Grenze International Journal of Engineering and Technology, June Issue

Traceability of Counterfeit Product Detection in Supply Chain through Blockchain

Rashmi Asthagi[1], Shardul Kedar[2], Shruti khatal[3], Sujal khardekar[4] and Siddesh Khaple[5]
[1-5]Vishwakarma Institute of Technology/Department of Computer Engineering, Pune, India
Email: {rashmi.asthagi, kedar.shardul21, shruti.khatal21, siddesh.khaple21, sujal.khardekar21}@vit.edu

***Abstract*— In recent years, industries involved in manufacturing products have experienced an increasing reliance on counterfeit items. This phenomenon significantly impacts businesses' sales and profits. To address this challenge and ensure the authentication of genuine goods across the supply chain, a functional blockchain system is essential in preventing fraud and counterfeiting of goods. Blockchain technology allows customers to verify the product's origin without depending on trusted third parties for secure understanding of the product's authenticity. An application utilizing blockchain technology inherently ensures "tamper-resistant" data content. A blockchain serves as a decentralized and distributed digital ledger that stores transactional documents, known as public blocks, across numerous networks' databases. This study proposes the use of a barcode scanner to identify counterfeit goods, connecting each barcode to a Blockchain-Based Management (BCBM) system. The suggested technique involves recording product information and its unique code as database blocks within the blockchain. It begins by acquiring the customer's specific code and then cross-references it with the records in the blockchain database. If the code matches, the buyer receives confirmation; if not, the purchaser is prompted to provide the product's purchase location. This step aids in determining the source of any counterfeit items.**

***Index Terms*— Blockchain, Traceability, Counterfeit products, Supply chain, Security.**

I. INTRODUCTION

In today’s era, the issue of counterfeiting is significant. The annual sales of counterfeit goods range from an estimated $1.7 trillion to $4.5 trillion, depending on estimates. This put counterfeiting at least tenth in terms of economy, slightly larger than Canada's GDP overall and maybe fourth largest above Germany. Additionally, it is to blame for 2.5 million job losses worldwide [1] Using Blockchain technology to counter these challenges can revolutionize the manufacturing industries.

A decentralized network-based digital ledger of transaction records is what is known as blockchain technology. Blockchains are made up of blocks, which are data records, and each block is linked to the one before it in an irreversible chain. The phrase "blockchain" refers to the collection of all transactions into one block. Due to block chain's distributed nature and peer-confirmed guarantees, when compared to traditional centralized databases, the information cannot be handled. When someone wishes to conduct a transaction, they go straight to the network, where algorithms determine the transaction's legitimacy. A chain of transactions is created by connecting the new one with the earlier one after the transaction has been validated. The blockchain is the name of this network.

Grenze ID: 01.GIJET.10.2.188_1

In fig., the blocks of a blockchain have some important features that ensure the blockchain technology principles are followed. Among these features the 3 important features that describe a block in a blockchain are:

A. Relevant Information

Every block has relevant information depending on the blockchain network. In the proposed paper the blocks will be storing information about the product, seller, manufacturer, etc. Once such information is stored in the blocks it's very difficult to manipulate the stored information by intruders as Blockchain technology follows the consensus rule which implies majority voting. All the people in the network have a copy of the blockchain. To alter the information stored in the block it should be allowed by the majority of the nodes in the network.

B. Hash

Hash is like a unique entity just like fingerprints of humans for the data stored in a block. Every block in the blockchain network has a unique code called hash.

C. Prev Hash

Previous Hash is the hash code of the block which is connected before the current block. The previous hash of the first block is 0 as there is no block before the first block. The previous hash code of the second block is the hash code of the first block. This helps in forming chains of blocks.
There are other features associated with the block like transaction date, timestamp, etc.

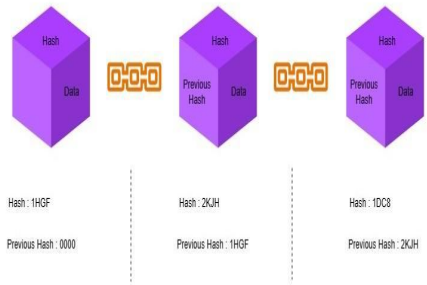


Figure 1. Introduction

The method of locating fake products by utilizing blockchain technology is referred to as fake product detection in blockchain. Blockchain is a distributed, unchangeable digital record that offers transaction security and transparency. Businesses can make sure their items are authentic by using blockchain, and buyers can trust the legitimacy of the goods they buy. It operates by digitizing the product's origin and following its progression through the supply chain. The transaction is documented on the blockchain every time the product is transferred, resulting in a visible and unchangeable history of the product. This document is intended to confirm the legitimacy of the product and stop fraud.
Using blockchain technology, the proposed project suggests a unique method for identifying fake goods that authenticates products and keeps a transparent ledger of all transactions involving those products. Manufacturers can guarantee the authenticity and genuineness of their products by registering each one on the blockchain and giving it a distinct digital identity. This enables customers to check the product's legitimacy before buying it, assuring that they are getting the real deal. These are the system's primary goals:
1) Guard consumers and brands
2) Company earnings
3) Ensuring compliance with regulations
4) Promoting moral behaviour
Blockchain can speed up the verification process, guaranteeing that the products are real while lowering the chance that fakes will enter the supply chain. The Paper will also go through some advantages of this including increased. transparency, supply chain traceability, and consumer protection.
Businesses may instantly spot any discrepancies or irregularities in the supply chain that may suggest the possibility of fraud by using the blockchain record, which gives an immutable and transparent record of the cosmetic item's route. goods that are phony or counterfeit. If an item's record indicates, for instance, that it was

created at a different place than the one where it was If the goods is false or counterfeit, it will be made clear on the package.

II. Literature Review

The paper gives a brief description of the traditional RFID technology used to avoid the supply of fake products in the supply chain. The major disadvantages of the RFID technology is highlighted in the paper. One of the disadvantages is the ease of cloning such RFID tags. The other one was the RFID technology wasn't proving to be successful in the post-supply chain. This led to the implementation of Counterfeit product detection using Blockchain. The developed system was named POMS (Product Ownership Management System).The customer can reject a product that is passed as an original product by RFID technology but the seller doesn't have the ownership of the product being sold. The paper emphasizes on the business idea where the manufacturer can give incentives to all those sub-parties of the supply chain which will promote the use of the system and hence avoid counterfeit products supply in post supply chain.[2]

The proposed paper has divided the development of the anti-counterfeit product System into two phases. The first phase includes the research aspects which include in depth study of blockchain technology and designing system specifications and developing methods. The second phase includes prototype development, testing and validation of the results, and improvement of the specifications of the system. The products are monitored from the manufacturer till it reaches the consumers in the supply chain. Additionally, the system will ensure that the products can be accurately traced. Once they are created, they will be registered on the traceability platform so that they may be tracked, recognized, and updated along the way. Through the platform, trading partners will be able to communicate details regarding product status and physical movements as they move from one firm to the next and eventually reach the end user [3].

The paper points out different challenges created due to the flow of counterfeit products in the supply chain which ranges from economic to defamation. The proposed prototype will make use of blockchain technology and QR codes to detect the originality of the product. The unique feature of the proposed prototype is it also sends a notification to the manufacturer about the place or location where the fake product of their brand is detected. The QR code is made tamper-proof using a graphic technique which makes the QR code difficult to copy [4].

This study proposes a system to identify counterfeit goods using barcode readers linked to blockchain. The system tracks product specifications and unique codes in a database. It verifies the code against customer-provided blockchain data and notifies the client if the code is correct. If the code is invalid, it collects information on the item's purchase location to identify manufacturers of fake goods. The paper explores the integration of RFID and blockchain technology in the agri-food supply chain traceability system. It analyses their applications, advantages, and disadvantages. By ensuring reliable data exchange throughout the supply chain, this system can enhance food safety and traceability [5].

This paper proposes a blockchain-based framework for intelligent quality management in supply chains. The framework offers a theoretical basis for information resource management in distributed, cross-organizational settings. The authors plan to involve domain experts for evaluation and application in real-world scenarios.[6]

The paper aims at detecting counterfeit medicines. The importance of the system is highlighted by stating all the health-related issues that can be encountered if fake drugs or medicines are used in the post-supply chain or at any stage of the supply chain. The proposed system allows users to get all the necessary information about the medicines that they will consume which includes the contents of the medicines, and side effects of the medicine. This is achieved by using blockchain technology. This also makes sure that the people in between don't evade paying any taxes. The System prototype consists of an application termed DApp which stands for Distributed Application and along with it a back-end Distributed File System (DFS) is used which provides support to a private blockchain network.[7].

The proposed system utilizes blockchain technology to combat counterfeit products by recording the supply chain of goods at every transaction stage using QR codes, ensuring transparency and ownership tracking. Key tools such as Ganache, MetaMask, Truffle Suite, and Solidity are employed to develop and deploy the system effectively. Ganache serves as a development blockchain for testing smart contracts, while MetaMask enables secure interactions with the Ethereum network. Truffle Suite streamlines DApp development, and Solidity facilitates the creation of secure smart contracts. Through the integration of these technologies, the system establishes a robust infrastructure for verifying product authenticity, enhancing consumer trust in the supply chain [8].

The suggested approach is based on documenting the logistics needs for moving medicines from the point of manufacture to the patient on the blockchain network. If fake medication is ever put into the system, it will be

promptly identified, and its spread will be prevented. A hyper ledger fabric platform is used to mimic the system, and its performance is contrasted with that of other approaches. The system that has been created, according to the results, is computationally demanding but provides a solid defence against the threat of counterfeit drugs.[9]
The paper emphasizes the development of system which will take the responsibilities of data storage, privacy of the data, pharma-product traceability, and ensuring the quality of the product. The paper focuses on cloud-based storage which uses an off-chain IPFS (Interplanetary File System) and on-chain couch Database. The record of the drugs will be accessed via smart contracts in Hyperledger Blockchain.[10]
The proposed paper focuses on providing a QR code to the product which the customers can scan through an app developed. The QR code of the product is linked to the blockchain. The system is developed using Android Studio and Firebase Cloud. The algorithm used is SHA-256 which stands for Secure Hash Algorithm. This algorithm is used by the manufacturer to generate a QR code for a product after manufacturing. The customer scans the QR code to ensure the originality of the product.[11]
From the above-related works, it was observed that some of the existing counterfeit product detection systems used traditional methods like RFID tags and technology which can be exploited by scammers by duplication of ID tags, while other existing systems used blockchain technology for detecting fake products but there was no provision made for the customers to share their feedback to the owners or manufacturers of the brand. The system proposed has a customer feedback feature that will enable customers to share the details of the shop where they encountered fake products through our application, this will allow the owners and manufacturers of the brand to take legal action against the scammer.

III. METHODOLOGY

The suggested solution would be a decentralized application (DApp) that is constructed using Ethereum as the primary blockchain for maintaining all data and processing transactions related to the products of the companies listed on DApp. The image below depicts the fundamental system architecture. A decentralized method for confirming the authenticity of goods along the entire supply chain is what Ethereum does in order to detect phony products using smart contracts. The smart contract feature of Ethereum, which enables the development of self-executing contracts with predefined rules and circumstances, can be used to build this system.
Here is an illustration of how this system functions:
1. A manufacturer gives a product a special identity and logs it on the Ethereum blockchain.
2. Each entity involved (such as distributors, retailers, etc.) logs their interactions with the product on the blockchain as it progresses through the supply chain. By doing this, a permanent record of the product's travels is produced, which can be used to confirm its legitimacy.
3. The verification procedure is automated using smart contracts. For instance, a smart contract may be set up to verify the authenticity of a product by comparing its unique identifier to the blockchain record. Payment to the producer or distributor could be made automatically through the smart contract if the product completes the verification process.
4. If fraudulent goods are discovered, the smart contract displays a bogus product verification status. This is due to the immutability of the blockchain record, which prevents any alterations or tampering. Additionally, using smart contracts can simplify the verification process and lessen the need for middlemen.
5. The customer is provided with a feedback form if the product is identified as fake. The feedback form is filled out by the customer where the customer mentions the name of the shop where such products are being sold, the address of the shop, and images of the product. This will be stored in a database which can be viewed by manufacturers for taking further action.
In fig 3., After the Manufacturing of the product, the manufacturer adds the details of the product into the blockchain network. Hence a unique QR code is generated for every product manufactured which is linked to the blockchain network. Now the Customer will scan the QR code on the product to be bought. If the product is real, then on scanning the QR code all the details of the product will be made available for the customer to see. If the product is not registered on the blockchain network by the manufacturer, then the QR code won’t show anything which will conclude the fact that the product is fake and the QR code displayed on the product is also fake. The customers will also be provided a web page on the anti-counterfeit product detection website where the customers can provide reviews of the stores that sell them fake products. These reviews will be analysed and provided to the manufacturing companies so that they can take legal action against such stores that are illegally harming their economic growth as well as their reputation. The Manufacturer will be provided access to view the database of customer reviews which will help them in taking necessary action.

The customer review form will take the name, and address of the store along with the image of the product that has been detected as fake by the system or shop where fake products are being sold and in detailed experience of the customer.

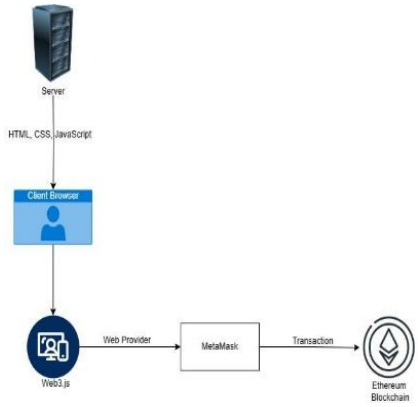


Figure 2. System Model

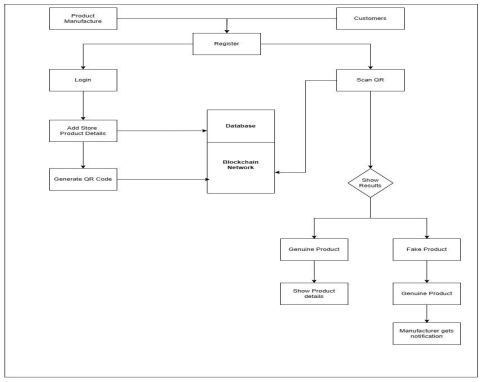


Figure 3. System Architecture

A. Tools and Technology

1. Truffle and MetaMask

In fig 2., the simplest method for interacting with DApps in a browser is MetaMask. It is a Chrome or Firefox extension that establishes a connection to an Ethereum network without requiring the browser to execute a complete node. It has the ability to connect to the primary Ethereum network, any of the testnets (Ropsten, Kovan, and Rinkeby), or a local blockchain like the ones developed by Ganache or Truffle Develop.[12]

2. Solidity

The Ethereum Network team developed Solidity, an object-oriented programming language, especially for building and developing smart contracts on Blockchain platforms. It is employed in the development of smart contracts, which produce a blockchain system's transaction record chain and carry out business logic.[13]

3. Web3.js

Using HTTP, IPC, or WebSocket, developers can communicate with a local or distant Ethereum node with the help of the Web3.js library. You can create clients or websites that communicate with the blockchain by using this library. This can include, among other things, transferring Ether between users, examining data from smart contracts, and developing smart contracts.[14]

4. Ganache

Software engineers frequently use Ganache to build a local blockchain network for testing and development. By using Ganache to simulate a blockchain network on their local PC, developers may test various scenarios and debug their blockchain apps efficiently. Ganache facilitates the rapid development of Filecoin and Ethereum-based distributed apps.[15]

IV. RESULTS

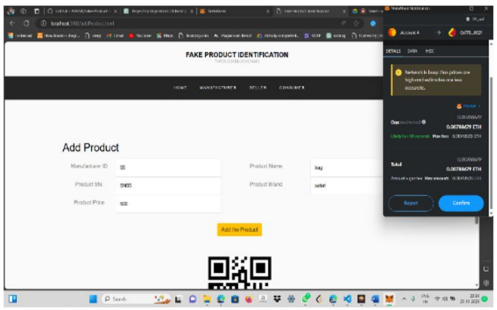


Figure 4. Add Product.

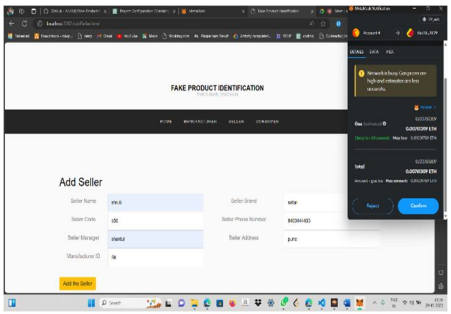


Figure 5. Add seller

In fig 4., task of adding the product to the blockchain network is performed by the manufacturer. A QR code is generated for the product. This QR code will be responsible for proving the originality of the product.
In fig 5., the task of adding the seller is again performed by the manufacturer. The manufacturer will add all the sellers who will be selling the original products.

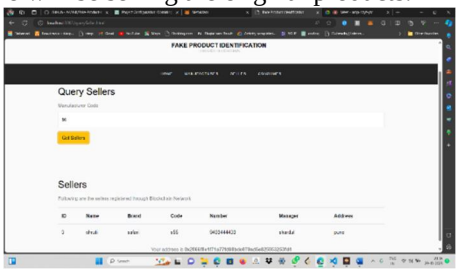


Figure 6. Sellers registered on blockchain

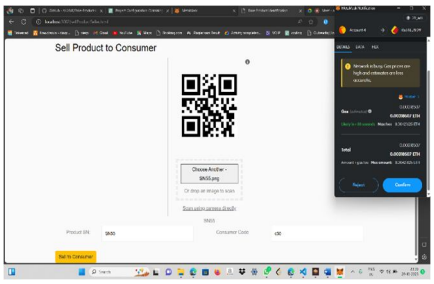


Figure 7. The product is sold to consumer by the seller

In fig 6., once the sellers are added by the manufacturer, they get registered on the blockchain network.
In fig 7., now the product is sold to consumer by the seller. Here seller needs to mention the Customer code while selling the product.

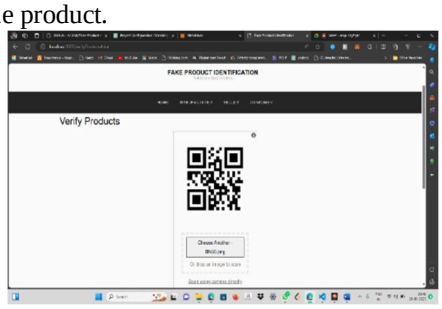


Figure 8a. Customer uploads the QR code on the product.

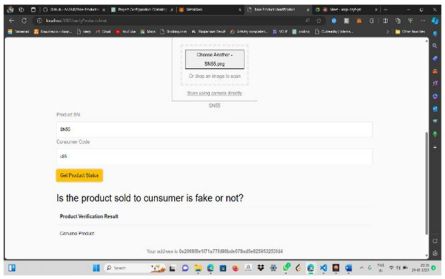


Figure 8b. Result obtained is a genuine product.

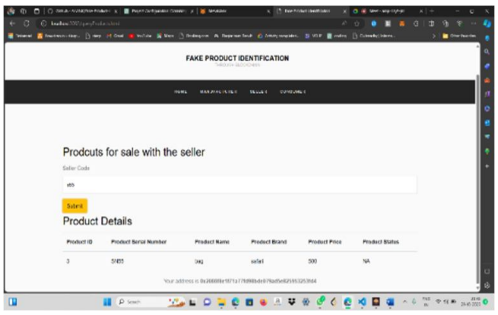


Figure 8c. Products available with seller for sale

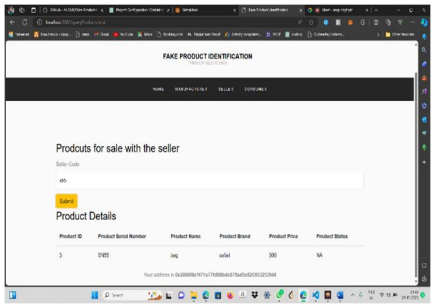


Figure 8d. Product is identified as fake

In fig 8a., once the customer uploads the QR Code the customer has to mention the customer code which is provided by the seller while selling the product to the customer.
In fig 8b., now if the product is original, it will display genuine product. The user can go ahead and buy the product.
In fig 8c., the user can also check the products for sale section where the user can search the seller code and see whether the product, they are buying is available or not. This is another additional method for cross-checking the originality of the product.
In this scenario fig 9., the customer can move to customer feedback form provided where the customer can raise the problem. The customer's input is stored in a database which is then provided to the manufacturers who in turn take strict actions against such shops.
In fig 10., the manufacturer can have a look into the images provided by the customers, name, and address of the shop and take strict actions against such stores which defame their company's brand and harm their economic growth.

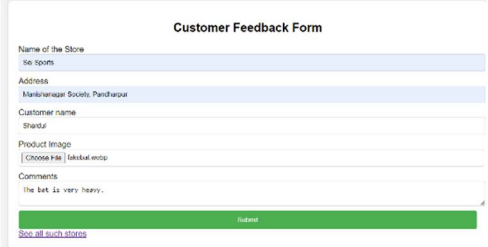
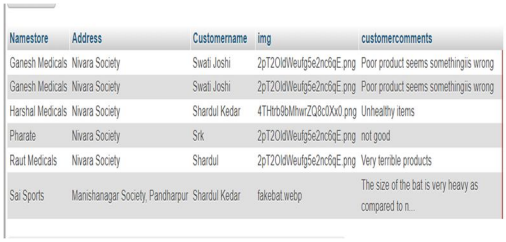


Figure 9. Customer feedback form



Namestore	Address	Customername	img	customercomments
Ganesh Medicals	Nivara Society	Swati Joshi	2pT2OldWeufg5e2nc6qE.png	Poor product seems somethingis wrong
Ganesh Medicals	Nivara Society	Swati Joshi	2pT2OldWeufg5e2nc6qE.png	Poor product seems somethingis wrong
Harshal Medicals	Nivara Society	Shardul Kedar	4THtrb9bMhwrZQ8c0Xx0.png	Unhealthy items
Pharate	Nivara Society	Srk	2pT2OldWeufg5e2nc6qE.png	not good
Raut Medicals	Nivara Society	Shardul	2pT2OldWeufg5e2nc6qE.png	Very terrible products
Sai Sports	Manishanagar Society, Pandharpur	Shardul Kedar	fakebat.webp	The size of the bat is very heavy as compared to n...

Figure 10. Database of customer review

V. CONCLUSIONS

Nowadays, the black market and internet sales of counterfeit goods are expanding rapidly. The largest problem in the supply chain is the block market. Despite its inability to prevent the sale of counterfeit goods, the government has passed a number of rules and regulations. As a result, a strategy for identifying counterfeit goods and offering security solutions to warn both manufacturers and consumers in the supply chain are needed.
In this article, we presented a blockchain management system that would enable both consumer and business vendors to track and identify the actual product. via means of a smartphone. Additionally, it will recognize fakes. items and the reliability of the manufacturer for both customers and business vendors.

ACKNOWLEDGMENT

We would like to thank Prof. Rashmi Ashtagi for her valuable guidance which helped us in solving many difficulties raised during the development of the project.

REFERENCES

[1] https://www.forbes.com/sites/forbesbusinesscouncil/2022/08/02/the-global-impact-of-counterfeiting-and-solutions-to-stop-it [Last accessed: 29 November 2023]
[2] K. Toyoda, P. T. Mathiopoulos, I. Sasase and T. Ohtsuki, "A Novel Blockchain-Based Product Ownership Management System (POMS) for Anti-Counterfeits in the Post Supply Chain," in IEEE Access, vol. 5, pp. 17465-17477, 2017.
[3] Gayialis, S.P., Kechagias, E., Papadopoulos, G.A., Konstantakopoulos, G.D. (2019). Design of a Blockchain-Driven System for Product Counterfeiting Restraint in the Supply Chain. In: Ameri, F., Stecke, K., von Cieminski, G., Kiritsis, D. (eds) Advances in Production Management Systems. Production Management for the Factory of the Future. APMS 2019.
[4] Shreekumar, T., Puneet Mittal, Sukhwinder Sharma, Rajesh N. Kamath, Sreeja Rajesh, and B. Nruthya Ganapathy. "Fake Product Detection Using Blockchain Technology." Journal of Algebraic Statistics 13, no. 3 (2022): 2815-2821.
[5] Feng Tian, "An agri-food supply chain traceability system for China based on RFID & blockchain technology," 2016 13th International Conference on Service Systems and Service Management (ICSSSM), Kunming, 2016.
[6] S. Chen, R. Shi, Z. Ren, J. Yan, Y. Shi and J. Zhang, "A Blockchain-Based Supply Chain Quality Management Framework," 2017 IEEE 14th International Conference on e-Business Engineering (ICEBE), Shanghai, China, 2017.
[7] Sylim P, Liu F, Marcelo A, Fontelo P Blockchain Technology for Detecting Falsified and Substandard Drugs in Distribution: Pharmaceutical Supply Chain Intervention JMIR Res Protoc 2018.
[8] Bali, Aadeesh, Amrit Singh, and Sunandan Gupta. "Fake Product Detection System Using Blockchain." In Conference: Fake Product Detection Using Blockchain. 2022..
[9] Pandey, P., Litoriya, R. Securing E-health Networks from Counterfeit Medicine Penetration Using Blockchain. Wireless Pers Commun 117, 7–25 2021.
[10] Mani, V., Prakash, M. & Lai, W.C. Cloud-based blockchain technology to identify counterfeits. J Cloud Comp 11, 67 2022.
[11] Chitalkar, Sonali P., Manali B. Khurud, Tejaswini L. Tambe, Madhavi G. Varpe, and S. Y. Raut. 2021. “Fake Product Detection Using Blockchain Technology.” International Journal of Advance Research and Innovative Ideas in Education, January.
[12] https://trufflesuite.com/docs/truffle/how-to/truffle-with-metamask/ [Last Accessed: 29 November 2023]
[13] https://www.simplilearn.com/tutorials/blockchain-tutorial/what-is-solidity-programming [Last Accessed: 29 November 2023]
[14] https://www.datastax.com/guides/what-is-web3js [Last Accessed: 29 November 2023]
[15] https://cointelegraph.com/news/how-to-use-ganache-for-blockchain-project-development [Last Accessed: 29 November 2023]