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A BLOCKCHAIN-BASED MANAGEMENT SYSTEM FOR DETECTING COUNTERFEIT IN THE SUPPLY CHAIN

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Abstract **-** In recent years, Counterfeit goods play a vital role in product manufacturing industries. This Phenomenon affects the sales and profit of the companies. To ensure the identification of real products throughout the supply chain, functional blockchain technology is used for preventing product counterfeiting. By using blockchain technology, consumers do not need to rely on trusted third parties to know the source of the purchased product safely. Any application that uses blockchain technology as a basic framework ensures that the data content is 'tamper resistant'. Because a blockchain is a decentralized, distributed, and digital ledger that stores transactional records known as blocks of the public in several databases known as chains across many networks. Therefore, any involved block cannot be changed in advance, without changing all subsequent blocks. In this paper, counterfeit products are detected using a barcode reader, where the barcode of the product is linked to a Block Chain Based Management (BCBM) system. So the proposed system may be used to store product details and the unique code of that product as blocks in the database. It collects the unique code from the customer and compares the code against entries in the blockchain database. If the code matches, it will give a notification to the customer, otherwise, it gets information from the customer about where they bought the product to detect counterfeit product manufacturers.

Keywords: counterfeit, supply chain, Blockchain, Ethereum, QR code.

1. INTRODUCTION

A blockchain is a distributed database that is shared among the nodes of a computer network. As a database, a blockchain stores information electronically in a digital format. Blockchains are best known for their crucial role in cryptocurrency systems, such as Bitcoin, for maintaining a secure and decentralized record of transactions. The innovation of a blockchain is that it guarantees the fidelity and security of a record of data and generates trust without the need for a trusted third party. One key difference between a typical database and a blockchain is how the data is structured. A blockchain collects information together in groups, known as blocks, that hold sets of information. Blocks have certain storage capacities and, when filled, are closed and linked to the previously filled block, forming a chain of data known as the blockchain. All new informational follows that a freshly added block is compiled into a newly formed block that will then also be added to the chain once filled. Blockchain is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network. An *asset* can be tangible (a house, car, cash, land) or intangible (intellectual property, patents, copyrights, branding).

Virtually anything of value can be tracked and traded on a blockchain network, reducing risk and cutting costs for all involved. Business runs on information. The faster it's received and the more accurate it is, the better. Blockchain is ideal for delivering that information because it provides immediate, shared, and completely transparent information stored on an immutable ledger that can be accessed only by permissioned network members. A blockchain network can track orders, payments, accounts, production, and much more. And because members share a single view of the truth, you can see all details of a transaction end to end, giving you greater confidence, as well as new efficiencies and opportunities.

2. Background

In this section, we discuss the overview of Block Chain. Specifically, A blockchain is a distributed ledger with growing lists of records (blocks) that are securely linked together via cryptographic hashes. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data(generally represented as a Merkle tree, where data nodes are represented by leaves). The timestamp proves that the transaction data existed when the block was created.

2.1 Overview of BlockChain

Since each block contains information about the previous block, they effectively form a chain (compare linked list data structure), with each additional block

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linking to the ones before it. Consequently, blockchain transactions are irreversible in that, once they are recorded, the data in any given block cannot be altered retroactively without altering all subsequent blocks. Blockchains are typically managed by a peer-to-peer (P2P) computer network for use as a public distributed ledger, where nodes collectively adhere to a consensus algorithm protocol to add and validate new transaction blocks. Although blockchain records are not unalterable, since blockchain forks are possible, blockchains may be considered secure by design and exemplify a distributed computing system with high Byzantine fault tolerance.
A blockchain was created by a person (or group of people) using the name (or pseudonym) Satoshi Nakamoto in 2008 to serve as the publicly distributed ledger for Bitcoin cryptocurrency transactions, based on previous work by Stuart Haber, W. Scott Stornetta, and Dave Bayer.[6] The implementation of the blockchain within Bitcoin made it the first digital currency to solve the double-spending problem without the need for a trusted authority or central server. The Bitcoin design has inspired other applications[3][2] and blockchains that are readable by the public and are widely used by cryptocurrencies. The blockchain may be considered a type of payment rail.

Private blockchains have been proposed for business use. Computerworld called the marketing of such privatized blockchains without a proper security model "snake oil";[8] however, others have argued that permissioned blockchains, if carefully designed, maybe more decentralized and therefore more secure in practice than permissionless ones.

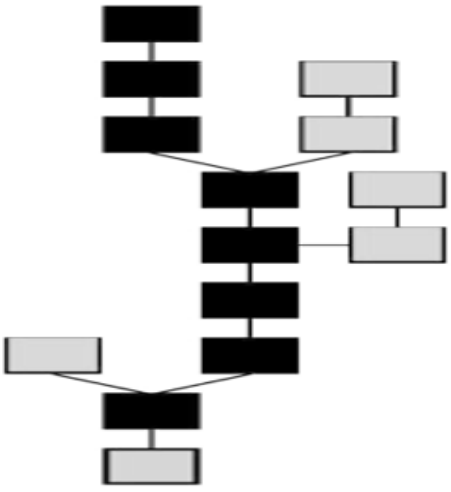

Fig 2.1: Block Chain Formation

Blockchain formation. The main chain (black) consists of the longest series of blocks from the genesis block (green) to the current block. Orphan blocks (purple) exist outside of the main chain.

3. Related work

Various researchers have proposed different methods for establishing a blockchain-based supply chain management system. One of them presented a counterfeit product identification system using an Android application where a product can be searched in the Blockchain network 13]. Another paper displayed a take product detection system using blockchain where SHA-256 Algorithm was used to identify a product 1+1. A fully functional anti-product forgery system was designed by a group of researchers that uses digital signature for vert-fixation 3]. In one of the papers, a blockchain-based Product Ownership Management System was proposed. It displayed the use of a blockchain-based system over traditional RFID-based systems [6]. Another paper presented a food traceability system using lot and block chain collectively. In this model, they used fuzzy logic to evaluate the food quality 171. A paper displayed a system where blockchain was used with RFID to remove the limitation in post-supply chain 18. To improve the current supply chain method a paper used blockchain combined with IOT to track product origin.

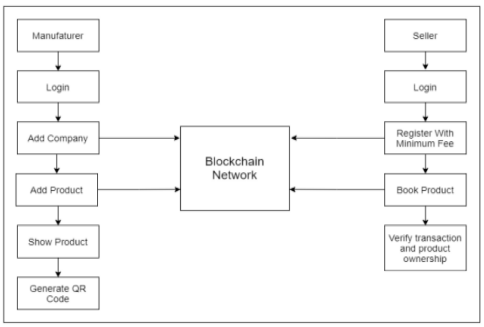

Fig 3: System Diagram

4. Proposed System

In this project, counterfeit products are detected using a barcode reader, where a barcode of the product is linked to a Block Chain Based Management (BCBM) system. So the proposed system may be used to store product details and the unique code of that product as blocks in the database. It collects the unique code from the customer and compares the code against entries in the blockchain database. If the code matches, it will give a notification to the customer, otherwise, it gets information from the customer about where they bought the product to detect counterfeit product manufacturers.They are quick and real-time refurbish, have minimum cost and lower risk in execution, have no

intermediaries, and have high accuracy. The combination of blockchain technology and smart contracts gives more flexibility. Low-cost and easy implement

5. Existing System

They proposed the POM system, which tries to copy the real products of counterfeiters because they cannot prove the existence of products in this system. If the seller does not possess their ownership, consumers can reject the purchase of counterfeit products even with a genuine product code. This technique can discover several fake products such an approach is vulnerable to identical tags. Once the attacker copies the RFID tags attached to the authentic product, and then this counterfeit duplicate label is inserted in the supply chain. The author proposed a decentralized Blockchain technology [3] approach to make sure that users do not trust the sellers to find if products are real.

Therefore, the manufacturer can use this system to provide real products without managing the stores, which operated directly. It can considerably reduce the cost and product quality assurance. The system can effectively lower the threshold of genuine products and provide financial resources to the companies. It is also an easier approach to provide consumers with the confidence that they will not purchase fake products. However, there is no code simplicity and redundancy. Authors have proposed an anti-counterfeiting scheme based on RFID, which is used to detect fake products at the time of purchase by a consumer. In this system, they proposed to use lightweight and low-cost tags used for deployment in large-scale industries. There is no option for product return scenarios, security verification, and applications to test. In this paper, they proposed an open architecture product to trace the genuineness and quality of products and to manage the internet-based credit of manufacturing using chemicals among various builders. The method of that signature is to represent the special characteristics of personalized products. Low accuracy, Low flexibility**,** High cost

6. Methodology

The system proposed here uses a Meta Mask cryptocurrency wallet for transactions and the smart contract here has been deployed to the Rinkeby Test Network of the Ethereum Blockchain. The DApp is based on three major stakeholders, the Manufacturer, the Seller, and the Consumer.

A. System Diagram

Fig.3 depicts the system diagram of the proposed DApp. Every user of the DApp has to be authenticated before logging in. This authentication system has been implemented using Firebase which is a platform provided by Google for developing interactive mobile and web applications. After successful authentication, the manufacturer can add their company to the DApp and enroll products of the company. The contract address of the company is provided to the manufacturer and all the company data as well as the manufacturer's account address are stored in the blockchain network.

After a product has been included in the blockchain, it is assigned a QR code for verification. The sellers can buy products from the manufacturer after registration. The ownership transfer of the product can be tracked through the QR code.

B. Manufacturer

The manufacturer's functions include adding the company to the blockchain by providing the company name and setting the minimum registration fee to become a seller or retailer for the company. The manufacturer solely preserves the rights to enroll products in the network. The manufacturer can also control the distribution status of products and transfer ownership after a seller has bought the product stock.

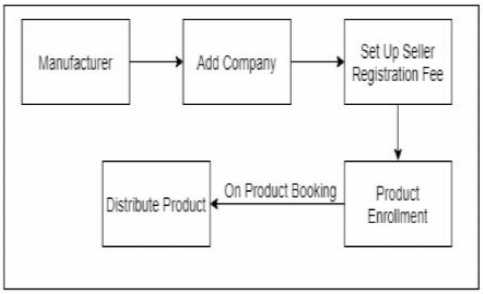

Fig 6: Manufacture's Working Process

The manufacturer performs two major functions namely adding and distributing products in this system. For adding a product Algorithm 1 is used.

Algorithm 1: Create a Product

Input: Product Name, Product Price, Product Stock
Output: Added Product
If msg. the sender is not the manufacturer **then**
throw;
end
else
insert product in product array
end if

For the distribution of the product Algorithm 2 is used. The product and order status in the blockchain is changed through this.

Algorithm 2: Distribute the Product

Input: Product ID
Output: Changed Product Status
if msg sender is not the manufacturer **then**
throw;
end
else
change product status to 'Shipped' and set order status as complete
end if

C. Seller

A seller can pay the minimum fee set by the manufacturer and register for the company. After registering once, the seller can buy any product as well as track its distribution. Product status is set from 'Ready To Go' to 'Shipped' after the manufacturer ships it out to the seller.

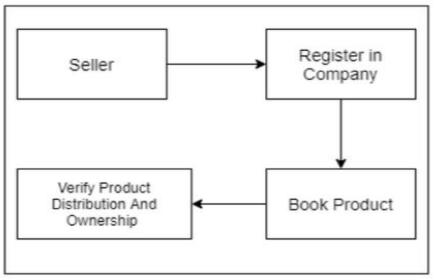

Fig 6.2: Seller working process

Algorithm 3 here is used to make sure a seller pays the minimum registration fee set by the manufacturer.

Algorithm 3: Seller Registration

Input: Minimum amount of registration fee set by the manufacturer
Output: Registered Seller
if msg. the sender is a registered seller or the fee is less than requirement **then**
throw:
end
else
map msg. sender is true
end if

Algorithm 4 here is used by the seller to buy or book products from the manufacturer. It records the seller's data in the blockchain.
Algorithm 4: Buy Product
Input: Product ID, Seller Name, Amount to buy
Output: Set the Current Owner of the product as msg Sender
if msg sender is not a registered seller **then**
throw;
end
else if the msg. value is less than the required amount then
throw;
end
else
set the product owner's name as the seller's name and the store account address of the seller
end if

D. Consumer
A consumer can scan the QR code provided with each product and verify the transfer of ownership of the product from the manufacturer to the seller. The consumer can also verify the name of the current owner of the product and check its distribution status.

E. Blockchain
Blockchain technology provides promising opportunities in the supply chain management paradigm. Blockchain data is stored on nodes where each node has a complete copy of the blockchain database. Orders, payments, accounts, prices of products, etc. can be tracked, shared, and secured using a blockchain network. Some important features of blockchain technology in supply chain management include:
1) Security and Privacy: Blockchain uses the public key encryption method of cryptography for data security. Users have public and private key pairs which are used to validate transactions and these transactions are immutable and permanent.
2) Decentralization: As blockchain is a distributed ledger technology, it doesn't rely on a third party or any centralized authority.
3) Transparency: Data stored in Blockchain is public and anyone can enquire about their transactions. The transactions can be governed by a set of rules known as the smart contract.
The system proposed here uses a Meta Mask cryptocurrency wallet for transactions and the smart contract here has been deployed in the Rinke by Test Network of the Ethereum Blockchain. The DApp is based on three major stakeholders, The Manufacturer, the seller, and the consumer.

F. Ethereum DApp Architecture
Fig. 4 here depicts the base architecture of the system. The user interface (UI) here has been developed using Reacts. If the user wants to interact with the smart contract, the DApp will use Web3.js which communicates with Meta Mask through its provider. Meta Mask creates a transaction and signs it with the user's private key.
This transaction is then sent to the Ethereum network. The transaction is processed, verified, and added to a block in the network. The private keys of the user are never Recorded in the process so the user can safely connect to the network.

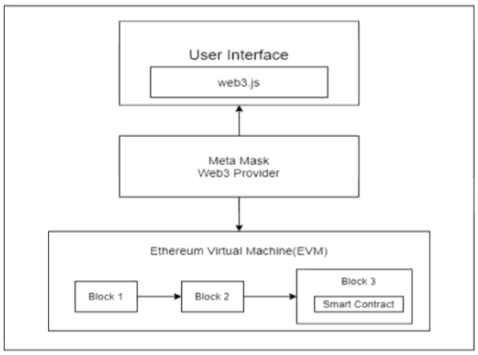

Fig 6.3:Ethereum DApp Architecture

7. RESULT ANALYSIS

Sending data to the Blockchain comes with some cost referred to as transaction cost. Miners tend to prioritize transactions with higher costs. Transaction cost is measured in gas and gas fees are paid in Ethereum's native currency ether (ETH). The table indicates the transaction cost and gas fees required for the proposed system.

Sl No.	Function Description	Transaction Cost (gas)	Gas Fee (ETH)
1	Deploy Contract of our system	133405	0.001333
2	Adding New Company	1068597	0.001069
3	Seller Registration	45755	0.000046
4	Product Enrollment	208571	0.000209
5	Buying Product	41581	0.000042
6	Product Distribution	55578	0.000056
Total=0.002755 ETH/ $8.56			
Deploy= $4.14			

Table1:Cost Calculation

Here Coin Market Cap [101 was used to convert Ether to US dollars. Remix which is a web browser IDE for developing DApp was used to determine the gas needs. Meta Mask was used for contract interaction and determining the costings. The cost for deploying our contract in the Rinke by Test Network is 0.001333 ETH which is equivalent to 4.14 US dollars. The overall cost for the system is less than 10 US dollars which proves the cost-effectiveness of the proposed model.

The product ownership transfer, as well as product quality assurance costs, are also reduced here compared to current market trends to verify product authenticity. A consumer can scan the QR code and verify the ownership transfer of the product. The manufacturer's account address, the seller's account address, and the name as well as the status of the product are recorded in the OR code. If the product status is 'Shipped', the product transfer is genuine and the order is set to 'complete in the blockchain. The QR code is provided with a copy-sensitive digital image pattern.

8. CONCLUSION

The ownership tracking system is being reshaped through distributed ledgers of Blockchain technology. Due to rapid changes in the Ecommerce and business sectors, the current trends of the supply chain are being affected. The DApp developed here ensures greater transparency in the supply chain management and can also be entrusted for use in Ecommerce. As such, administrative costs and complicated proc.

edures are eliminated by this process. Besides, the cost for enrolling each product in the proposed model is only 0.000209 ether which is equivalent to 0.65 US dollars that can sufficiently reduce costs for large chain stores. The model also ensures the end-user verification system through a QR code and transactions here can be verified on Ethersean too. In future work of the proposed model, the functions included can be improved further to bring reliability to supply chain management.

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Ms.Bondu Vennela,Ms.Jeela Sindhu, Ms.Nuthalapati Sevitha are studying B.E., in Computer Science and Engineering from Anna University in 2023.