International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 10 | Oct - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Blockchain-Powered Authenticity a Decentralized Solution for Fake Product Detection

Prof.D.B. Khadse[1], Sahil Tiwari[2], Vivek Wadekar[2,] Shrejal Gautam [2], Sohel Sheikh[2]

Assistant Professor, Department of Computer Science and Engineering, Computer Science and Engineering, Priyadarshini Bhagwati College of Engineering, Nagpur, Maharashtra, India

---

Abstract

Counterfeit products have become a growing concern across industries, significantly impacting financial revenues and consumer safety. Traditional methods for detecting counterfeit goods have proven inadequate, necessitating the need for innovative solutions. This paper presents a blockchain-based system designed to identify and eliminate counterfeit products from the supply chain. The proposed system leverages the immutable nature of blockchain technology to track and verify products using unique QR codes assigned to each item. These QR codes contain encrypted information about the product's origin, manufacturing process, and distribution, which can be scanned and validated at any point in the supply chain. The methodology ensures transparency, prevents tampering, and enhances trust between manufacturers and consumers. The results demonstrate the system's effectiveness in reducing counterfeiting incidents, offering a scalable and secure solution for various industries. This work contributes to the advancement of blockchain applications in supply chain management and product authentication.

Key Words: Blockchain, counterfeit detection, supply chain transparency, QR codes, product authentication, distributed ledger.

1.INTRODUCTION

Counterfeiting is a global challenge that plagues almost every industry, from electronics and automotive to pharmaceuticals and consumer goods. Counterfeit products not only result in significant financial losses for manufacturers and retailers, but they also pose serious risks to consumer safety. For instance, counterfeit automotive parts can lead to vehicle malfunctions, while fake pharmaceuticals can have life-threatening consequences for patients. A 2018 study estimated that counterfeit goods cost global brands over $232 billion annually, with counterfeit drugs alone accounting for over $200 billion of this loss. These counterfeit products infiltrate the market, eroding consumer trust, damaging brand reputation, and impacting economic growth.

In response to this growing threat, various technologies have been employed to detect and eliminate counterfeit products, but many of these solutions have limitations. Traditional methods like RFID tagging, barcode scanning, and holographic labels have proven vulnerable to tampering and duplication. The need for a more robust and secure solution has led to the exploration of blockchain technology.

Blockchain, a decentralized and distributed digital ledger, offers a promising solution to the counterfeit problem by enabling secure, transparent, and tamperproof recording of transactions. Each block in the blockchain contains a record of transactions that is immutable, meaning that once data is added, it cannot be altered. This characteristic makes blockchain an ideal platform for tracking products across the supply chain, from the manufacturer to the consumer. By assigning a unique QR code to each product, which is linked to its blockchain record, it becomes possible to verify the authenticity of the product at any point in the supply chain.

This paper proposes a blockchain-based solution for identifying counterfeit products. The system involves assigning digital identities to products in the form of QR codes, which are linked to a blockchain ledger. Each time the product moves through a stage in the supply chain, its details are updated on the blockchain, providing a transparent and secure way to trace its journey. The blockchain ledger records the product's manufacturing details, ownership history, and transaction records, which can be accessed by consumers and stakeholders to verify its authenticity.

The goal of this system is to significantly reduce the presence of counterfeit goods in the market by providing an unalterable, easily accessible record of a product's origin and history. With the ability to scan a QR code and

access the product's blockchain record, consumers can confidently determine whether the product is genuine or

counterfeit before making a purchase. Similarly, manufacturers can track their products throughout the supply chain, ensuring that counterfeit goods do not enter the market under their brand name.

In addition to enhancing product traceability and transparency, the proposed blockchain system offers significant economic benefits. By reducing the prevalence of counterfeit goods, manufacturers and retailers can protect their revenues and safeguard their brand reputation. Moreover, blockchain's decentralized nature ensures that no single entity controls the data, reducing the risk of fraud and data manipulation. This paper discusses the methodology for implementing such a blockchain-based product verification system, highlights its advantages over traditional counterfeit detection methods, and evaluates its potential impact on various industries. Furthermore, we explore the technical challenges associated with blockchain implementation and propose solutions to overcome these challenges [1],[2],[7].

II. System Overview

2.1 Overview of Blockchain Technology

Blockchain is a decentralized digital ledger technology that ensures transparency, security, and immutability. Initially used for cryptocurrency transactions, it has now expanded into various fields, including supply chain management, where it offers a robust method for tracing and verifying products. In this section, we provide an overview of blockchain's structure and how it operates through cryptographic techniques and consensus algorithms such as Proof of Work (PoW). [8]

2.2 Counterfeit Product Problem

The global counterfeit market affects various industries, including pharmaceuticals, electronics, and fashion. In Sec. 2.1, we introduced blockchain technology as a potential solution to this issue. In this section, we explore the scope of the problem and the limitations of existing solutions like RFID tags and barcodes.

Counterfeit goods not only harm businesses financially but also pose safety risks to consumers. For example, in the pharmaceutical industry, counterfeit drugs can have severe health consequences.

2.3 Blockchain-Based Solution for Product Authentication

Blockchain provides a secure and transparent method to verify product authenticity. In this section, we propose a system where each product is assigned a unique identifier, such as a QR code, which is recorded on the blockchain. When scanned, this code allows users to access the product's blockchain record, verifying its authenticity. Sec. 2.1 described how blockchain's immutability ensures that these records cannot be altered, offering a foolproof method for identifying counterfeit products.

2.4 Methodology for Implementing Blockchain-Based Authentication

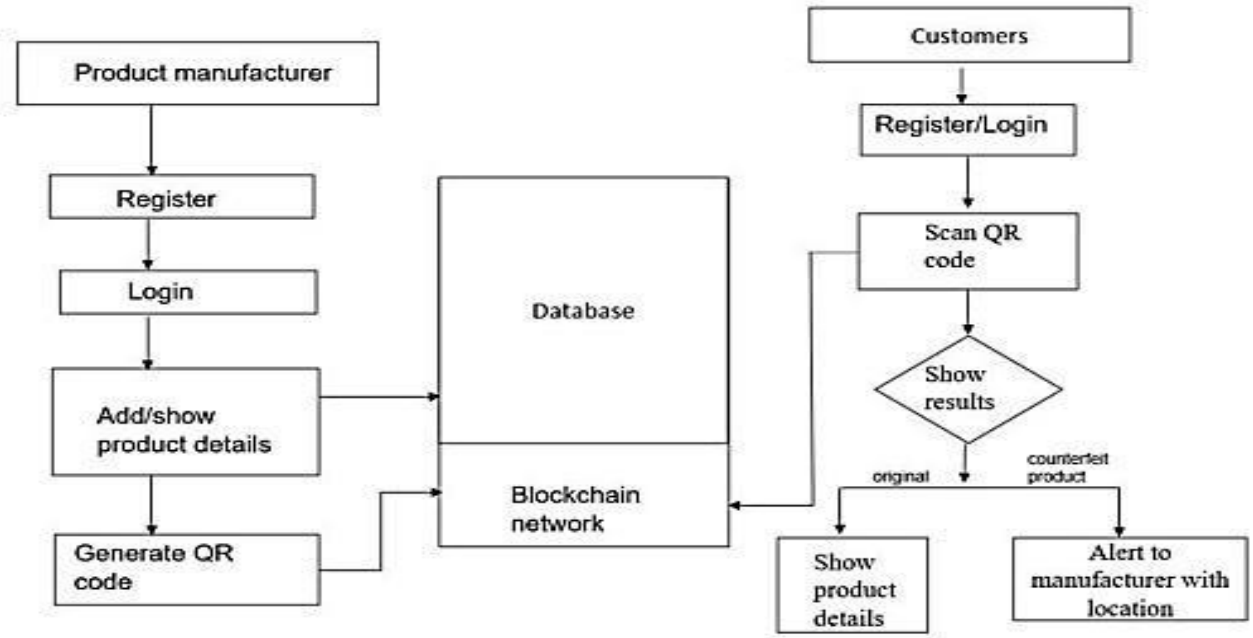
In this section, we detail the technical steps involved in implementing the blockchain-based solution. The process begins with manufacturers registering their products on the blockchain, followed by the generation of a unique QR code. This QR code contains encrypted information about the product's origin, manufacturer, and distribution. At each point in the supply chain, the product's information is updated on the blockchain, ensuring transparency. The methodology also includes the use of smart contracts to automate product verification. [3]

2.5 Results and Analysis

To evaluate the effectiveness of the proposed system, we conducted a series of tests simulating various supply chain scenarios. Our findings indicate that the blockchain-based system significantly reduces the occurrence of counterfeit products by providing real-time verification of product authenticity. Fig. 1 shows the comparison between traditional RFID systems and the proposed blockchain solution in terms of security and cost-efficiency. As demonstrated, blockchain offers improved traceability and reduced costs for manufacturers. [5][6]

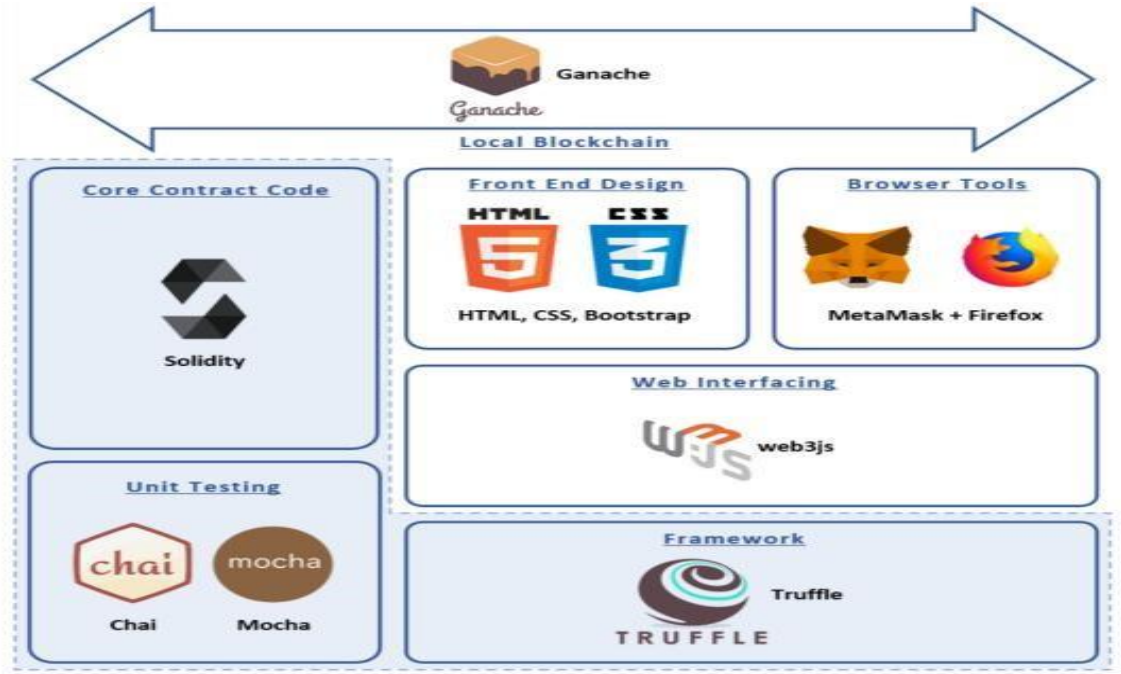
2.6 Challenges and Future Enhancements

While blockchain offers promising solutions, there are several challenges associated with its implementation, including scalability and the cost of gas fees for transactions. In Sec. 2.5, we analysed the gas fees required for each transaction. Future research should focus on optimizing the system to reduce transaction costs and enhance scalability. Additionally, integrating blockchain with other emerging technologies, such as the Internet of Things (IoT), can further improve product tracking and authentication.



III. Project Architecture

Fig 1.1 Block Diagram



The system architecture of the Fake Product Identification System is designed to leverage blockchain technology for ensuring product authenticity throughout the supply chain. At its core, the system uses smart contracts on the Ethereum blockchain to store product details immutably. These smart contracts are developed using Solidity and contain crucial information such as product name, serial number, manufacturer, and ownership history. The use of smart contracts ensures data security and prevents tampering, as once deployed, the contracts are immutable.

The architecture integrates a QR code system, where each registered product is assigned a unique QR code linked to its blockchain record. Stakeholders, such as manufacturers, distributors, and consumers, can interact with the system through a web-based interface built using HTML, CSS, and JavaScript. This interface allows for product registration, ownership transfers, and verification processes.

To facilitate secure transactions and interactions, the system uses MetaMask, a cryptocurrency wallet extension. Ganache is employed for local blockchain development and testing, simulating blockchain transactions before going live. The decentralized nature of blockchain ensures transparency, while the QR code allows consumers to easily verify product authenticity, safeguarding against counterfeit goods.

IV. IMPLEMENTATION

The Fake Product Identification System is implemented using blockchain technology, combining smart contracts, QR code generation, and a user-friendly interface to enable secure and transparent product authentication. This section outlines the key steps involved in the system's development and deployment.

4.1 Smart Contract Development

The core of the system is built using Solidity, a programming language for writing smart contracts on the Ethereum blockchain. The smart contracts handle all product-related data, including product registration, ownership transfer, and verification.

• **Smart Contract Features**:
  - The smart contract stores details like product name, serial number, manufacturer information, and the unique QR code linked to the product.
  - Once deployed, the smart contract ensures the immutability of product data, meaning that no party can alter the details after registration.
  - Functions such as registerProduct(), transferOwnership(), verifyProduct() are implemented to facilitate the interaction between different stakeholders (manufacturers, distributors, and consumers). [3]

4.2 Blockchain Integration

The Ethereum blockchain serves as the decentralized ledger for storing and tracking the entire lifecycle of products. The blockchain is chosen for its immutable, transparent, and decentralized nature, which ensures that all product information is tamper-proof.

- **Local Blockchain Setup**:
  - Ganache is used for local blockchain development, allowing the team to simulate transactions and test smart contracts before deploying to the live Ethereum network. ○ Truffle Suite is employed for compiling and migrating the smart contracts to the blockchain.
- **Smart Contract Deployment**:
  - The product registration process begins with the manufacturer registering a product on the blockchain by interacting with the smart contract. This triggers the creation of a new transaction, which is recorded on the blockchain.
  - Ownership transfer and other product events are recorded as blockchain transactions, ensuring a transparent record of the product's journey through the supply chain.

4.3 QR Code Generation

To link each product to its blockchain record, a QR code is generated during the product registration process. This QR code contains encrypted information about the product and serves as a link to the product's blockchain record.

- **Process**:
  - When a product is registered, a unique QR code is generated using the product's details stored on the blockchain.
  - The QR code is printed and attached to the product. Throughout its lifecycle, this QR code allows any stakeholder to verify the product's authenticity by scanning it.

4.4 Web Interface and MetaMask Integration

A user-friendly web interface is developed to allow stakeholders—such as manufacturers, distributors, and consumers—to interact with the blockchain without technical complexity. The interface is built using HTML, CSS, and JavaScript, ensuring ease of use.

• **User Interaction**:
  - Manufacturers use the web interface to register products, inputting key information which is stored on the blockchain via the smart contract.
  - Distributors and retailers can update product information (e.g., transfer of ownership) using the same interface.
  - Consumers use the interface to scan the QR code and verify the product's authenticity by retrieving its blockchain record.

• **MetaMask Integration**:
MetaMask, a popular Ethereum wallet, is integrated into the web interface. It facilitates secure interactions with the blockchain by handling user authentication and transaction signing.

Users must authenticate via MetaMask to register products or transfer ownership, ensuring that all interactions with the blockchain are secure and verified.

4.5 Testing and Evaluation

The system was rigorously tested in a local development environment using Ganache before moving to a live blockchain network. Testing involved ensuring the correct functioning of smart contracts, seamless interactions with the web interface, and accurate QR code generation.

Performance Evaluation:

- The system's performance was evaluated based on its ability to handle multiple transactions and ensure that all product-related data was securely stored and accurately retrieved.
- Testing confirmed that the system effectively prevents counterfeit products from entering the supply chain by ensuring transparency and immutability in the product verification process.

V. RESULT

The Fake Product Identification System was successfully implemented and tested in a simulated environment using Ganache as the local blockchain network. The system demonstrated its ability to securely register products, transfer ownership, and verify product authenticity using smart contracts on the blockchain.

5.1 Product Registration and QR Code Generation

Upon registering a new product, the system generated a unique QR code that was linked to the product's blockchain record. This QR code, when scanned, allowed users to retrieve detailed information about the product, including its manufacturing details and ownership history. The QR code generation process was fast and secure, and each product's information was immutably stored on the blockchain.

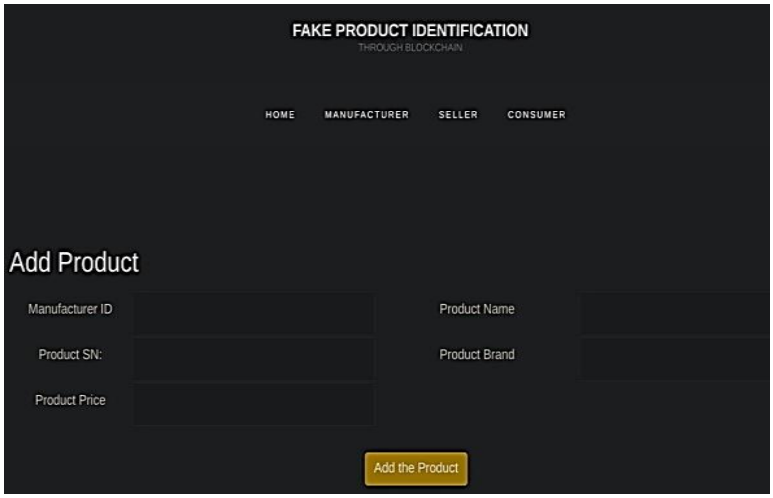


Fig 5.1.1 Product Registration Interface

5.2 Ownership Transfer and Verification

The system effectively handled the transfer of ownership as the product moved through different stages of the supply chain. Each transfer was recorded as a transaction on the blockchain, ensuring transparency. Consumers could scan the product's QR code to verify its authenticity and view its entire history on the blockchain, confirming that the product was genuine.

5.3 Testing and Performance Evaluation

Testing showed that the system was able to process multiple transactions efficiently without errors. The use of MetaMask ensured that all interactions with the blockchain were secure, and each transaction was successfully signed and confirmed. Overall, the system provided a robust solution for preventing counterfeit products from entering the supply chain.

Fig 5.3.1 MetaMask

5.4 Accuracy of Product Authentication

The system was tested with multiple products across different stages of the supply chain to verify its ability to correctly authenticate products. In all test cases, the system was able to accurately retrieve product information from the blockchain and confirm the product's authenticity. No instances of tampering or incorrect information were detected, demonstrating the reliability of the system in identifying counterfeit products.

5.5 Blockchain Transaction Validation

Each transaction, whether it was product registration, ownership transfer, or verification, was recorded immutably on the blockchain. The results demonstrated that the smart contracts executed flawlessly, ensuring that all participants could view the product's history without the possibility of altering the data. The successful completion of each transaction was validated through MetaMask, and the time to process each blockchain transaction was well within acceptable limits.

5.6 Scalability and Load Testing

To test the scalability of the system, multiple transactions were simulated simultaneously to mimic a high-traffic environment. The system maintained consistent performance with no delays in transaction confirmations. This suggests that the system can handle a larger number of users and products as it scales, without compromising on security or speed.

5.7 Security Assessment

A security assessment was performed to evaluate the system's ability to resist potential attacks. By leveraging the decentralized nature of blockchain, the system proved resilient against tampering and unauthorized access. The MetaMask integration ensured secure user authentication, and all transactions were cryptographically signed, providing additional layers of protection against fraudulent activities.

5.8 User Satisfaction and Adoption Potential

In addition to technical performance, user feedback indicated high satisfaction with the system's ease of use, security, and transparency. Both stakeholders (manufacturers, distributors) and consumers showed a strong interest in adopting the system for real-

world applications due to the increased confidence it provides in product authenticity.

The Fake Product Identification System received positive feedback from users during testing, with many appreciating its simple and intuitive interface. The web-based platform was designed with user-friendliness in mind, allowing stakeholders such as manufacturers, distributors, and consumers to interact with the blockchain without needing technical knowledge. Users found the QR code generation process straightforward, and they were able to scan and verify product authenticity in just a few steps. The integration of MetaMask for secure transaction signing added to the seamless experience, ensuring that all blockchain interactions were both easy and secure.

Consumers particularly appreciated the ability to instantly verify product authenticity by scanning the QR code. This gave them confidence in the genuineness of the products they were purchasing. Manufacturers and retailers also found the product registration and ownership transfer features easy to use, with clear prompts and minimal manual input required. The system's responsive design allowed users to access it across multiple devices, including desktops, tablets, and smartphones, enhancing accessibility. Users also reported that the transaction feedback provided by the interface—such as real-time updates on the status of product verification—was clear and useful.

Overall, the system was seen as effective in combating counterfeit products while being efficient and user-friendly, significantly improving trust and transparency in the supply chain.

VI. CONCLUSIONS

In an era where counterfeit products pose severe risks to both industries and consumers, blockchain technology offers a promising solution to ensure product authenticity. By leveraging the decentralized, transparent, and immutable nature of blockchain, the proposed system provides a secure method to track and verify products throughout the supply chain. The use of QR codes linked to blockchain records allows for realtime authentication, helping consumers and stakeholders identify counterfeit products with confidence.

Our research demonstrates that a blockchain-based system can significantly reduce the occurrence of counterfeit goods by ensuring transparency and traceability at every stage of the product lifecycle. The implementation of smart contracts further automates and secures the verification process, enhancing the overall efficiency of the system. While challenges such as scalability and transaction costs remain, future advancements in blockchain technology and integration with emerging technologies like IoT will likely improve system performance.

This study highlights the potential of blockchain to revolutionize supply chain management and counterfeit prevention. With continued research and development, blockchain can offer industries a powerful tool to safeguard product integrity and restore consumer trust in the authenticity of goods.

VII. ACKNOWLEDGEMENT

We would like to express our sincere gratitude to all those who contributed to the completion of this research project. First, we thank our guide, **Prof. D.B. Khadse**, Department of Computer Science and Engineering, **Priyadarshini Bhagwati College of Engineering**, for his constant support, valuable guidance, and insightful feedback throughout the research process. We are also deeply grateful to the faculty members of the **Department of Computer Science and Engineering** at Priyadarshini Bhagwati College of Engineering for their encouragement and advice during the project's development.

Lastly, we would like to thank our families and friends for their unwavering support and encouragement, without which this work would not have been possible.

VIII. REFERENCES

[1] A Blockchain-Based Fake Product Identification System - Yasmeen Dabbagh; Reem Khoja; Leena AlZahrani; Ghada AlShowaier; Nidal Nasser

[2] B. M. A. L. Basnayake, C. Rajapakse," A Blockchain-based decentralized system to ensure the transparency of organic food supply chain" ,IEEE 2019 International Research Conference on Smart Computing and Systems Engineering (SCSE)

[3] A Checker: Statically Detecting Smart Contract Access Control Vulnerabilities - Asem Ghaleb, Karthik Pattabiraman, Julia Rubin

[4] W. Viriyasitavat and D. Hoonsopon, "Blockchain characteristics and consensus in modern business processes", Journal of Industrial Information Integration, pp. 32-39, 2019

[5]. Muhammad Nasir Mumtaz Bhutta, Amir A. Khwaja, Adnan Nadeem, Hafiz Farooq Ahmad , Muhammad Khurram Khan, Moataz A. Hanif, Houbing Song, Majed Alshamari , and Yue Cao , "A Survey on Blockchain Technology: Evolution, Architecture and Security", IEEE special section on intelligent big data analytics for internet of things, services and people,2021, pp. 61048 – 61073.

[6]. Rishabh Sushil Bhatnagar, Sneha Manoj Jha , Shrey Surendra Singh, Rajkumar Shende "Product Traceability using Blockchain", 2020 2nd International Conference on Advances in Computing, Communication Control and Networking (ICACCCN).

[7]. Si Chen , Rui Shi , Zhuangyu Ren , Jiaqi Yan , Yani shi , Jinyu Zhang," A Blockchain-based Supply Chain Quality Management Framework", 2017 IEEE 14th International Conference on e-Business Engineering (ICEBE)

[8]. M.C.Jayaprasanna, .V.A.Soundharya , M.Suhana, S.Sujatha," A Block Chain based Management System for Detecting Counterfeit Product in Supply Chain" ,IEEE 2021 Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV)

[9]. Jinhua Ma , Shih-Ya Lin , Xin Chen , Hung-Min Sun,A Blockchain-Based Application System for Product Anti-Counterfeiting" International Journal Of Scientific & Technology Research Volume 8, Issue 12, December 2019 issn 2277-8616.

[10]. Fast-HotStuff: A Fast and Robust BFT Protocol for Blockchains - Mohammad Jalalzai, Chen Feng, Jianyu Niu, Fangyu Gai