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Counterfeit Product Detection Using Blockchain Technology

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***Abstract*: In recent years, Counterfeit products play an important role in product manufacturing industries. This affects the companies name, sales, and profit of the companies. Blockchain technology is used to identification of real products and detects fake products. Blockchain technology is the distributed, decentralized, and digital ledger that stores transactional information in the form of blocks in many databases which is connected with the chains. Blockchain technology is secure technology therefore any block cannot be changed or hacked. By using Blockchain technology, customers or users do not need to rely on third-party users for confirmation of product safety. In this project, with emerging trends in mobile and wireless technology, Quick Response (QR) codes provide a robust technique to fight the practice of counterfeiting the products. counterfeit products are detected using a QR code scanner, where a QR code of the product is linked to a Blockchain. So, this system may be used to store product details and generated unique code of that product as blocks in the database. It collects the unique code from the user and compares the code against entries in the Blockchain database. If the code matches, it will give a notification to the customer, otherwise it will give the notification to the customer that the product is fake.**

***Keywords*: Counterfeit product, QR code, Blockchain, Solidity, Smart contracts.**

1. Introduction

The global development of products and technologies entails risks such as counterfeiting and duplication, leading to potential harm to a company's reputation, revenue, and customer well- being. To address this issue, blockchain technology can be employed, offering a secure and tamper-resistant way of recording information. A blockchain is a decentralized digital ledger that duplicates and distributes transactions across a network of computers. Each block in the chain contains multiple transactions, and new transactions are added to all participants' records. By generating a hash code for each product and creating a chain of transactions, blockchain ensures the genuineness of products. A proposed system involves assigning a QR code to a product, allowing end customers to scan it and access comprehensive information, thereby verifying the product's authenticity.

A. Objective of Project

The idea of this project came into existence because of the increase in the counterfeit products. The objectives of this

1. To Design Anti Counterfeit System using Blockchain.
2. To secure product details using a QR code and image.
3. Provide security to the clients by offering data to client.

B. Scope and Limitation of Project

In recent years, the spread of counterfeit goods has become global. There are many fake products in the current supply chain. According to the report, fake product incidents have risen in the last few years. It is necessary to have a system for customers or users to check all the details of the product so that users can decide that the product is real or fake. In India currently, there is no such system to detect counterfeit products. So, the solution involves a simple QR code-based identification that can help the end-user or customers to scan and identify the genuineness of the product by using a smartphone.

The limitations of using blockchain for fake product detection are as follows:

1. *Data accuracy:* The integrity of the blockchain relies on accurate data entry; incorrect information can compromise its effectiveness and lead to false verification results.
2. *High implementation costs:* Implementing blockchain can be expensive, especially for small businesses, potentially limiting its widespread use and effectiveness.

2. System Design

A. System Architecture

System architecture refers to the design and organization of software and hardware components of a system to meet certain functional and non-functional requirements.

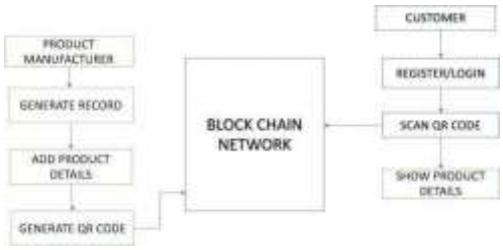

Fig. 1. System architecture

3 Blockchain

Blockchain is collection blocks that are linked together which stores information. Each block has a timestamp, transaction data and hash of its own and hash of 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 one and 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].

3.1 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 solve 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 a proof of work. These blocks are then chained together creating a long history of all transactions that are permanent. The transaction is complete.Whole procedure is done as shown in figure 1.[5][6]

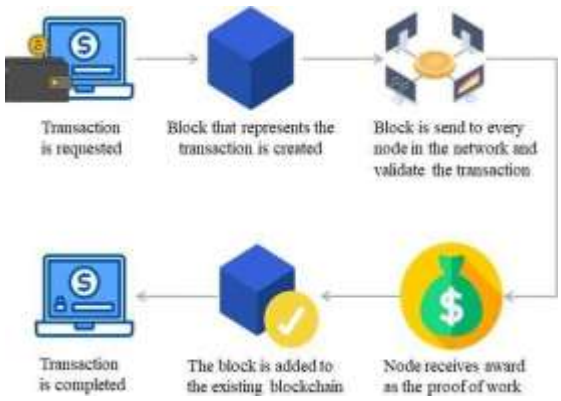

Figure 1: Working of Blockchain [6]

3.2 Blockchain Features

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

Figure 2: Features of Blockchain [7].

1. Security and privacy : Blockchain uses cryptogra- phy to secure its 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 similar to bank OTP and passwords and prevent it from leak- ing to ensure the security of its data on blockchain [5][7][8].

2. Decentralized : In a decentralized blockchain net- work, no one has to know or trust anyone else. Each member in the network has a copy of the exact same data in the form of a distributed ledger. If a mem- ber's ledger is altered or corrupted in any way, it will be rejected by the majority of the members in the network [5][7].

3. Untraceability : Once the block is entered into the blockchain, it cannot be tampered. Due to this if the block in the Blockchain is altered and is immedi- ately 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 ad- vantages 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].

3.3 Importance of Blockchain

Blockchain increases trust as we don't have to depend on any third party. The smart contracts which are basically programs on blockchain are run only when certain condi- tions are met. Since all the blocks stores its data along with hash of previous block it becomes difficult to modify the blockchain with false information. If attacker changes information of block , it's hash also change but the hash of next block remains same. To alter 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].

4 Literature Survey

The survey focused on understanding the sources of coun- terfeits, impact on the 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 product with public and private keys as QR code, the app used to scan the QR should have crypto- graphic functionality to decrypt the QR code. The man- ufacturer is also supposed to run server to accept request and match the buyers name, and items code. The scanning app should have cryptographic functionality to decrypt ci- phertext of the item code encoded in the QR code [9]. Be- natia and Baudry et.al explains traceability-CPS based ar- chitecture 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 analytic to enhance product. Safety and quality. The proposed algorithm con- sist on computing the most fre- quent item sets in the prod- uct transaction database. This item sets are then used as genuine product trajectories and can serve in detecting ab- normal product behavior[10].

Khalil and Doss et.al comes up with the solution of using RFID based system to reduce counterfeiting. This system allows consumers to query in-store the tag at- tached to an item to verify its legitimacy. RFID-based anti-counterfeiting and anti-theft schemes are suitable for large scale implementation in retail environments. The proposed scheme is lightweight and suitable for imple- mentation using low-cost passive RFID tags. Tran and Hong's anti- counterfeiting protocol are used. This system is immune to DOS attacks [11]. Habib and Sardar et.al gives explanation on SCM trends. They are examined in

their work process that executives' difficulties and transac- tion issues are problems featured in the SCM. Hence pro- posed a solution, SCM by considering the blockchain as a

technological feature for solving them. Primary method for structuring new models should find the transaction pro- cess at a plan level [12].

Daoud and Vu et.al focuses on the architecture of AI Application. 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 re-quired. Faster R-CNN achieves high accuracy and low training speed [13]. Chen and Shi et.al explains SCQI. Framework for blockchain based SCQI provides a theo-retical basis to intelligent quality management of supply chains based on blockchain technology. RFID technology is used to record quality information, trans- action infor-mation. Smart contracts are used to execute quality control and improve the efficiency of the supply chain [14]. Toy- oda, Kentaroh and Mathiopoulos, P Takis et.al Proposed system to detect fake product with the help of QR code.

End users can scan the QR code assigned to product to get the product details and transaction history, the steps in- volved Product enrolment, ship product to distributor, and ship product to retailer, end user gets details about the pro- duc [15].

In a Blockchain based system the data is stored on each node, then the nodes exchange information with each other over the network. Each node maintains all Blockchain data. The node verifies the received trans-actions and include them in the new block based on its own Blockchain data, and try to obtain the rights of the new block. Ethereum as the back-end Blockchain oper- ating system. Store relevant information on product sales in Blockchain which is accessible to everyone. It is cost efficient [7]. In this blockchain technology for informa- tion sharing is proposed. Is this the information is in the control of the owner so third party interference is diffi- cult. Users are always aware of the data that is being collected about them and how it is used. The blockchain block contains sender, amount, receiver, transaction id, product id and metadata [16]. Ethereum is a open-source Blockchain.Ethereum is a technology that's home to dig- ital money,global payments and applications.The process is simple as to get into the portal,pick a wallet that lets you connect to Ehereum and manage your funds , Get the ETH, use applications powered by Ethereum, start building [17].

Abhijeet and Adrew et. al.[18] discusses various find- ings on counterfeiting in global supply chain environments based on various papers and online surveys of profession- als 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 drug market. Strategies used by industries to tackle this problem include avoidance, prevention based on previous experience, destruction. The counterfeit prod- ucts were difficult to identify for customers due to avail- ability of forged certificates.

The limitations in the existing systems are that brands used QR codes on products to prove the validity of the product.But the QR code can be copied and used to la- bel counterfeit products[9]. In the RFID based system that low Cost RFID tags can be used for auto identification of products, but due to cloning of RFID tags, this method is not suitable [14]. In AI and machine learning application, CNN takes more time and memory.It needs training and testing phase before its actual deployment.Artificial Intel- ligence 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 prod- uct [13]. There is no power for the customer,suppliers and retailers to check the integrity of product.

5 Working

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 architec- ture is shown in figure 3

Ethereum

It 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 replaces the involvement of third- party members. These are basically protocols that execute when the conditions are satisfied. They never change, that means no one can tamper with the contract [19].

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. System give cus- tomers the power to track the history of an entire prod- uct from manufacturer to 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.

Customer:

Customers can check the integrity of the product by scan- ning QR code which will list the history of transactions and thus verifying the genuinity of the product. At the time of customer purchasing the product after the QR scan in supply chain history, if the last location is not matched with the purchase

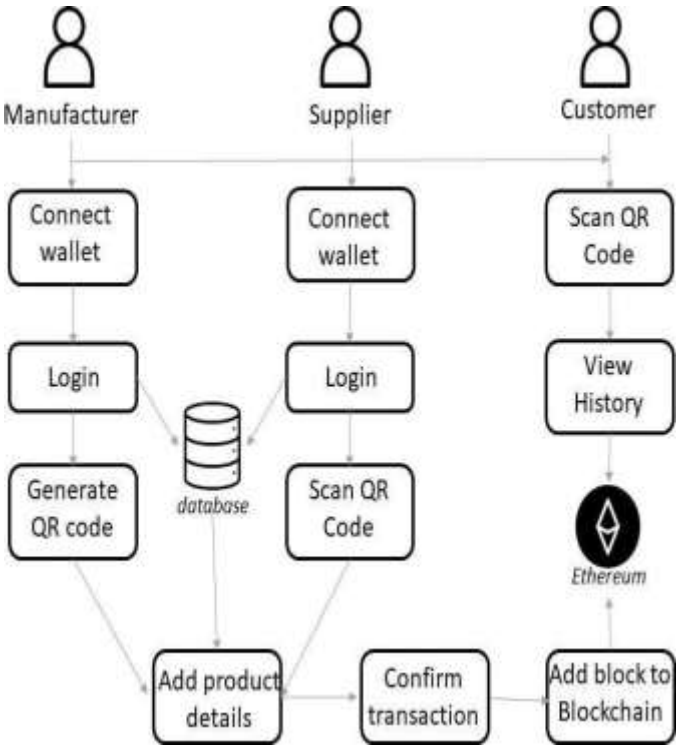

Figure 4: System Flow.

Manufacturer:

Manufacturer logs into the manufacturer account and generates QR Code for Product and adds other required details of the product and by using his ethereum wallet, the manufacturer adds a block to Ethereum blockchain. The userid 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 own account and uses his own 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.

The process of detecting a counterfeit product by the customer while purchasing is shown in figure 5.

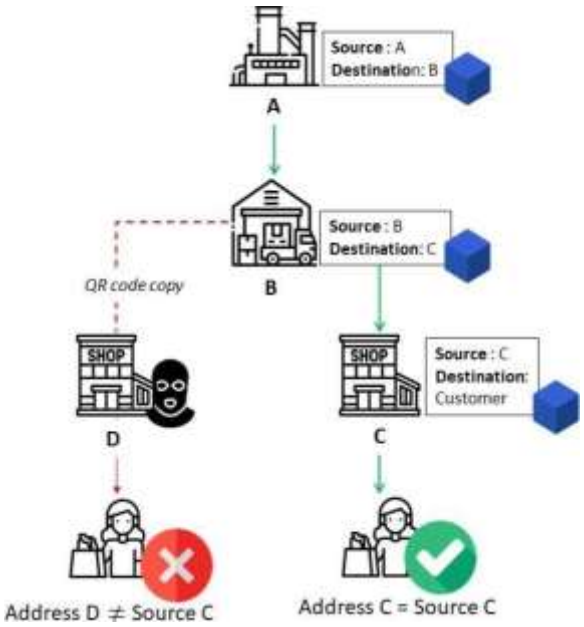

Figure 5: Dealing with Counterfeit Product.

5 Result and Discussion

The proposed system allows both manufacturers and sup- pliers to interact with the system to add their respec- tive block containing the transaction details to blockchain without modifying other's block. The contracts for the manufacturer and supplier block are written using solidity. Since the code is running on local network ganache have been used for local testing. The host"127.0.0.1", and port 7545 is configured in tru✏e-config.js file. The contracts are then compiled and deployed using tru✏e. Migrations files are created for deployment. Migrations are files that help us to deploy contracts on an ethereum blockchain net- work.

The interface is created using React. To allow in- teracting with ethereum blockchain Web3.js library is used which is used to perform actions like sending ether, confirming transactions reading and writing data from smart contracts. Metamask is installed on a browser which is a wallet to interact with ethereum blockchain, to allow accessing ethereum wallet through a browser. Accounts from ganache are imported into the metamask. To add supplier and manufacturer blocks they have to 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 integrity.Accounts can be categorized into manufacturer ,sup- plier and customer as shown in Figure 6. The manufac- turer connects to his Ethereum account using the Meta- mask Wallet as shown in Figure 7.

Figure 6: Landing page.

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