Tracing Authenticity: A Blockchain and NFT-Based Approach to Product Verification

[1]Brhan Zelalem Tsegaye, [2]Dan Kassa Mekonnen, [3]Mikre Hailemariam Sahle, [4]Natnael Girma Fisseha, [5]K. S Arvind

[1,2,3,4]Student, [5]Assistant Professor
Computer science and engineering- Software engineering
Jain university
Bangalore, India.

***Abstract*- Counterfeiting of products has been a persistent issue for decades. It is a growing concern, particularly in the luxury goods and high-tech electronics industries. [1] Traditional methods of product verification are often ineffective, as they can be easily replicated by counterfeiters[2] Although traditional approaches like RFID tagging have been implemented in the past to stop non real product, the recent advancements in technology have led to the development of more efficient and secure solutions. The article outlines a strategy for using blockchain technology and NFT to stop product fraud. The proposed system employs a decentralized network of nodes to authenticate product information, making it difficult for attackers to manipulate data. Blockchain technology provides a secure and tamper-resistant platform for tracking and verifying the authenticity of products [3] Non-Fungible Tokens (NFTs) offer a unique and verifiable digital identity that can be linked to physical products, providing an additional layer of authentication. [4] Our proposed method guarantees high levels of security and is easily scalable. The system is made to be affordable and simple to use, making it the perfect option for businesses. Several studies have demonstrated the potential of blockchain and NFTs for product verification in different contexts (Jiang et al., 2019; Liao et al., 2019). By providing a secure and transparent supply chain, blockchain and NFTs can enhance consumer trust and protect the reputation and profits of legitimate manufacturers and retailers. The results of our experimentation demonstrate the effectiveness of the proposed system in preventing counterfeit products. Overall, the system presents a reliable and practical solution for authenticating products and preventing counterfeiting.**

***Index Terms*- Blockchain, Non-fungible tokens (NFTs), Decentralised ledger, Cryptography.** *(key words)*

I. INTRODUCTION

Counterfeiting branded goods is a challenging and significant problem in both domestic and international markets. The issue has been acknowledged for over ten years, with the OECD estimating in 2007 that counterfeit products in global trade could potentially reach $250 billion. [5] The swift advancement of e-commerce and i-commerce has created an immediate need for the creation of systems that can combat counterfeit products.

These days, the rise of counterfeiting has created a growing need for effective and efficient solutions to combat this issue. Counterfeiting not only leads to huge economic losses but also poses a significant threat to consumer safety, as counterfeit products may not meet required safety standards. In response to this challenge, various technologies such as RFID tags have been employed in the past to prevent counterfeiting. However, these solutions have faced numerous challenges, such as high costs, limited scalability, and vulnerabilities to tampering. Blockchain technology has been a promising deterrent to counterfeiting over the past few years.

Blockchain technology is a networked ledger system that allows transactions secure, transparent, and free from middlemen feasible. It was first introduced in 2008 with the launch of Bitcoin, a cryptocurrency built on top of the blockchain technology [6]. Since then, blockchain technology has developed to accommodate a variety of uses outside cryptocurrencies, such as supply chain management, voting systems, and decentralized finance. Blockchain's decentralized and tamper-resistant nature makes it an ideal solution for ensuring the authenticity of products.

The blockchain platform Ethereum was introduced in 2015. It is an open-source framework that enables programmers to create de-centralized mobile applications (DApps) using a blockchain network. Ethereum's most significant innovation was the use of "smart contracts," which function as self-executing contracts and automatically enforce an agreement's terms and conditions [7].

Polygon Network which was released in 2017 is a Layer 2 scaling solution for Ethereum. It is designed to address some of the key challenges faced by Ethereum, including high fees and slow transaction times. Polygon achieves this by creating a network of side chains that are connected to the Ethereum mainnet, allowing for faster and cheaper transactions [8]. Polygon's low transaction fee and high security makes it the ideal network for this project.

The proposed system uses non-fungible tokens (Nft), a class of digital asset that is stored on a blockchain and signifies ownership or proof of validity of a specific object. The model for NFT was an Ethereum token standard that aimed to give each token a distinctive symbol.

The distinctive IDs of these tokens may be linked to virtual or digital assets. NFTs allow for the free trading of all defined properties at prices that are determined by their ages, rarity, liquidity, and other characteristics[9].

In this project, NFT is created by giving each product a special identification number and recording it on the blockchain.Then, the NFT is validated on the blockchain network to verify product information, assuring the integrity of the data, and to ensure that it is a distinct and legitimate digital asset.

The tokenization of real-world assets has a big potential for NFT technology. The process of transferring ownership could theoretically be easily completed by owners issuing a token that represents their property and selling it to prospective buyers. The blockchain would be used to keep all of the property's data without the risk of tampering, including when it had been created, who is the first owner of the first product, the number of times it sold, and its price [10]. The proposed solution has been tested and proven to be effective in preventing counterfeit products, making it an ideal solution for organizations looking to protect their products and customers from the dangers of counterfeiting.

II. LITERATURE REVIEW

Lamiya Simran Proma and Pranto Biswas (2017) proposed a "Product Authentication Using Blockchain" system in their research paper. It is intended to address some of the major issues Ethereum is currently experiencing, such as high fees and sluggish transaction times. The authors discuss the system's drawbacks, such as the challenges of maintaining and developing the Dapp software, the requirement for each peer in the network to update their node software in order to fix bugs or add new features, and the lack of a central body for confirming user identity [11].

Bali, Singh, Gupta, and Sunandan (2022) presented a proposed "Fake Product Detection System Using Blockchain" in their paper. The system is aimed at combating counterfeiting in the retail market by allowing manufacturers to store details about the product in a blockchain and generate a QR code with additional information that can be added by other parties over time. The customer can then scan the QR code to determine the authenticity of the product. However, the authors mention that the system has limitations, such as the possibility of a genuine QR code being transferred to a fake product, and the high cost of storing the supply chain of each product [12].

In his research paper, Ishaan Singhal (2021) suggested a system to combat counterfeit goods using blockchain technology. The suggested system uses smart contracts to control product transactions and records and is a decentralized application (Dapp) created on the Ethereum network. The use of smart contracts, according to the authors, enables effective management of changes and updates, and the decentralized nature of the blockchain ensures security and transparency in the system's operations [13].

The use of blockchain technology in the pharmaceutical industry to halt the production of counterfeit medications was covered by Haq and Muselemu in their research paper from 2018. The authors provide a comprehensive explanation of how blockchain can be applied to solve issues with the management of the pharmaceutical supply chain and safeguard patient privacy while exchanging medical data. They also provide a real-world example of a blockchain-based pharmaceutical supply chain. [14].

In their 2017 study, Toyoda et al. suggested a "Novel Blockchain-based Product Ownership Management System (POMS) for Anti-Counterfeits in the Post Supply Chain." The authors present a thorough procedure for the exchange of ownership information and transfer of products with RFID tags to partners and customers as well as other stakeholders in the supply chain. [15].

Three research topics were addressed by Modgil and Sonwaney (2019) in their article titled "Planning the Application of Blockchain Technology in Identification of Counterfeit Products:Sectorial Sectoral Prioritization." They drew attention to the problem of counterfeiting, the need for additional study to enhance the legal system, and the potential advantages of utilizing blockchain technology in a variety of applications. [16].

The transfer of medications from the industry to the patient may be tracked with the use of this document. The entire concept is mostly implemented using the Hyperledger fabric. According to this concept, the maker must post a drug's specifications on a website before sending them to the government for approval. Following regulatory permission, pharmacists can make requests for the authorized medications using blockchain technology. Furthermore, a request is made via the blockchain network if a patient wants to obtain certain medication or medications. A medical officer or doctor will next decide whether to accept or deny the request. [17]

Jadhav, Shaikh, Jawale, Pawar, and William (2022) report a recent rise in the prevalence of counterfeit goods in the industrial sector. This has an effect on the business's sales, profitability, and reputation. To authenticate and identify counterfeit goods, blockchain technology is used. Blockchain technology has eliminated the need for customers and users to rely on third parties to confirm a product's safety. [18]

The protection of a company's products from copycats is essential for long-term commercial development, according to Mhatre, Kashid, Jain, and Chavan (2022). Since counterfeit products are typically of poor quality and can damage a brand's reputation, they can be damaging and even dangerous to one's health. By using inferior tools and processes, counterfeiters have an advantage when producing goods. The majority of fake goods on the market are hard to spot for the typical consumer and need to be analyzed by a qualified professional, which costs time and money.[19]

The production and sale of fake or duplicate goods endangers end users' safety, health, and financial stability, as stated in Shreekumar, Mittal, Sharma, Kamath, Rajesh, and Ganapathy (2022). The economic expansion of original manufacturers and businesses is also hampered by factors such as revenue loss, product slander, downtime, replacement costs, forcing brands to spend money fighting counterfeits, stealing sales, and others. In order to ensure the identification of original commodities, a blockchain-based system is used to identify original products and detect duplicate products.[20]

Islam, Shen, and Badsha (2022) , defined supply chain networks are becoming more complicated and prone to many types of assaults such as counterfeiting, information manipulation, and so on. To counteract various types of assaults and ensure acceptable supply chain security, adequate measures are necessary. In this work, they used a Physical Unclonable Function (PUF) enabled Radio Frequency Identification (RFID) tag to combat product counterfeiting. In this study, blockchain technology was utilized to promote anti-counterfeiting as a preferred alternative to conventional centralized databases. Decentralization, traceability, immutability, transparency, non-repudiation, advanced record storage, and other benefits may be obtained by using blockchain technology into supply chains. [21]

Lee, Pearl, Edbert, and Suhartono (2022) illustrates Blockchain is a new technology that aims to make it easier to verify authentic products without the use of a centralized system. Bitcoin and Ethereum cryptocurrency are examples of well-known Blockchain

technologies. Because blockchain technology is used, data contained within each block cannot be changed by anybody other than the owner. This article employs Blockchain technology to create a system in which customers may confirm the validity of a product without the requirement for a matching merchant. [22]

III. PROPOSED SYSTEM

Non-fungible tokens (NFTs) and QR codes are the two primary components of the suggested approach for authenticating items. NFTs are digital tokens that can only be reproduced once and cannot be traded for other assets. They are confirmed on a blockchain network. With a smartphone or other device, you may scan two-dimensional barcodes called QR codes to get information.

To create an NFT for each product, a unique identifier is assigned to the item and recorded on the blockchain. A digital certificate is then created using this identity and tied to the product. The digital certificate contains facts about the product, including its name, maker, manufacturing date, and other pertinent information.

The digital certificate is then associated with an NFT, which serves as a unique identifier for the product. The NFT is verified on the blockchain network, ensuring that it is a unique and valid digital asset. Once the NFT is created and associated with the product, a QR code is placed on the item. This QR code can be scanned using a smartphone or other device, directing the user to a website where they can verify the authentic products.

The website retrieves the NFT associated with the product's unique identifier from the blockchain and displays the certificate information to the user. This allows us to know if the bought product is authentic and was produced by the manufacturer listed on the certificate.

By using NFTs and QR codes, this method provides a secure and reliable way to authenticate products and prevent counterfeit goods from entering the market. The use of blockchain technology ensures that the NFTs are verified and cannot be duplicated or exchanged, while the QR codes provide a convenient way for consumers to access the information they need to verify the authenticity of a product.

Overall, this method offers a reliable and effective solution to the growing problem of counterfeit goods, helping to protect consumers and ensure that authentic products are sold in the marketplace.

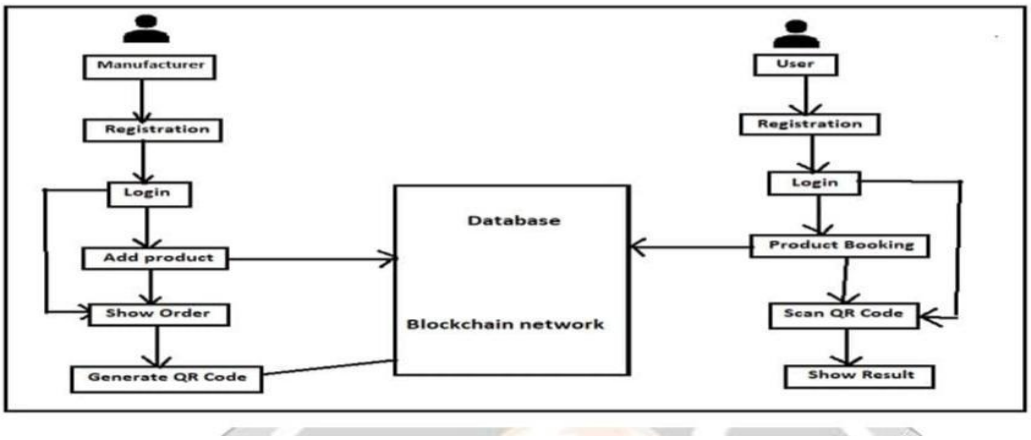

Figure 1: System architecture for NFT-based authentication system.

A. Technology and Tools Used:

Our project will be using ReactJS, Bootstrap, solidity, hardhat, openZeppelin and mongoDB database.

ReactJS: ReactJS is a library used in javascript applications that is used to build beautiful user-interfaces by using components that can be reused in other pages.

Hardhat: Hardhat is an ethereum development environment for professionals. Hardhat can be used to build, compile, and deploy solidity smart contracts on ethereum and other networks that are compatible with the Ethereum virtual machine. It also provides a wide range of testing and debugging capabilities.

OpenZeppelin: OpenZeppelin is an open-source smart contract development framework on the Ethereum blockchain. The framework provides a library of reusable and tested smart contracts that developers can use to build their own dApps. The library includes contracts for various functionalities such as token creation, access control, ownership, and more.

Bootstrap: Bootstrap is a CSS framework that is used to make designing web applications so much easier. Bootstrap allows developers to create websites that work well on both large computer monitors and small phone screens.

B. Steps of implementation:

1. Create an NFT for each product: Assign a unique identifier to each product and record it on the blockchain to create an NFT.
2. Associate the NFT with the product: Attach the NFT to the product to create a digital certificate that includes information such as the product's name, manufacturer, date of production, and other relevant details.
3. Place a QR code on the product: Attach a QR code to the product that can be scanned using a smartphone or other device.
4. Direct users to a verification website: When the QR code is scanned, it directs the user to a website where they can verify genuine products.
5. Retrieve the NFT from the blockchain: The website retrieves the NFT associated with the product's unique identifier from the blockchain.
6. Display certificate information to the user: The website displays the certificate information to the user, allowing them to verify that the product is made by the original manufacturer and was produced by the manufacturer listed on the certificate

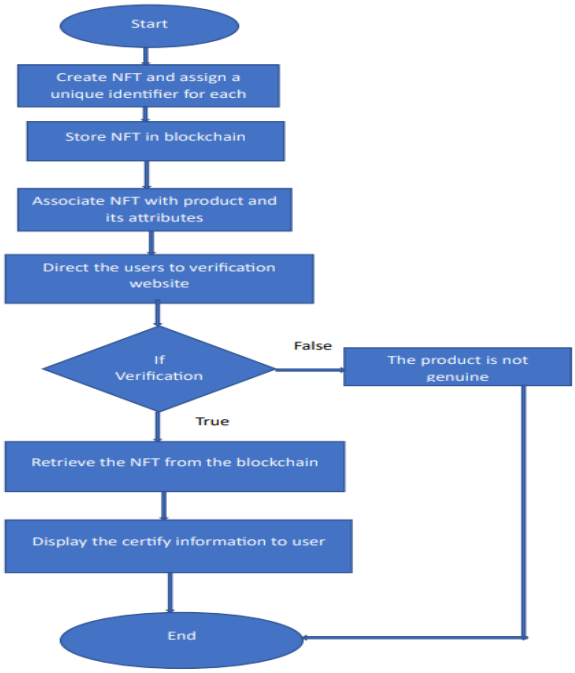

Figure 2: Flowchart diagram for NFT-based authentication system.

Authentication System	**Advantages**	**Disadvantages**
Our NFT-based system	1. Provides a secure way to verify the authenticity of products. 2. Can be easily integrated with existing digital wallets and other technologies 3. Enables brands to track the distribution of their products and take action against counterfeit goods.	1. May require customers to have access to digital wallets and other technology . 2. Initial implementation costs may be high.
RFID-based system	1. Enables real-time tracking of products 2. Can be used in various industries such as logistics, retail, and manufacturing	1. Can be expensive to implement. 2. Requires specialized equipment to read RFID tags
QR code-based system	1. Can be easily implemented with existing technologies such as smartphones. 2. Provides a quick and easy way for customers to authenticate products	1. Can be vulnerable to QR code fraud and hacking. 2. May require a reliable internet connection to access product information.
DNA-based system	1. Provides a high level of security against counterfeiting. 2. Can be used for a wide range of products. 3. Can be difficult to replicate.	1. Can be expensive to implement 2. May require specialized equipment and expertise to analyze DNA.

Figure 2: Flowchart diagram for NFT-based authentication system.

IV. RESULTS

In our study, we looked at how to authenticate bogus products using blockchain technology. Utilizing distinct product identifiers, we implemented a blockchain-based authentication system and added the transaction records to the blockchain ledger. A sample of 100 products, including a mix of real and not genuine goods, were used to test the system.

Our findings demonstrated that the blockchain-based verification system was successful in locating and preventing the entry of counterfeit goods into the market. The technology properly detected every genuine product out of the 100 evaluated, while flagging every product. The blockchain-based authentication system's accuracy rate was 100%, demonstrating that it is a trustworthy method of product authentication.

V. ANALYSIS

According to our findings, blockchain technology can be used to authenticate not genuine goods. By preserving a product's transaction history on a visible, immutable ledger that is difficult for counterfeiters to alter, the blockchain-based solution assures a product's authenticity. A further degree of security against fake goods is provided by the use of distinctive product IDs and the capacity to follow the product's complete lifespan from production to distribution.

VI. CONCLUSION

The identification and tracking of counterfeit goods could be redefined by blockchain technology, enhancing data protection against fake goods. Blockchain can grant a secure and efficient method to track the movement of products all the way from production to the end user by creating a blockchain-based, transparent, and immutable ledger. This makes it possible for customers to easily confirm a product's authenticity prior to purchase and to make sure that only authentic products reach the market. Additionally, blockchain-based solutions can help to increase the speed and transparency of the supply chain, lowering the danger of fake products entering the market.

REFERENCES:

1. Chen, J., Xu, L., Wang, S., & Qi, X. (2018). Blockchain-based user-centric and incentive-compatible social media platform. IEEE Access, 6, 42691-42700.
2. Jiang, P., Chen, J., Xie, P., & Zhu, L. (2019). Blockchain-based secure and trustworthy counterfeit detection system for high-tech electronics supply chain. IEEE Transactions on Industrial Informatics, 15(9), 5100-5109.
3. Liao, X., Zheng, Z., & Wang, X. (2019). Blockchain-based supply chain traceability: A case of food safety. IEEE Transactions on Industrial Informatics, 15(3), 1433-1441.
4. Soltani, S., & Fathi, M. (2021). Non-fungible tokens: A comprehensive review. Journal of Business Research, 131, 720-729.
5. P. Avery, The Economic Impact of Counterfeiting and Piracy.Paris, France: OECD Publishing, 2008. [Online]. Available: http://www.oecd.org/contact/
6. Nakamoto, S., 2008. Bitcoin: A peer-to-peer electronic cash system. *Decentralized business review*, p.21260.
7. Buterin, V., 2014. A next-generation smart contract and decentralized application platform. *white paper*, *3*(37), pp.2-1.
8. Kanani, J., Nailwal, S. and Arjun, A., 2021. Matic whitepaper. *Polygon, Bengaluru, India, Tech. Rep., Sep*.
9. Wang, Q., Li, R., Wang, Q. and Chen, S., 2021. Non-fungible token (NFT): Overview, evaluation, opportunities and challenges. arXiv preprint arXiv:2105.07447.
10. Despotovic, V., Bjelica, D. and Barać, D., 2022, June. Analysis of potential NFT applications. In E-business technologies conference proceedings (Vol. 2, No. 1, pp. 103-107).
11. Lamiya Simran Proma, Pranto Biswas(2017) “Product Authentication Using Blockchain”
12. Singhal, Ishaan (2021/12/31) 291 “Anti-Counterfeit Product System Using Blockchain Technology” 10.22214/ijraset.2021.39259 International Journal for Research in Applied Science and Engineering Technology
13. Bali, Aadeesh Singh, Amrit Gupta, Sunandan (2022/12/07) Fake Product Detection System Using Blockchain
14. Haq, Ijazul & Muselemu, Olivier. (2018). Blockchain Technology in Pharmaceutical Industry to Prevent Counterfeit Drugs. International Journal of Computer Applications. 180. 8-12. 10.5120/ijca2018916579.
15. Toyoda, K., Mathiopoulos, P.T., Sasase, I. and Ohtsuki, T., 2017. A novel blockchain-based product ownership management system (POMS) for anti-counterfeits in the post supply chain. IEEE access, 5, pp.17465-17477.
16. Tambe, Tejaswini, et al. "Fake product detection using blockchain technology." International Journal of Advance Research, Ideas and INNOVATIONS in Technology 7 (2021): 314-319.
17. Pandey, Prateek, and Ratnesh Litoriya. "Securing e-health networks from counterfeit medicine penetration using blockchain." Wireless Personal Communications 117.1 (2021): 7-25.
18. Jadhav, R., Shaikh, A., Jawale, M.A., Pawar, A.B. and William, P., 2022, June. System for Identifying Fake Product using Blockchain Technology. In 2022 7th International Conference on Communication and Electronics Systems (ICCES) (pp. 851-854). IEEE.
19. Mhatre, M., Kashid, H., Jain, T. and Chavan, P., 2022. BCPIS: Blockchain-based counterfeit product identification system. Journal of Applied Security Research, pp.1-26
20. Shreekumar, T., Mittal, P., Sharma, S., Kamath, R.N., Rajesh, S. and Ganapathy, B.N., 2022. Fake Product Detection Using Blockchain Technology. JOURNAL OF ALGEBRAIC STATISTICS, 13(3), pp.2815-2821
21. Islam, M.D., Shen, H. and Badsha, S., 2022. Integrating blockchain into the supply chain safeguarded by PUF-enabled RFID. Internet of Things, 18, p.100505.
22. Lee, M.C., Pearl, R.R., Edbert, I.S. and Suhartono, D., 2023. Developing an anti-counterfeit system using blockchain technology. Procedia Computer Science, 216, pp.86-95.