iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** VII **Month of publication:** July 2025

DOI: https://doi.org/10.22214/ijraset.2025.66868

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

Review Paper on Leveraging Blockchain Technology for counterfeit Product

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Abstract: ***This project introduces a blockchain-based approach to address the rising issue of counterfeit products. The system uses unique identifiers, such as QR codes or RFID tags and image processing for each product, allowing for efficient tracking and verification. By associating these identifiers with a decentralized blockchain ledger, various stakeholders such as consumers, product providers, and regulatory authorities can easily verify the authenticity of products in real-time. Any attempts to insert counterfeit goods into the supply chain are swiftly detected and recorded, ensuring quick response actions.***
Additionally, the system promotes better collaboration and data exchange between manufacturers, distributors, retailers, and regulatory agencies, contributing to a more transparent and efficient supply chain. Blockchain's secure and immutable ledger provides a detailed and auditable record of each product's journey, from production to final use, while smart contracts help enforce compliance with regulatory standards. By enhancing traceability, reducing administrative overhead, and safeguarding product integrity, this solution strengthens market security and plays a crucial role in combating counterfeit products.
Keywords: Counterfeit product, blockchain, product supply chain, authenticity verification, products, smart contracts, distributed ledger

I. INTRODUCTION

In the subsequent sections, this paper will delve into the foundational concepts of blockchain technology, elucidating its relevance and potential applications within the context of combating counterfeit products. Furthermore, it will explore case studies and existing initiatives that have leveraged blockchain to address this issue, highlighting the benefits, challenges, and lessons learned from these implementations. Through a comprehensive analysis of blockchain's capabilities and its impact on counterfeit product prevention, this paper aims to contribute to the growing body of knowledge surrounding the role of emerging technologies in safeguarding public health and ensuring product authenticity.

This paper also aims to explore the intersection of blockchain technology and counterfeit product detection, elucidating the principles and mechanisms by which blockchain can mitigate the pervasive issue of counterfeit goods. Through the use of smart contracts and unique identifiers like QR codes or RFID tags, this approach enables real-time tracking and verification of product provenance, ensuring that each step of a product's journey is securely recorded and accessible to authorized participants. By doing so, the blockchain-based system not only enhances supply chain visibility but also empowers consumers, healthcare providers, and regulatory authorities to make informed decisions and quickly identify instances of counterfeit products.

II. THE WORKING OF A BLOCKCHAIN-BASED COUNTERFEIT PRODUCT LEVERAGING PROJECT

Here's a step-by-step breakdown of how Blockchain Technology can identify counterfeit products.

A. Product Identification and Tagging

- Step 1: Every product is assigned a distinct identifier, such as a QR code, RFID tag, or NFC chip.
- Step 2: The identifier is securely attached to the product or its packaging during manufacturing or assembly.
- Step 3: This unique identifier is connected to a blockchain-based digital record storing essential product details:
    - Manufacturer information
    - Batch number
    - Production and expiration dates
    - Product specifications

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B. Uploading Product Data to Blockchain

- Step 1: After tagging, a digital record is generated on a blockchain platform (e.g., Ethereum, Hyperledger).
- Step 2: The product's data, including its unique identifier, is stored in an unchangeable blockchain ledger, ensuring the product's history is tamper-proof.
- Step 3: All stakeholders (manufacturers, distributors, retailers, and regulators) can access this decentralized ledger, promoting transparency across the supply chain.

C. Product Distribution and Tracking

- Step 1: As the product moves through the supply chain (from manufacturer to distributor to retailer), its journey is logged on the blockchain.
- Step 2: At each transfer point, the involved parties update the blockchain with:
    - Transfer timestamp
    - Location (if applicable)
    - Parties involved in the transaction
- Step 3: Authorized stakeholders can view this tracking information in real time, ensuring full visibility of the product's movement.

D. Product Verification by Consumers or Retailers

- Step 1: Upon receiving the product, consumers or retailers can scan the QR code or read the RFID/NFC tag using a smartphone or dedicated device.
- Step 2: The device retrieves the product's complete history from the blockchain.
- Step 3: The consumer or retailer verifies whether the product details match the packaging information, confirming its authenticity.
- Step 4: If the details align, the product is genuine. If not, the system triggers an alert.

E. Detection of Counterfeit Products

- Step 1: Counterfeit products will either lack a matching unique identifier on the blockchain or display inconsistent/incomplete data.
- Step 2: Any discrepancy results in the product being flagged as potentially counterfeit.
- Step 3: An alert is sent to relevant stakeholders, such as regulators, retailers, and manufacturers, for prompt action.
- Step 4: The blockchain records the incident, creating a permanent trace of the counterfeiting attempt for future reference or legal proceedings.

F. Smart Contract Enforcement

- Step 1: Smart contracts are used to enforce rules such as:
    - Restricting access or modifications to authorized parties only
    - Automatically triggering alerts and actions upon detecting counterfeit attempts
    - Ensuring compliance with regulations and industry standards (e.g., packaging, storage)
- Step 2: If the product passes through authorized channels and meets all conditions, the smart contract confirms its authenticity. Any deviation results in a flagged issue.

G. Final Product Delivery and Consumer Access

- Step 1: Once a product reaches the consumer or patient, they can use a verification app or device to confirm its authenticity.
- Step 2: The app or device shows the product's entire supply chain journey, giving the consumer confidence that the product is genuine and safe to use.
- Step 3: In case of any concerns or questions, consumers can raise them with the manufacturer, distributor, or regulatory authorities using the data provided on the blockchain.

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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

H. Post-Purchase Monitoring and Feedback

- Step 1: After purchase, the system continues to monitor the product for quality issues or recalls.
- Step 2: If a problem is identified, the system traces the product back to its origin, identifies affected items, and ensures a swift recall.
- Step 3: Consumers can provide feedback, which is logged on the blockchain for future quality improvements and regulatory actions.

I. Transparency and Reporting

- Step 1: All activities, including product transfers, verifications, and counterfeit detections, are permanently recorded on the blockchain.
- Step 2: Authorized parties (e.g., regulators, manufacturers) can access real-time data about the product's status and history at any time.
- Step 3: Regular reports generated from blockchain data help evaluate the effectiveness of the counterfeit detection system and ensure compliance with regulations.

J. Image Processing

- Step 1: Manufacturers can upload the original image of the product to the blockchain network.
- Step 2: Consumers can use the product verification system to compare physical appearance with the blockchain-stored image, ensuring visual authenticity.

III. CHALLENGES AND LIMITATIONS

1) Technical Expertise: Developing and maintaining the blockchain system demands specialized technical skills, which may be scarce or costly to acquire.
2) Scalability: Scaling blockchain networks to handle a large volume of transactions quickly and efficiently remains a challenge, especially during peak demand periods.
3) Interoperability: Ensuring seamless data exchange between different blockchain platforms and legacy systems used by various supply chain participants can be difficult.
4) Data Privacy: Balancing the need for transparency with protecting sensitive business and patient data presents privacy concerns that require careful consideration.
5) User Adoption: Convincing stakeholders to adopt and effectively utilize the new technology may require substantial efforts in training and change management.
6) Network Consensus: Ensuring consensus mechanisms align with the goals of the project and are resistant to attacks is essential for maintaining data integrity.
7) Adoption Barriers: The reluctance of some supply chain participants to embrace emerging technologies like blockchain can slow down adoption

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IV. ENHANCEMENT AND FUTURE DIRECTIONS

1) Enhanced User Interfaces: Develop user-friendly interfaces and mobile apps for seamless scanning, verification, and interaction with the blockchain system, thereby improving user adoption.
2) Artificial Intelligence (AI) Integration: Utilize AI algorithms to analyse supply chain data, identify patterns, and detect anomalies that could indicate counterfeit product incidents.
3) Predictive Analytics: Implement predictive analytics to anticipate potential counterfeit threats and optimize supply chain processes for greater efficiency.
4) Cross-Industry Collaboration: Collaborate with other industries facing similar supply chain challenges to share best practices and develop cross-industry blockchain standards

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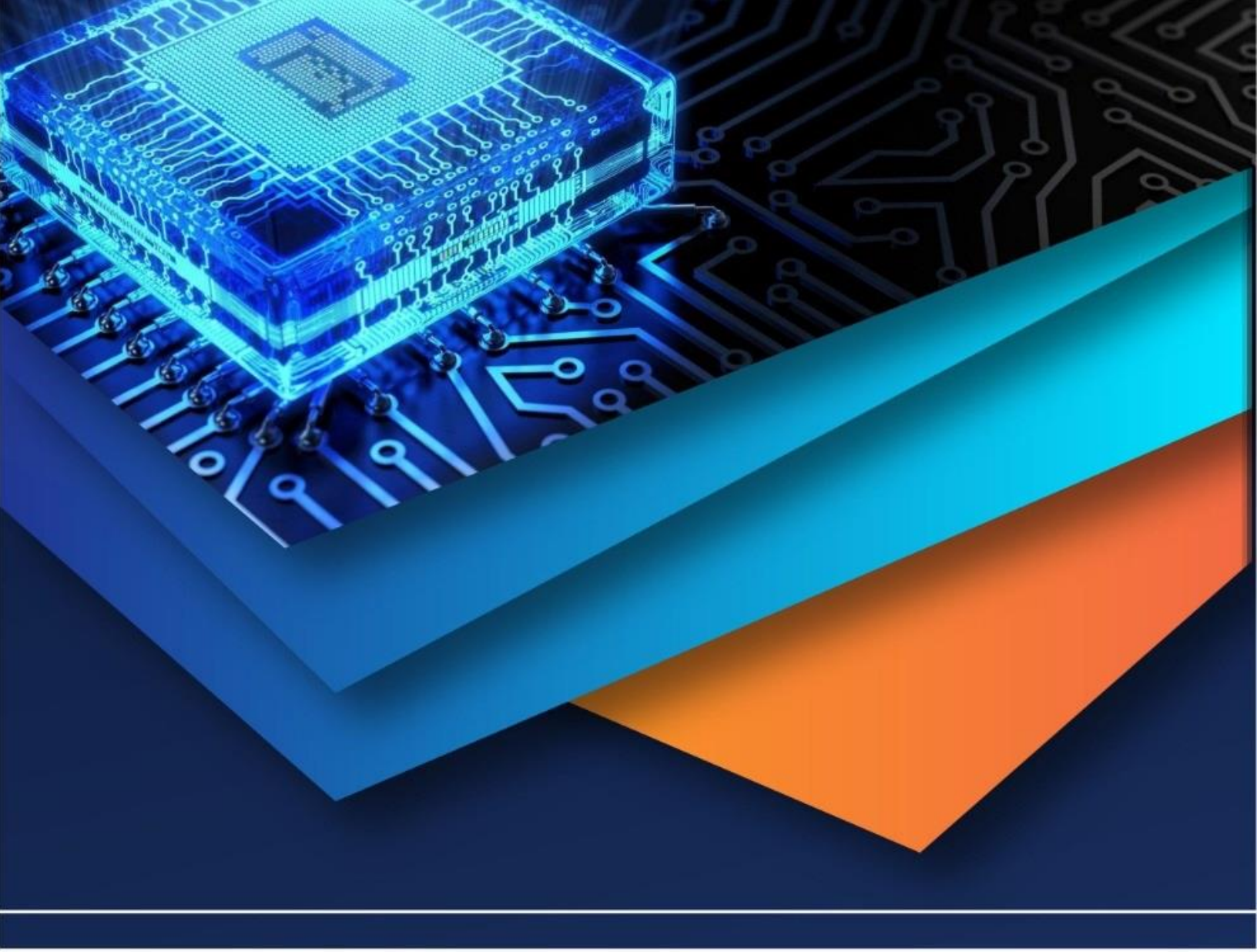
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V. CONCLUSION

Blockchain technology introduces a groundbreaking approach to combating counterfeit products, delivering unparalleled transparency, traceability, and security throughout supply chains. Despite challenges in achieving widespread adoption, its advantages—such as bolstering product authenticity, minimizing counterfeiting risks, and fostering consumer confidence—are significant. As blockchain continues to evolve and integrate with other technologies, it holds immense potential to transform and enhance anti-counterfeiting measures across diverse industries.

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