Grenze International Journal of Engineering and Technology, January Issue

Blockchain Powered Fake Product Identification: A Smart Contract and QR Code Approach to Combat Counterfeiting

Shivakumara T[1], Muneshwara M S[2], Amaresh K[3], Shweta Deshpande[4], Santhosh G[5] and Sukesh H A[6]
[1,5]Dept. of MCA, BMSIT&M, Yelahanka, Bengaluru, Karnataka, India
Email: shivakumarat@bmsit.in. santu73g@gmail.com
[2]Dept. of CSE, BMSIT&M, Yelahanka, Bengaluru, Karnataka, India
Email: muneshwarams@bmsit.in.
[3]Dept. of ISE, Atria Institute of Technology, Bengaluru, Karnataka, India
Email: amareshkalman-gi94@gmail.com
[4]Research Scholar, Bengaluru
Email: pethkarshweta@gmail.com
[6]Dept. of CSE, SEACET, K R Puram, Bengaluru, Karnataka, India
Email: sukesh.seacet@gmail.com

Abstract— **In the contemporary market, counterfeit products undermine consumer trust, compromise brand integrity, and pose substantial risks to public safety. This work addresses this pervasive issue by presenting an innovative Fake Product Identification System that leverages the immutability and transparency of blockchain technology. The core functionality involves the creation and utilization of smart contracts, which securely store crucial product identification details.**

The system's implementation utilizes key technologies, including Truffle for smart contract development, Ganache for local blockchain setup, and Web3.js for seamless interaction with the blockchain network.

To establish a secure and user-friendly environment, the system is designed to work with Chromium-based browsers, with the Metamask extension facilitating secure transactions and interactions with the block-chain. As part of the deployment process, QR codes are generated, providing end users with a fast and easy way of determining the legitimacy of a product. The success of the work is proved through good testing and analysis, which proves its ability to successfully prevent counterfeit attempts and increase the general level of marketability of products.

In addition to proposing a workable means to prevent counterfeiting, the proposed system offers the foundation for further developments in counterfeiting prevention. In addition to solving the immediate problems that arise because of counterfeiting, the use of blockchain technology furthers the dialogue concerning safe and open product identification in a range of sectors. This work utilises blockchain technology to create a reliable and safe marketplace for product identification, combating counterfeit goods and ensuring authenticity.

Index Terms— **combat, counterfeit, ganache, blockchain, product, fake.**

Grenze ID: 01.GIJET.12.1.315

I. INTRODUCTION

This study proposes a novel "Fake Product Identification System" (FPIS) that utilises smart contracts and blockchain technology to help securely store and manage product identification data. The system provides an immutable and transparent ledger, ensuring product authenticity throughout the supply chain. With features like QR code verification and MetaMask integration, the system enables easy and secure product validation. By leveraging blockchain technology, the system reduces the risk of fraud and tampering, fostering trust between consumers and businesses. The FPIS has significant technical and broader implications, contributing to a transparent and safe marketplace. This initiative aims to boost consumer confidence and enhance company resilience against counterfeit risks.

II. LITERATURE SURVEY

Francisco et al. (2018) found that blockchain technology can boost product authenticity and supply chain transparency by creating an immutable record of transactions visible to all participants. Their research showed that blockchain is effective in anti-counterfeiting efforts, increasing traceability and reducing fraud. This makes it an ideal solution for enhancing supply chain security and trust.

Kshetri (2018) explored blockchain's potential in eliminating counterfeit goods globally, highlighting its applications and security benefits, particularly when combined with IoT and mobile technologies [1]. This integration creates a trustworthy ecosystem. Meanwhile, Tian (2016) proposed a blockchain-based tracking system for the food supply chain, showcasing blockchain's potential in product lifecycle tracing and utilising smart contracts to automate verification and reduce counterfeiting risks [2].

Kim and Laskowski (2018) developed a blockchain-based system for verifying electronic parts, utilis-ing QR codes to access blockchain information and track product movement and origin in real-time, demonstrating the approach's scalability and practicality [4]. Bozic and Pucihar (2021) found that con-sumers trust companies that use blockchain technology for product authentication, particularly when combined with technologies like QR codes that provide quick access to verification information [5]. Casino et al. (2019) reviewed over 100 blockchain applications in supply chains, concluding that blockchain's decentralised and cryptographic properties make it a reliable medium for preventing for-gery, and emphasising the importance of integrating it with front-end technologies like RFID or QR codes [6]. Dwivedi et al. (2020) examined the benefits and challenges of using blockchain technology in anti-counterfeiting systems [7].. Although blockchain is far secure and transparent, the authors high-lighted that the low adoption rate is due to issues that need to be solved such as high transaction costs and regulatory uncertainty when blockchain is adopted widely [7].

Underwood (2016) explored the use of blockchain in supply chain enterprises. The author emphasized that the technology of blockchain could be applied to establish products' unchangeable records, and help businesses to fight illegal change and counterfeit commodities in international markets [8]. A well-written research study about blockchain technology application in sustainable supply chain man-agement, put by Saberi et al. 2019. They also laid emphasis on how blockchain provides data transpar-ency, reduces fraud and provides end-to-end traceability that serves as the cornerstone of identifying and eliminating counterfeit goods [9]. Mettler (2016) proposed the concept of blockchain technology for healthcare supply chain. Although this research was specific to the domain of food trading, it pro-vided insight into the effective use of blockchain-based secure and traceable records to prevent coun-terfeit medicines, which is a major problem in the pharmaceutical industry [10].

Kamble, Gunasekaran and Dhone (2020) reviewed the impact blockchain could have on improving the security and trust of a manufacturing supply chain. Their work supports the proposition that block-chain technology significantly reduces the introduction of counterfeit components in conjunction with unique product identifications such as QR codes [11]. Chen et al. (2020) have examined the use of blockchain-enabled QR codes in supporting intelligent traceability systems. A prototype system al-lowed customers to verify product information via QR code, reducing fraud risk by accessing block-chain-based data [12]. Sharma et al. (2020) created a blockchain model for tracing agricultural prod-ucts, utilising smart contracts for automated data entry and QR codes for customer access to supply chain information [13].

Abeyratne and Monfared (2016) proposed using blockchain in manufacturing for permanent record-keeping to track product lifecycles, laying the groundwork for anti-counterfeit solutions [15]. Cole et al. (2019) explored blockchain adoption in the fashion industry, finding that QR codes can verify product origin and authenticity, protecting brand reputation [14]. Yadav and Singh (2020) developed a blockchain-based system with QR code scanning for product verification, allowing users to scan codes and store product info on a permissioned blockchain [16]. Treiblmaier (2018) discussed blockchain's potential in supply chain management, highlighting its decentralized control and immutable data stor-age for global product tracking and authentication [17]. Kamble et al. (2019) confirmed blockchain's efficacy in providing visibility and traceability, essential for identifying and preventing counterfeit goods in supply chains [18].

Montecchi, Plangger, and Etter (2019) analyzed blockchain's potential to promote trust in combating fake goods and their impact on companies. In order to promote the verification of products in real time, they proposed to have blockchain technology integrated with easy-to-use applications such as QR codes [19]. Quick response (QR) code: This is incorporated into a blockchain-based anti-counterfeit solution put forth by Patel and Patel (2021) to improve product authentication security and transparen-cy. Every stage of the product life from manufacture to delivery could be recorded on a distributed ledger based on its system architecture [20].

III. Existing System

The majority of product verification in the conventional supply chain and retail settings relies on static barcodes or QR codes printed on product packaging. Usually, these codes only hold a small amount of data, like the product ID or manufacturer information. But counterfeiters can easily copy, alter, or re-print them. Users lack a trustworthy method to confirm a product's authenticity because the stored data is neither securely protected nor dynamically updated. The tracking of a product's path from produc-tion to sale is also opaque, making it challenging to identify the times and locations of counterfeiting. Furthermore, centralized databases—which are susceptible to data manipulation, hacking, and single points of failure—are the foundation of current systems.

IV. Proposed System

To guarantee a safe and open method of product verification, the suggested system combines block-chain technology with QR code authentication. A distinct QR code that connects to an unchangeable blockchain record is given to every product. The product's origin, manufacturing date, ownership trans-fers, and transportation history are all included in this record. The system retrieves real-time product information straight from the Blockchain when a user scans the QR code with a mobile app or website, guaranteeing that the information is genuine and impenetrable by unauthorized individuals. With this method, the dangers of centralized databases are removed, and it is practically impossible for counter-feiters to duplicate legitimate product credentials. Using blockchain improves accountability, trust, and traceability throughout the supply chain.

The main focus of the project is the creation and application of a Fake Product Identification System intended to address the widespread problem of fake goods in a variety of industries. Fundamentally, the system makes use of blockchain technology's revolutionary potential, particularly smart contracts, which are used to safely store and handle important product identification information. The technology aims to provide a transparent and immutable version of the truth by locking product information in a public and tamper-proof ledger of accounts called blockchain, enhancing the authenticity of products and minimizing the risks and hazards associated with the proliferation of counterfeit goods.

Key aspects of the work's technological base are Web3.js to communicate seamlessly with the block-chain network, Ganache for the local setup of the blockchain and Truffle for smart contract develop-ment. This combination approach ensures that there will be a robust and comprehensive defense against the continually sophisticated techniques of counterfeiters. By producing QR codes as a de-ployment process, end users can easily verify the legitimacy of products. Additionally, the system is integrated with Chromium based browsers to enable secure transactions and blockchain interactions using the MetaMask extension.

The system design of the project on the identification of fake products consists of a painstaking combi-nation of elements from web development and blockchain technologies, and is designed to create a safe, open and easy-to-use environment for product identification. The main part of the architecture is a decentralized smart contract in Solidity, which ensures that product information is unchangeable and impenetrable. It is within the de-deployment phase that a powerful development framework, Truffle, comes into center stage and compiles and deploys smart contracts easily. Before transferring to a live network, developers can practice and test their smart contracts in a controlled testing environment on a private blockchain network made possible with the Ganache. Web3.js is a JavaScript library that pro-vides an interface to help the web interface communicate with the blockchain easily. The user's point of access to the system is the web interface, which was developed using the markup languages of web programming: the combination of CSS and JavaScript, which is known as the ABC of web development. Users can register new products or confirm the legitimacy of already-existing ones using this interface. An additional degree of convenience and security is provided by the incorporation of the browser ex-tension Metamask, which enables users to safely manage their wallets and sign transactions. The entire system is

architected to prioritize user experience, ensuring that product identification processes are not only secure but also intuitive and accessible. With the integration of these technologies, the system design fosters an ecosystem where trust in product authenticity is paramount, reshaping the landscape of product identification through the lens of blockchain innovation
This architecture ensures loose coupling between components, real-time responsiveness, and support for secure, role-based operations.

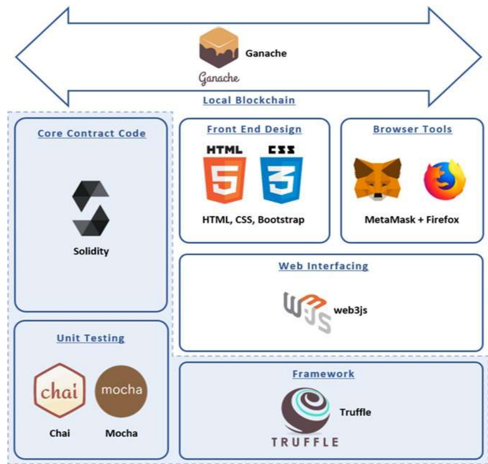

Figure 1. System Architecture

V. METHODOLOGY

The deployment of the Fake Product Identification System was a good example of how blockchain technology and QR code authentication can be used to prevent counterfeited goods. With each entry being permanently stored on the blockchain, the system allowed manufacturers to safely register their products. By scanning QR codes, customers could instantly confirm authenticity, and the information they obtained matched the blockchain's records, guaranteeing tamper-proof validation.

A. Platform Workflow

The workflow of the Fake Product Identification System begins with user authentication, where manu-facturers and consumers securely access the platform through a web interface integrated with Meta-Mask for wallet management and transaction signing. Once authenticated, the manufacturer registers product details such as the product ID, batch number, name, price, and manufacturing date. These de-tails will be recorded on the blockchain using smart contracts that were developed in Solidity and de-ployed in Truffle. The results, after a successful registration process, the system issues a special QR code that is placed on the packaging of the product and links directly to the entry in its blockchain.
After making a purchase, customers can use the web application to scan the QR code and make sure to buy a legitimate product. For that, the application accesses the blockchain through Web3.js and communicates with the blockchain to obtain the corresponding product record. The product is only displayed as authentic if it matches the information in the blockchain, otherwise the system displays fake. The process gains a safe, simulated blockchain environment in which transactions can be tested and validated through a Ganache during this procedure. Event logs provide accountability and tracea-bility throughout the supply chain, and smart contracts ensure immutability and prevent the illegal change or duplicate entry in the chain. Thus, the platform creates a transparent, impenetrable, and easy-to-use ecosystem for verifying products, which increases the confidence of customers and protects the brand.

B. Functional Outcomes

The effectiveness of the Fake Product Identification System in preventing the counterfeit products were confirmed by number of useful results. With the assistance of smart contracts, the system essen-tially enabled manufacturers to input details of products on the blockchain, ensuring that each was transparent and un-amendable. manufacturers, sellers, consumers.

C. Performance Evaluation

Since all test cases involving authentic QR codes showed accurate product details and invalid or tam-pered QR codes were consistently identified as counterfeit, the system demonstrated high accuracy. Boundary value analysis and unit testing verified that the system could successfully manage both typi-cal and extreme input scenarios.

In terms of efficiency, verification requests are executed in real time with negligible delay, owing to the use of Ganache for blockchain simulation and Web3.js for optimized interaction. Average response times for QR code scans remained under two seconds, ensuring a smooth user experience.

The system demonstrated promising scalability. During load testing with multiple product registrations and simultaneous QR scans, the platform maintained stable performance without significant increases in latency. However, evaluation indicated that migration to a public blockchain may introduce transac-tion fees and latency, suggesting the need for optimization in large-scale deployments.

From a security standpoint, the blockchain's immutable ledger and smart contracts effectively prevent-ed tampering, duplicate entries, and unauthorized data modifications. All critical test cases involving attempted record manipulation failed as expected, reinforcing system reliability.

D. Security and Data Integrity

The Fake Product Identification System ensures security and data integrity through a combination of blockchain immutability, cryptographic mechanisms, and controlled access methods. All product in-formation is stored on the blockchain using smart contracts, ensuring that once data is recorded, it can-not be altered or deleted. This immutability safeguards against tampering and unauthorised modifica-tions. Each transaction is cryptographically signed and verified through MetaMask, providing secure authentication and preventing fraudulent activities.

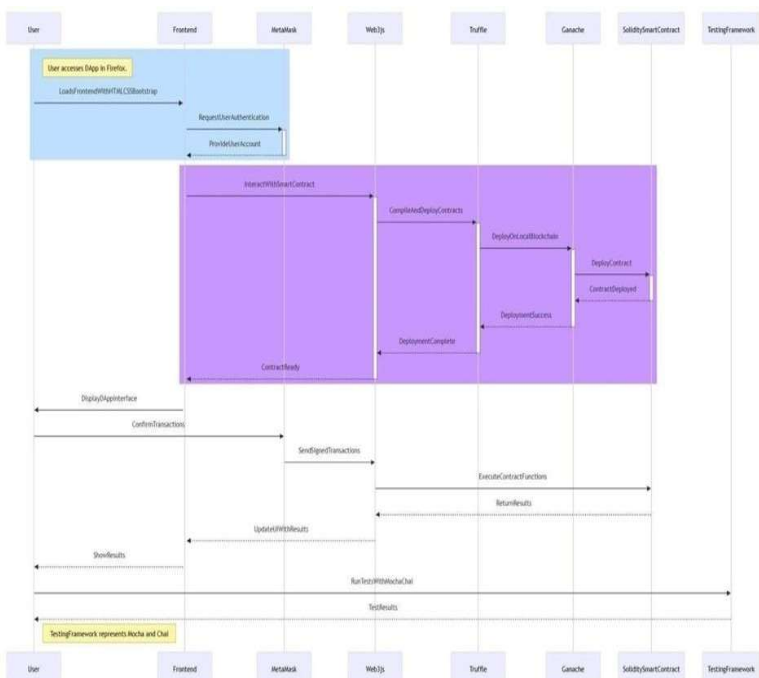

Figure 2. Sequence Diagram

Developed with the help of the programming languages HTML, CSS, and JavaScript, thus the interface offers a neat and organized presentation of information, so users can navigate it with the minimum amount of technical knowledge.

E. Scalability and Maintainability

The system is scalable as it can take the load of more and more product registrations and verification requests through blockchain technology. Testing on Ganache revealed that it performs well under con-current requests.

One of the advantages for large-scale adoption is the support of modular design, thereby simplifying switching to public and consortium-based Ethereum networks. The architecture is left open to lower the latency and transaction fees by adjusting to Layer-2 solutions or private block-chains. Reusable smart contract components and a separate frontend and backend to maintainability in the modular and tiered structure of the system. Effective maintenance and upgrades are also aided by proper documentation and version control.

VI. Conclusion and Future Work

This work presents a new concept of a Fake Product Identification System with the help of blockchain technology that can prevent counterfeiting and guarantee the authenticity of the products. The system's implementation of smart contracts, Truffle, Ganache, and Web3.js allows a secure and transparent plat-form for the identification of products. The QR code-based verification process makes it easy for end-users to know the legitimacy of a product. The success of the system is shown through extensive testing and analysis of the system and its potential for enhancing the marketability of products and countering attempts at counterfeiting it. This work contributes to the creation of secure and open systems for iden-tifying products, providing a secure and safe market place for customers and companies.

References

[1] N. Francisco and D. Swanson, “The Supply Chain Has No Clothes: Technology Addition of Blockchain for Sup-ply Chain Transparency,” Logistics, vol. 2, no. 1, p. 2, Mar. 2018, doi: 10.3390/logistics2010002.

[2] N. Kshetri, “1 The emerging role of Big Data in key development issues: Opportunities, challenges, and con-cerns,” Big Data for Development, pp. 12–24, 2017, doi: 10.1016/j.telpol.2017.09.003.

[3] F. Tian, “An agri-food supply chain traceability system for China based on RFID & blockchain technology,” in 2016 13th International Conference on Service Systems and Service Management (ICSSSM), Kunming, China, 2016, pp. 1–6, doi: 10.1109/ICSSSM.2016.7538424.

[4] H. M. Kim and M. Laskowski, “Toward an ontology-driven blockchain design for supply-chain provenance,” Intelligent Systems in Accounting, Finance and Management, vol. 25, no. 1, pp. 18–27, Jan. 2018, doi: 10.1002/isaf.1424.

[5] K. Božič and A. Pucihar, “Trust in a Blockchain-Based Supply Chain,” Electronic Markets, vol. 31, pp. 1–13, 2021, doi: 10.1007/s12525-021-00480-y.

[6] F. Casino, T. Dasaklis, and C. Patsakis, “A systematic literature review of blockchain-based applications: Current status, classification and open issues,” Telematics and Informatics, vol. 36, pp. 55–81, Mar. 2019, doi: 10.1016/j.tele.2018.11.006.

[7] Y. K. Dwivedi et al., “Blockchain technology for combating fake news: A review and research agenda,” Infor-mation Systems Frontiers, vol. 23, pp. 1–14, 2021, doi: 10.1007/s10796-020-10067-4.

[8] S. Underwood, “Blockchain beyond bitcoin,” Communications of the ACM, vol. 59, no. 11, pp. 15–17, Oct. 2016, doi: 10.1145/2994581.

[9] S. Saberi, M. Kouhizadeh, J. Sarkis, and L. Shen, “Blockchain technology and its relationships to sustainable supply chain management,” International Journal of Production Research, vol. 57, no. 7, pp. 2117–2135, Apr. 2019, doi: 10.1080/00207543.2018.1533261.

[10] M. Mettler, “Blockchain technology in healthcare: The revolution starts here,” in 2016 IEEE 18th International Conference on e-Health Networking, Applications and Services (Healthcom), Munich, Germany, 2016, pp. 1–3, doi: 10.1109/HealthCom.2016.7749510.

[11] S. Kamble, A. Gunasekaran, and R. Dhone, “A digital supply chain framework: A simulation approach,” Inter-national Journal of Production Research, vol. 58, no. 8, pp. 2392–2412, 2020, doi: 10.1080/00207543.2019.1668070.

[12] Y. Chen, Z. Li, and Y. Chen, “Design of traceability system for agricultural products based on blockchain and QR code,” IEEE Access, vol. 7, pp. 96546–96554, 2019, doi: 10.1109/ACCESS.2019.2928230.

[13] P. Sharma, A. J. Singh, and M. K. Sharma, “Blockchain-based traceability system for food supply chains,” Journal of Cleaner Production, vol. 277, p. 123144, Dec. 2020, doi: 10.1016/j.jclepro.2020.123144.

[14] S. A. Abeyratne and R. P. Monfared, “Blockchain ready manufacturing supply chain using distributed ledger,” International Journal of Research in Engineering and Technology, vol. 5, no. 9, pp. 1–10, Sept. 2016, doi: 10.15623/ijret.2016.0509001.

[15] R. Cole, E. Stevenson, and L. Aitken, “Blockchain technology: Implications for the fashion industry,” Business Horizons, vol. 62, no. 5, pp. 623–632, Sept.–Oct. 2019, doi: 10.1016/j.bushor.2019.05.003.

[16] V. Yadav and A. Singh, “Blockchain-based framework for supply chain traceability: A case example of textile and clothing industry,” Computers & Industrial Engineering, vol. 153, p. 107130, May 2021, doi: 10.1016/j.cie.2020.107130.

[17] H. Treiblmaier, “The impact of the blockchain on the supply chain: A theory-based research framework and a call for action,” Supply Chain Management: An International Journal, vol. 23, no. 6, pp. 545–559, 2018, doi: 10.1108/SCM-01-2018-0029.

[18] S. Kamble, A. Gunasekaran, S. Parekh, and R. Venkatesh, “Modeling the blockchain enabled traceability in agriculture supply chain,” Computers & Industrial Engineering, vol. 135, pp. 382–395, July 2019, doi: 10.1016/j.cie.2019.06.024.
[19] M. Montecchi, K. Plangger, and M. Etter, “It’s real, trust me! Establishing supply chain provenance using block-chain,” Business Horizons, vol. 62, no. 3, pp. 283–293, May–June 2019, doi: 10.1016/j.bushor.2019.01.008.
[20] P. Patel and H. Patel, “Blockchain-Based Anti-Counterfeit System for the Supply Chain Using QR Code,” Inter-national Journal of Innovative Research in Science, Engineering and Technology, vol. 9, no. 6, pp. 5758–5765, June 2020, doi: 10.15680/IJIRSET.2020.0906171.