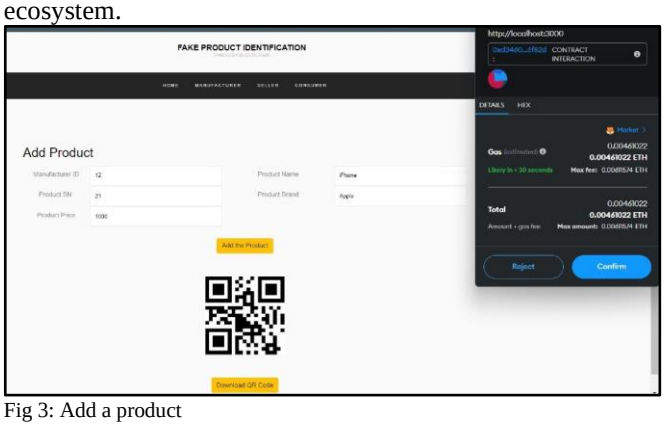

Fig 3: Add a product

The user-friendly interface as shown in Fig.3 allows the fake product detection system to interact with the Ethereum blockchain seamlessly. Using the Web3.js library, users can carry out necessary tasks like adding product information (manufacturer, serial number, name, brand, and price) and starting transactions by simply clicking the "Add Product" button. By integrating the MetaMask wallet into the browser, users can import accounts from Ganache for transaction confirmation, thereby acting as a secure gateway to the Ethereum blockchain. Manufacturers and suppliers can now contribute to the blockchain more quickly by using MetaMask to confirm their transactions, thanks to this simplified process. Additionally, end users can quickly confirm the originality of the item by downloading a QR code and scanning it to view all supply chain data.

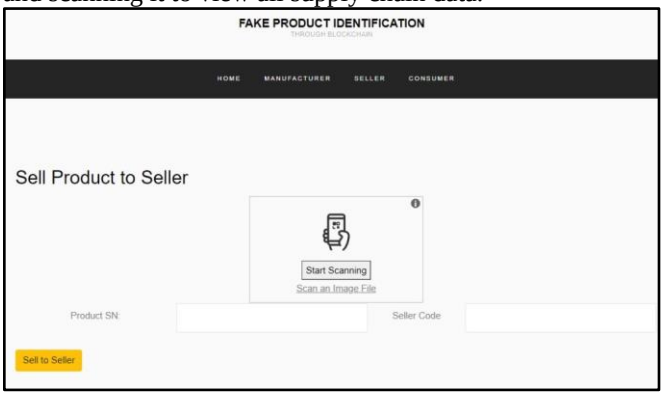

Fig 4: Sell Product

Combating fake goods has been transformed by this product verification system, which includes an embedded QR code produced during the submission of manufacturer details. Consumer codes and product serial numbers, among other important data, are easily uploaded by users via a QR code as shown in the Fig.4. The system instantly confirms the product's legitimacy when you click the "Get Product Status" button, providing a prompt result. The output is crystal clear and definitively states whether the product is real or fake as shown in Fig.5, answering any doubts about its authenticity. The supply chain's credibility is increased since this real-time validation guarantees that customers only receive authentic products.

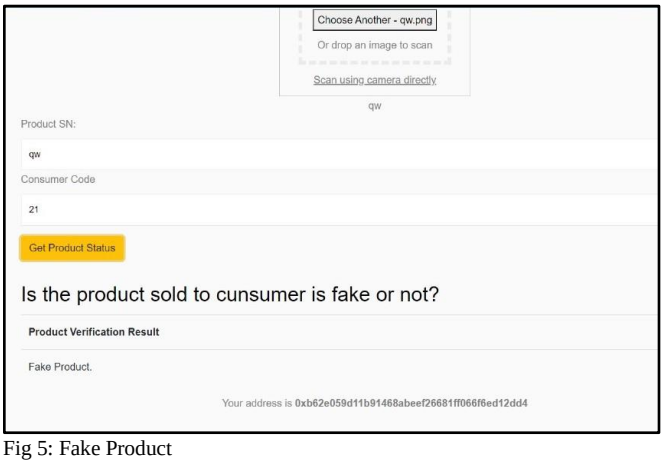

Fig 5: Fake Product

Using Solidity, contracts for manufacturer and supplier blocks are composed, and local testing is facilitated through the Ganache network. The Ethereum Network, along with Truffle and Web3.js, is employed for contract compilation and deployment. The React library is utilized to create the

interface, and MetaMask serves as the Ethereum wallet within the browser.

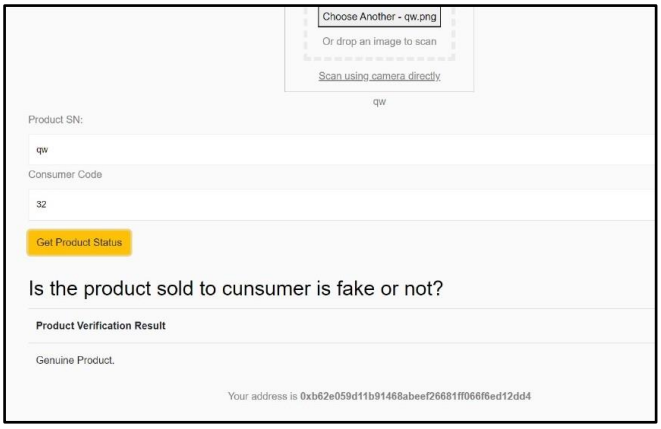

Fig 6: Genuine Product

The platform makes the process of selling products to sellers simple and streamlines transactions. By providing the seller code and product serial number, users can start a transaction by clicking the "Sell to Seller" button as shown in Fig.4. Moreover, image file scanning is supported by the platform, enabling users to quickly start the effective verification process. The selling process is made simpler by this intuitive interface, which also guarantees a safe and open transaction between the parties. The addition of these features demonstrates the commitment to building a dependable and easy-to-use platform for product transactions and verification inside the blockchain ecosystem. If the product is genuine the system will give output as “Genuine Product” as shown in Fig. 6. Customers, suppliers, and manufacturers are all included in the account structure. Manufacturers begin the process by issuing product QR codes and unique serial numbers after logging into their Ethereum accounts via MetaMask. The product details are then appended to these QR codes and added to the blockchain. MetaMask confirmation is used in the process to authenticate transactions. In contrast, suppliers add new blocks to the blockchain by logging into their accounts, scanning QR codes, and entering pertinent product details. There are several suppliers, so this process is repeated. The final consumer can access the entire supply chain history by scanning the QR code which is present on the product.

V. Conclusion And Future Scope

The proposed blockchain-enhanced fake product detection system has shown to be a reliable means of guaranteeing the authenticity and traceability of the products. The integrity of each block is maintained by the independent contribution of transaction details to the blockchain by suppliers and manufacturers. Users can add product information and start transactions to the intuitive interface and Web3.js and MetaMask’s smooth connection with the Ethereum blockchain. By using QR code verification for real-time validation, supply chain credibility is increased and consumers are guaranteed to receive only authentic products.

The platform's technological soundness is further demonstrated by the integration of Ethereum Network deployment, Ganache for local testing, and Solidity contracts. All things considered, the system effectively fights counterfeit goods, expedites the product verification process, and promotes supply chain transparency.

Additionally, the proper platform simplifies the selling process for sellers, which has an impact on the transactional side as well. A safe and effective exchange is guaranteed by providing an easy-to-use interface for the entry of seller codes and product serial numbers. The dedication to user convenience is demonstrated by the improvement of the verification process through the support for image file scanning. The account structure considers suppliers, consumers, and manufacturers, each of whom has a specific responsibility for maintaining the integrity of the product. The proposed system's decentralized as well as transparent design gives customers access to extensive supply chain histories, empowering them to make well-informed purchases. Essentially, the platform revolutionizes the dynamics of product transactions overall and not only meets the pressing need for counterfeit detection, but it also establishes a reputation for dependability and trust in the market.

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