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Detection of Counterfeit Products Using Blockchain

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Abstract— Supply chain management frequently faced issues such as service redundancy, poor coordination between several departments, and lack of standardization because of the lack of transparency. Product counterfeiting is very common nowadays and it's almost impossible to detect a counterfeit product just by looking at it. Counterfeiters cause significant challenges for legitimate firms, yet far too many people have no idea of the entire number of counterfeit items' influence on brands. There are several methods devised in the past to get away with this problem of product counterfeiting. The most popular methods are using RFID tags, Artificial Intelligence, QR code-based systems, etc. But each of them had a few disadvantages such as the QR code being copied from a genuine product and placed on a fake product, artificial intelligence using CNN and machine learning which needs heavy computational power, and so on. The idea of this project is to improve the detection of fake products by tracking their supply chain history. This is achieved with Blockchain technology, which ensures the identification and traceability of real products throughout the supply chain. The blockchain-based system makes everything decentralized and may be accessed by several parties at the same time. One of its main advantages is that the recorded data is difficult to change without the consent of all parties concerned, which makes the data extremely secure and protective from all vulnerabilities. This paper presents a system designed using blockchain technology for the detection of counterfeit products.

KEYWORDS:
1. BLOCKCHAIN
2. METAMASK
3. CNN
4. SQL

I. INTRODUCTION

Product counterfeiting happens when a product is sold pre-tending to be another product. It is consumer fraud and commonly defined as deceptive business practices that cause consumers to suffer financial or other losses. Ac- According to the Authentication Solution Providers' Association it costs the Indian economy INR 1 trillion every year. Counterfeit incidents increased by 20% on average between 2018-20.[1]. Counterfeit goods include counterfeit handbags, clothing, cosmetics, and electronics. It not only has negative effects on the economy but on citizens too. For example, poor cosmetics can affect the skin and cause skin diseases and rashes, and counterfeit electronic components can cause a malfunction in gadgets and can lead to unfavourable situations and mishaps. Poor quality clothes, and shoes when worn can cause discomfort. Hence this issue necessitates finding some solution for the sale of counterfeit products. Another consequence of counterfeiting is that a company's reputation. Because many customers are clueless that the object they are holding is a knock-o↵, they will accuse the genuine company if the Knockroe product fails to perform properly, comes apart rapidly, or fails to satisfy their expectations. Customers demand compensation, either in the form of a refund or a new product, and they seek it out directly from a legitimate company. A lot of affected businesses may find themselves in a scenario where they are dealing with an unhappy customer who is complaining about the bad quality of the item, and the customer care representative is unaware that the item in question is a counterfeit. Companies are caught in a tough situation, attempting to avoid wasting time and effort dealing with poor imitations of their goods while yet trying to keep their customers pleased. The harm caused by counterfeiters extends beyond customer relationships. Because of the behaviours of counterfeiters, distributors, retailers, and other business partners frequently lose faith in legitimate enterprises. The most successful mitigation measures for overcoming misleading counterfeit risk in global supply chains include network transparency, cost control and pre-supply evaluation approaches, and supplier relationship management. Hence the objective of this paper is to present the system designed for anti-counterfeit using Blockchain technology and to give end users and suppliers power to track the supply chain of products in a secure environment. An overview of the proposed system is aimed at solving the problem of brand counterfeiting and providing the chance for the customer, vendors, and suppliers to check the integrity of the product. The paper is organized as follows: The detailed explanation of Blockchain with its working and features is mentioned in section 2. Section 3 offers a comprehensive review of the literature. The proposed System in Section 4 includes the system model and the flow of the system. The simulation results for the proposed method are presented in Section 5. Section 6 is where the paper ends with the conclusion.

II. BLOCK CHAIN

Blockchain is a collection of blocks that are linked together and store information. Each block has a timestamp, transaction data, hash of its own, and hash of the previous block, so it is difficult to tamper with data. Blockchain is a decentralized system. It ensures that every new block added to the blockchain is the only true version that is agreed upon by all nodes in the Blockchain. It refers to the collective maintenance of a technical solution that maintains a continuous record file as a reliable database through decentralization [2][3][4].

2.1 WORKING OF BLOCKCHAIN

When a new transaction is entered, it is then transmitted in a network of peer-to-peer computers scattered across the world. The network of computers then solves the equations to confirm the validity of the transaction. They are called miners. Once confirmed to be legitimate transactions, they are clustered together into blocks. The miner then receives an award as proof of work. These blocks are then chained

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together creating a long history of all permanent transactions. The transaction is complete. The whole procedure is done as shown in figure 1.[5][6]

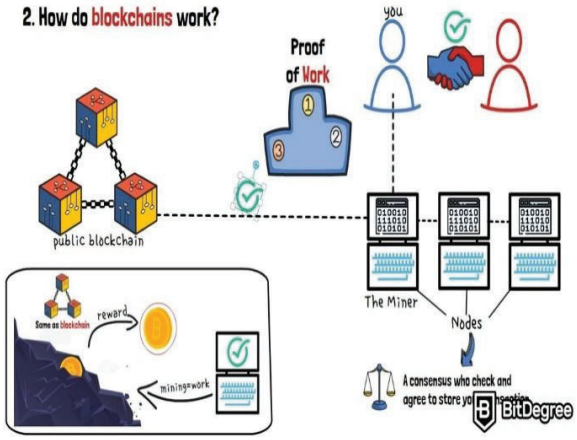

Figure 1: Working of Blockchain [6]

2.2 BLOCKCHAIN FEATURES

Blockchain can add data records to its database which does not depend on any centralized authority as an arbitrator, instead, it works on its consensus algorithms. Blockchain is an openly available database and is highly reliable. The features of Blockchain technology are described in detail below. The features of Blockchain are shown in figure 2.

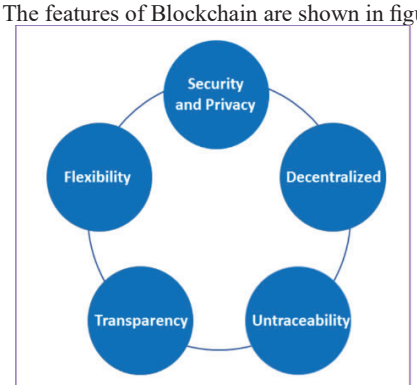

Figure 2: Features of Blockchain

1. Security and privacy: Blockchain uses cryptography to secure this data. Private key is used to sign the data, using public key we can verify whether the data has been tampered or not and check its genuine- ness. A user should protect its private key like bank OTP and passwords and prevent it from leaking to ensure the security of its data on blockchain [5][7][8].
2. Decentralized: In a decentralized blockchain network, no one has to know or trust anyone else. Each member in the network has a copy of the same data in the form of a distributed ledger. If a member's ledger is altered or corrupted in any way, it will be rejected by most of the members in the network [5][7].
3. Untrace ability: Once the block is entered into the blockchain, it cannot be tampered with. Due to this if the block in the Blockchain is altered and is immediately rejected or deleted.
4. Transparency: The data in Blockchain is completely public and can be viewed by the participants.
5. Flexibility: Being open source is one of biggest advantages of blockchain. Various public and private blockchains are available to the users, which can be used based on type of application which has to be created [5][7].

2.3 IMPORTANCE OF BLOCKCHAIN:

Blockchain increases trust as we don't have to depend on any third party. The smart contracts which are programs on blockchain are run only when certain conditions are met. Since all the blocks store their data along with the hash of the previous block it becomes difficult to modify the blockchain with false information. If the attacker changes the information of the block, its hash also changes but the hash of the next block remains the same. To alter the chain would require the consensus of more than half of the participants which is unlikely since lots of resources and financial amount is required. Also, other members would come to know of this drastic change [5].

3 LITERATURE SURVEY:

The survey focused on understanding the sources of counterfeits and, their impact on society. There exist various systems of fake product detection, which use Artificial Intelligence, QR codes, Machine Learning, and Blockchain. The methods discussed by Shaik included the use of providing products with public and private keys as QR codes, the app used to scan the QR should have crypto-graphic functionality to decrypt the QR code. The manufacturer is also supposed to run a server to accept requests and match the buyer's name and item code. The scanning app should have cryptographic functionality to decrypt the ciphertext of the item code encoded in the QR code [9]. Benattia and Baudry et.al explain that traceability-CPS-based architecture for supply chain management consists of several layers that interact to form a traceability-CPS. Also, the proposed architecture allows supply chain monitoring and data analytics to enhance the product. Safety and quality. The proposed algorithm consists of computing the most frequent item sets in the product transaction database. These item sets are then used as genuine product trajectories and can serve in detecting abnormal product behaviour [10]. Khalil and Doss et.al come up with the solution of using RFID based system to reduce counterfeiting. This system allows consumers to query in-store the tag attached to an item to verify its legitimacy. RFID-based anti-counterfeiting and anti-theft schemes are suitable for large-scale implementation in retail environments. Tran and Hong's anti-counterfeiting protocol is used. This system is immune to DOS attacks [11]. Habib and Sardar et.al explain SCM trends. They are examined in their work process that executives' difficulties and transaction issues are problems featured in the SCM. Hence posed a solution, Daoud and Vu et.al focus on the architecture of AI Applications. It has three main parts: the data set, detection models, and trained model. Anti-counterfeiting machine learning-based solution to detect fake products. Training models step and detecting logo step are the two steps of re-SCM by considering the blockchain as a technological feature for solving them. The primary method for structuring new models should find the transaction process at a plan level [12]. Daoud and Vu et.al focus on the architecture of AI Applications. It has three main parts: the data set, detection models, and trained model. Anti-counterfeiting machine learning-based solution to detect fake products. Training models step and detecting logo step are the two steps required for training speed. Faster R-CNN achieves high accuracy and low Chen and Shi et.al explains SCQI. Framework for blockchain-based SCQI

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provides a theoretical basis for intelligent quality management of supply chains based on blockchain technology. RFID technology is used to record quality information and transaction information. Smart contracts are used to execute quality control and improve the efficiency of the supply chain [14]. Toyoda, Kentaroh, and Mathiopoulos, P Takis et.al Proposed a system to detect fake products with the help of a QR code. End users can scan the QR code assigned to the product to get the product details and transaction history, the steps in- volved Product enrolment, shipping the product to the distributor, and shipping the product to a retailer, the end user gets details about the product Block Chain Data [15]. In a Blockchain-based system, the data is stored on each node, and then the nodes exchange information with each other over the network. Each node maintains all the node verifies the received transactions and includes them in the new block based on its own Blockchain data and tries to obtain the rights of the new block. Ethereum is the back end Blockchain operating system. Store relevant information on product sales in Blockchain which is accessible to everyone. It is cost efficient [7]. In this blockchain technology for information sharing is proposed. This information is in the control of the owner so third-party interference is difficult. Users are always aware of the data that is being collected about them and how it is used. The blockchain block contains the sender, amount, receiver, transaction ID, product ID, and metadata [16]. Ethereum is an open-source Blockchain. Ethereum is a technology that's home to digital money, global payments, and applications. The process is simple get into the portal, pick a wallet that lets you connect to Ethereum and manage your funds, Get the ETH, use applications powered by Ethereum, and start building [17]. Abhijeet and Adrew et. al. [18] discuss various findings on counterfeiting in global supply chain environments based on various papers and online surveys of professionals targeted at a national purchasing body and affiliated UK purchasing groups. It was found that counterfeiting is widely increasing in areas of low-cost spare parts and sectors like the drug market. Strategies used by industries to tackle this problem include avoidance, prevention based on previous experience, and destruction. The counterfeit products were difficult to identify for customers due to the availability of forged certificates. The limitations of the existing systems are that brands use QR codes on products to prove the validity of the product. However, the QR code can be copied and used to label counterfeit products [9]. In the RFID-based system, low-cost RFID tags can be used for auto identification of products, but due to the cloning of RFID tags, this method is not suitable [14]. In AI and machine learning applications, CNN takes more time and memory. It needs a training and testing phase before its actual deployment. Artificial Intelligence fails to detect tag reapplication attacks, wherein a counterfeiter removes a legitimate tag from a genuine product and reapplies it to a counterfeit or expired product [13]. There is no power for the customer, suppliers, and retailers to check the integrity of the product.

4 PROBLEM STATEMENT:

The proliferation of counterfeit products poses significant challenges to industries worldwide, undermining consumer trust, compromising safety, and causing financial losses to businesses. Traditional methods of product authentication and supply chain tracking are often inefficient, prone to tampering, and lack transparency. This project aims to leverage blockchain technology to develop a secure, decentralized, and tamper-proof system for detecting counterfeit products. By assigning unique digital identities to products and recording their lifecycle on an immutable blockchain ledger, the system will enable real-time verification of authenticity, enhance supply chain transparency, and empower consumers to make informed purchasing decisions. The solution will integrate smart contracts, QR codes, and a user-friendly interface to ensure seamless interaction and robust security.

5 PROPOSED SYSTEMS:

Counterfeit has spread worldwide and has huge effects on organizations, manufacturers, and consumers. It affects the influence of the organization and the well-being of the consumers. India is not excluded. The proposed system is aimed at consumer products, and it helps track the products by maintaining the product and the supply chain integrity by using Blockchain. This gives the customers the power to track the history of the entire product from the manufacturer to the customer using blockchain and QR codes.

5.1 SYSTEM MODEL:

The proposed system will be a decentralized application (Dapp) which will be implemented using the Ethereum Network as the main blockchain for keeping all the records and managing the transactions regarding the products of the companies listed on Dapp. The basic system architecture is shown in figure 3.

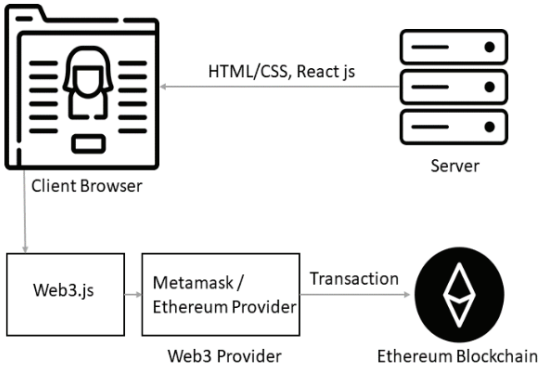

Figure 3: System Architecture [19]

Ethereum is a decentralized blockchain which uses a proof-of work consensus mechanism. Proof-of-work is adding block to the blockchain by solving the mathematical expressions. Solving the puzzle "proves" that nodes have done the "work" by using computational resources. It confirms that the block is added and recorded in the blockchain. This process is known as mining. Mining is typically brute force trial and error, but successfully adding a block is rewarded in Ethereum (ETH) [17][19].

Smart contract

Smart contracts are programs that are stored inside Blocks. Smart contracts replace the involvement of third-party members. These are basically protocols that are executed when the

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conditions are satisfied. They never change, which means no one can tamper with the contract [19].

5.2 FLOW OF PROPOSED SYSTEM:

The main aim of this proposed system is to maintain the Genuity of the product by helping the customer track the supply chain history of the product. The system gives customers the power to track the history of an entire product from the manufacturer to the customer using blockchain. This product anti-counterfeiting system based on Blockchain is composed of three roles, the Manufacturer role, the Seller role, and the Consumer role, as discussed and shown in figure 4.

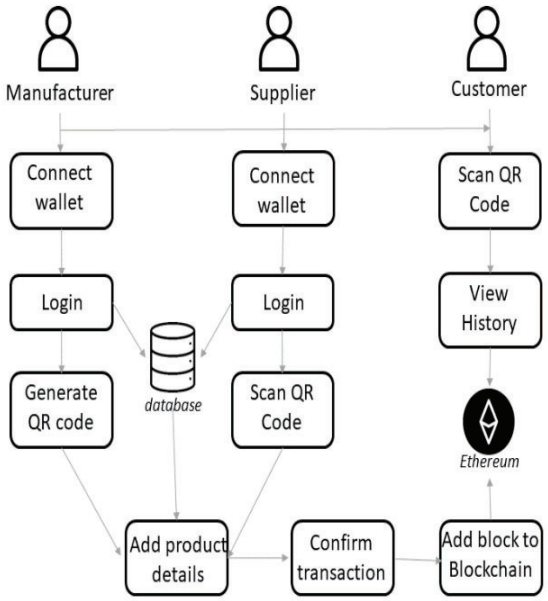


Figure 4: System Flow

Manufacturer:

The manufacturer logs into the manufacturer account generates a QR Code for the Product and adds other required details of the product by using his Ethereum wallet, the manufacturer adds a block to the Ethereum blockchain. The user ID of our local database and the wallet address of the entity will be mapped together, if both the things are there, that is a manufacturer logs in from his account and uses his wallet then only the block will be added to the digital ledger.

Supplier:

Supplier logs into supplier account and scans the QR code on the product. The seller can access information about his products that the manufacturer has entered. It adds its own details of the product like shop destination and pushes it into the Blockchain. Those details can be viewed by the buyer.

Customer:

Customers can check the integrity of the product by scanning the QR code which will list the history of transactions and thus verify the authenticity of the product. At the time of customer purchases the product after the QR scan in the supply chain history, if the last location is not matched with the purchase location, the customer will know that the product is not genuine. It concludes that the QR code was copied, and the customer becomes aware of counterfeiting. The process of detecting a counterfeit product by the customer while purchasing is shown in figure 5.

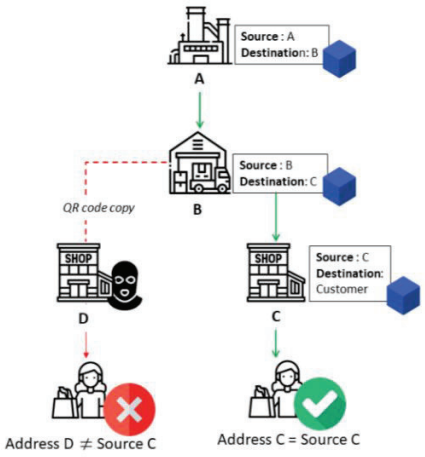


Figure 5: Dealing with Counterfeit Product

6 RESULT AND DISCUSSION:

The proposed system allows both manufacturers and suppliers to interact with the system to add their respective blocks containing the transaction details to the blockchain without modifying the other blocks. The contracts for the manufacturer and supplier block are written using solidity. Since the code is running on a local network ganache has been used for local testing. The host"127.0.0.1", and port 7545 are configured in true-config.js file. The contracts are then compiled and deployed using a true-config.js file. Migrations files are created for deployment. Migrations are files that help us to deploy contracts on an Ethereum blockchain network. The interface is created using React. To allow interaction with the Ethereum blockchain Web3.js library is used to perform actions like sending ether, confirming transactions, and reading and writing data from smart contracts. MetaMask is installed on a browser which is a wallet to interact with the Ethereum blockchain, to allow access to the Ethereum wallet through a browser. Accounts from ganache are imported into MetaMask. To add supplier and manufacturer block they must confirm the transactions using their account using MetaMask wallet which is connected using Web3.js.The end-user can then check the supply chain by scanning the QR code to check the product's integrity. Accounts can be categorized into manufacturer, supplier, and customer as shown in Figure 6. The manufacturer connects to his Ethereum account using the Meta-mask Wallet as shown in Figure 7.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 05, IIRA 5.0 (2026)

Figure 6: Landing Page

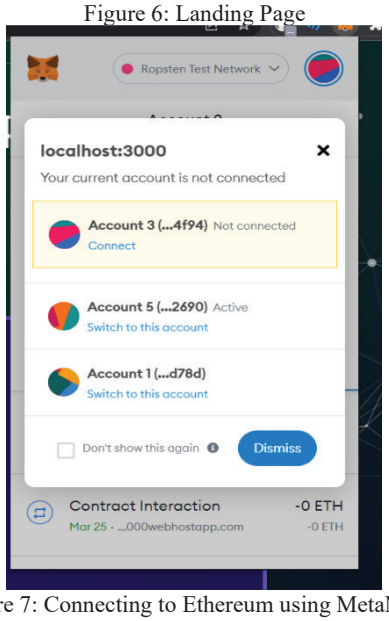
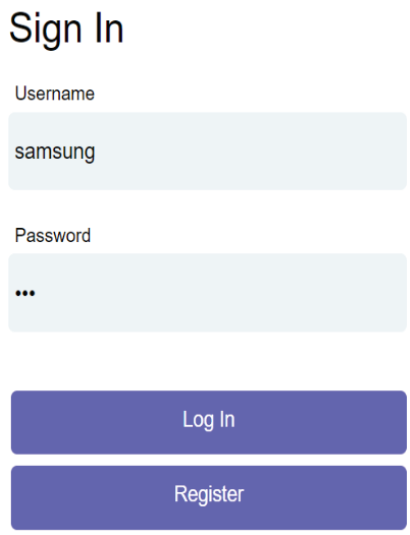


Figure 7: Connecting to Ethereum using MetaMask

The Manufacturer logs into his account using his credentials like username and password.



9. L database is used for storing manufacturer and supplier login details and their address.

id	name	uid	addr	category	password
10	samsung	26513	Samsung Electronics Huizhou Co., Ltd., Industrial ...	Electronics	202cb962ac
59	louis_vuitton	65464	116 Greene St, New York, NY 10012, United States	Fashion	df2a3e9e50

Figure 9: SQL Database

As shown in Figure 10, after logging into his count the manufacturer assigns a unique serial number for the product and generates its QR Code. This QR code is placed on the product when it is transported to other places. Along with this, the manufacturer fills other details of the product like its name, current address that is the source and destination where it is currently headed. Once all the details are filled the manufacturer clicks the add block button which is used to add all the filled details to the blockchain.

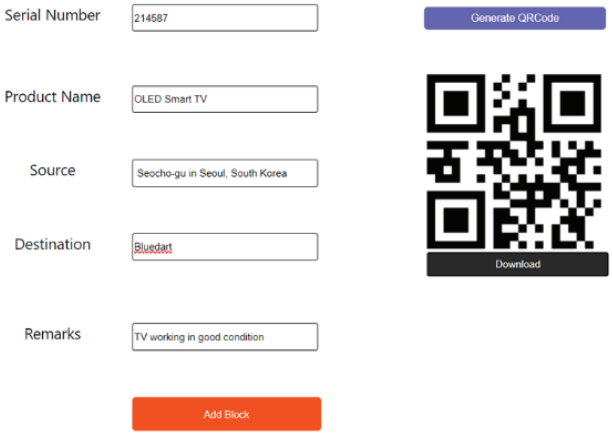


Figure 10: Manufacturer adding the details of the product

A MetaMask confirmation popup is displayed which asks for confirmation as in Figure 11.

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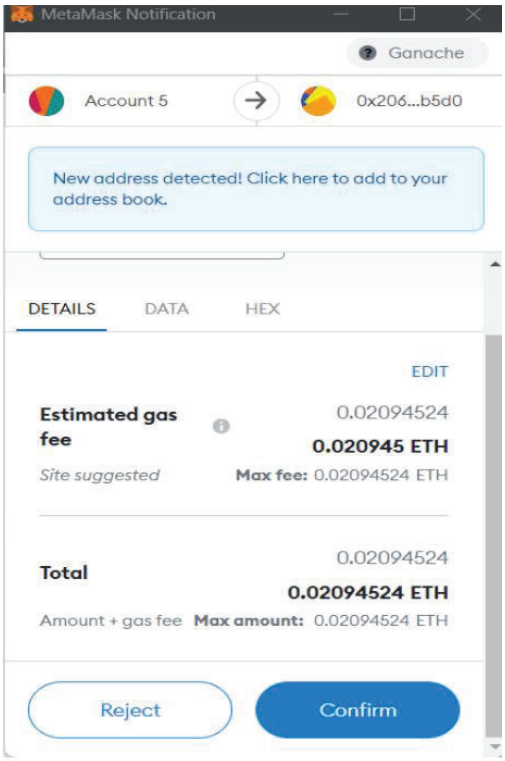

Figure 11: Completing the transaction with MetaMask wallet

Once confirmed the block containing all details is added to the blockchain and the success page is displayed as shown in Figure 12.

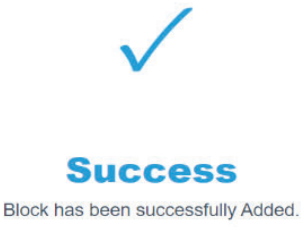

Figure 12: Message after the addition of block to the blockchain

Once the product reaches the supplier destination, the supplied needs to log into his account shown in Figure 13 and connect his MetaMask wallet.

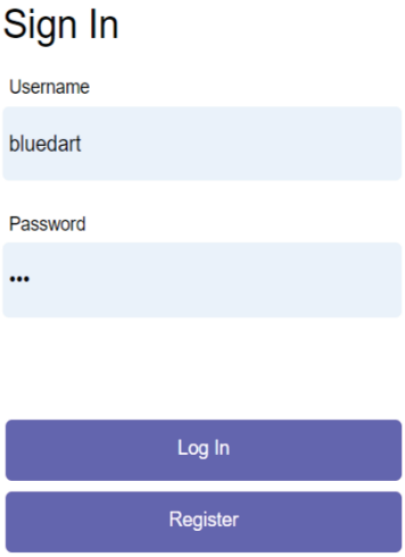

Figure 13: Supplier Login page

Once done the supplies is presented with screen to fill in the required details of product. This time the supplier doesn't generate the QR code, the supplier clicks on scan QR and scans the QR code. The supplier enters the required details for the product and clicks on add block as shown in Figure 14. The block gets added after the supplier confirms his transaction through the MetaMask wallet and logs out.

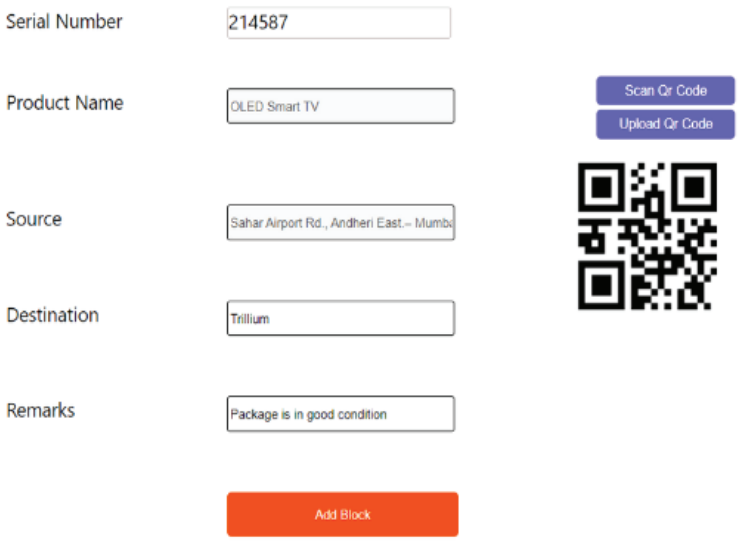

Figure 14: Supplier adding details of the product

Other supplier involved similarly log into their account and adds their respective blocks to the blockchain. After the product reaches the customer he can visit the customer page, scan the QR code as shown in Figure 15 and check the complete supply chain history of product.

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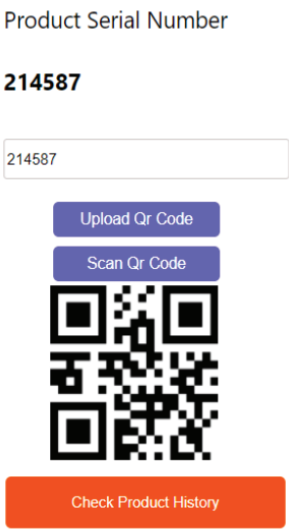

Figure 15: Customer page to check supply chain history of the product

The supply chain history as shown in Figure 16 and Figure 17 shows various information of like the product id, its name , source , destination address related to the entities involved , their Ethereum account address , times- tamp of when the block was added ,and any additional re- marks if added.

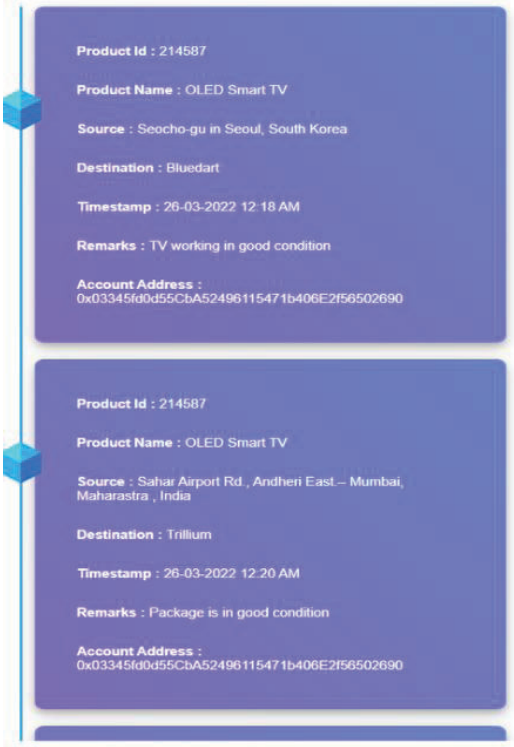

Figure 16: Supply chain history-1.

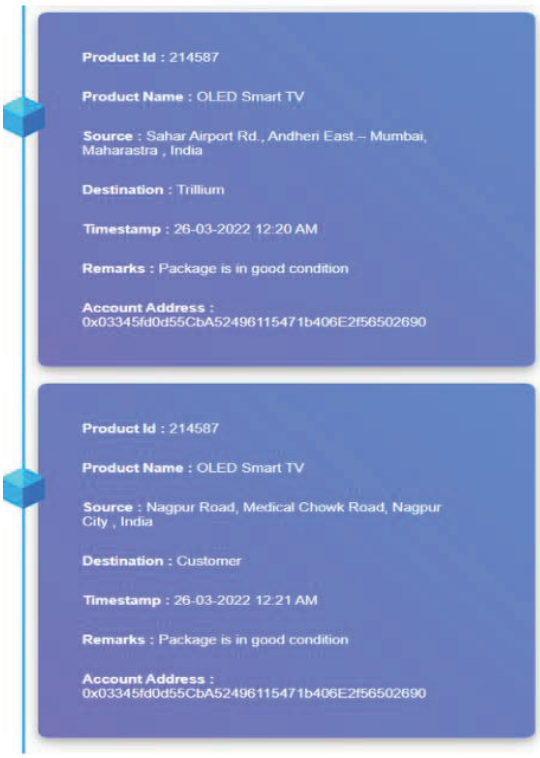

Figure 17: Supply chain history-2

At the time of customer purchases the product after the QR scan in the supply chain history, if the last location is not matched with the purchase location, the customer will know that the product is not genuine. It concludes that the QR code was copied, and the customer becomes aware of counterfeiting.

7 CONCLUSIONS:

Blockchain is a decentralized system, therefore the local suppliers cannot interfere with the checking or counterfeiting of the product in the proposed system. Manufacturers and Suppliers can use the system to store product details in Blockchain which offers certain properties such as tamper-resistance, data consistency, and confidentiality that assure the security and privacy of the data on the network. The customer views the product's supply chain history and verifies if the product is genuine. Customers can be sure about the integrity of goods they purchase. The proposed system can effectively lower the rate of counterfeiting of branded goods and provide the companies with an easier approach to provide consumers with the confidence that they will not purchase counterfeit goods. This system will help to build trust and good bonding between manufacturers and customers and indeed it will help in improving the economy and reducing corruption. Further systems can be extended to avoid fraud in banking, healthcare, voting systems, online shopping, and so on.

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