International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Securing the Supply Chain: A Blockchain Based Anti Counterfeiting Framework

Harshwardhan Sharad Dhokane[1], Rohit Rajkumar Chauhan[2], Aditya Yogesh Dharmadhikari[3], Rutuja Kalyan Choudhar[4]

[1, 2, 3,] Student, Computer Engineering, PES Modern College of Engineering, Pune

Abstract

Counterfeiting is a major problem in the antique industry, making it difficult to verify whether an item is genuine. This paper introduces a blockchain-based system that helps secure the antique supply chain by making all item records permanent and easy to trace. Each antique is registered on a blockchain with a unique ID, including details like images, ownership history, and location. A QR code is created for each item so that anyone can quickly check its authenticity. The use of blockchain technology ensures that the data cannot be changed, increasing trust between buyers, sellers, and other parties. A React.js-based interface has been developed to allow easy item registration, image uploading, and real-time location tracking, supported by a secure backend. Tests and evaluations show that this system can effectively reduce counterfeiting by improving the transparency and security of the antique supply chain.

Keywords: Blockchain Technology, Antique Counterfeiting, Supply Chain Security, Product Authentication, QR Code Verification, Provenance Tracking, Distributed Ledger, React.js Interface, Smart Contracts, Traceability System

1. Introduction

The antique industry has long faced significant challenges related to the verification of authenticity, ownership history, and overall trustworthiness of traded items. With the increasing value of historical artifacts and collectibles, counterfeiting has become a lucrative activity for fraudsters. Traditional methods of tracking provenance such as physical documentation, expert appraisal, and paper-based certificates are often unreliable, prone to tampering, and difficult to verify across stakeholders. These limitations pose a threat not only to collectors and sellers but also to the cultural and historical integrity of the items themselves.

In recent years, digital technologies have offered new opportunities to enhance security and transparency in supply chains. Among them, blockchain technology stands out due to its decentralized, immutable, and transparent nature. Originally developed to support cryptocurrencies, blockchain has since evolved to address a wide range of applications including finance, healthcare, and logistics. Its ability to store data in a tamper-proof manner and maintain a consensus among all participants makes it particularly suitable for applications where trust, traceability, and verification are crucial.

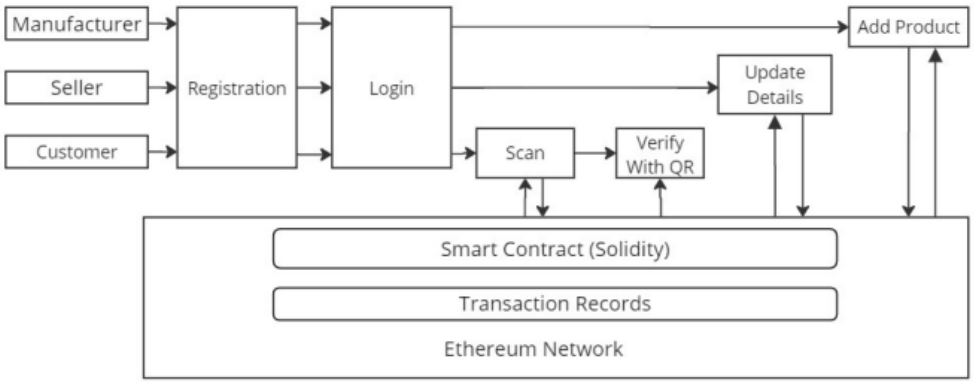
This paper proposes a blockchain-based framework to tackle the issue of counterfeit antiques by securing their lifecycle data on a distributed ledger. Each antique item is digitally registered on the blockchain with a unique identity, incorporating critical information such as high-quality images, metadata, ownership records, and location data. A unique QR code is generated and attached to each item, enabling instant access to its history and verification details through a simple scan. This system ensures that any attempts to forge or duplicate records can be easily detected, thereby enhancing trust across the supply chain.

The proposed solution also includes a user-friendly web application built with React.js, allowing sellers or curators to upload product data, images, and geolocation details seamlessly. The backend is designed to interact with the blockchain network and database to ensure data integrity and high performance. This combination of frontend and backend technologies provides an efficient and practical tool for real-world deployment in antique trading markets.

Through this research, we aim to demonstrate how integrating blockchain into the antique supply chain can not only help prevent counterfeiting but also build a transparent ecosystem where trust is embedded into the system architecture itself. The following sections detail the system design, implementation, and evaluation, highlighting its potential to transform the way antique authentication is managed.

2. Architecture

Figure 1 : System Architecture Diagram



The system architecture is designed to securely manage and verify antique products using blockchain technology, with active participation from multiple stakeholders, manufacturers, sellers, and customers. The system integrates frontend operations with blockchain-based backend logic on the Ethereum network using smart contracts.

a. User Interaction Layer :

The system supports three types of users:

- **Manufacturers**: Register and add genuine antique products.

- **Sellers**: List and update product details as items move through the supply chain.
- **Customers**: Scan and verify the authenticity of products before purchase.

All users begin by interacting with the system through the Registration and Login modules. These ensure that only verified users can access system functionalities according to their roles.

b. Product Management and Verification :

Once authenticated:

- Manufacturers and Sellers use the Add Product module to upload information about antiques, such as images, descriptions, and origin data.
- They can also Update Details if any change occurs (e.g., ownership, location).

To ensure product authenticity, QR codes are generated for each item. Customers can Scan these codes and then Verify the item using the QR code reader module.

c. Blockchain Integration :

At the heart of the system lies the Ethereum blockchain. It consists of two key components:

- Smart Contracts written in Solidity: These define the rules for registering, updating, and verifying antiques. Smart contracts handle the logic securely and autonomously.
- Transaction Records: Every product registration, update, and verification action is stored as a tamper-proof transaction on the blockchain.

By using smart contracts and storing records on the Ethereum network, the system ensures transparency, trust, and immutability throughout the antique's lifecycle.

d.Data Flow Summary :

- All major actions (adding products, scanning, verifying, updating) interact with the smart contract.
- Once a product is added or verified, the associated transaction is recorded permanently on the Ethereum blockchain.
- Customers can confirm product legitimacy by scanning the QR code and retrieving data directly from the blockchain-backed smart contract.

This architecture effectively builds a decentralized and transparent framework to combat counterfeiting in the antique industry. Each component plays a key role in preserving data integrity and ensuring end-to-end traceability of products.

3. Literature review

Counterfeiting in Traditional Systems :

- Industries such as luxury goods, pharmaceuticals, and antiques face ongoing challenges in verifying product authenticity.

- Conventional solutions like certificates, watermarks, and centralized databases are vulnerable to tampering and forgery.
- These systems often lack transparency and global traceability.

Adoption of Blockchain in Supply Chains :

- Blockchain has gained attention for its ability to store data immutably across a decentralized network.
- It eliminates the need for a central authority, reducing the risk of manipulation and improving trust.

Blockchain in the Art and Antique Sector :

- Platforms like Codex Protocol and Artery were developed to record artwork provenance on blockchain.
- While effective, many such platforms are limited to specific niches and lack widespread interoperability or transparency.
- These systems often do not provide open access or multi-role functionality.

QR Codes and IoT Integration :

- QR codes are increasingly used to connect physical products to digital blockchain records.
- In healthcare, systems like MediLedger link medicine packaging with blockchain data for end-user verification.
- This combination of physical tags with blockchain enhances accessibility and reliability for users.

Gap in Existing Solutions :

- Most existing blockchain systems do not fully address the unique needs of the antique market.
- The antique industry requires strict provenance tracking due to the unique and irreplaceable nature of items.
- There is a lack of inclusive systems that allow manufacturers, sellers, and customers to interact securely in one ecosystem.

4. Methodology

The proposed system aims to prevent the counterfeiting of antique products by leveraging the core features of blockchain technology, such as decentralization, immutability, and transparency. The methodology involves the design and development of a web-based application integrated with a blockchain backend that stores product data securely and enables QR-based verification. The system development can be divided into several key phases:

a. System Design :

- The architecture is built to support three user roles: Manufacturer, Seller, and Customer.
- Each user must first go through a registration and login process, which ensures access control and role-based functionality.

- After successful authentication:
  - ➢ Manufacturers and sellers can add antiques to the system using an "Add Product" interface.
  - ➢ Each product is assigned a unique identifier and linked to a QR code.
  - ➢ Customers can scan this QR code to access the product's history and verify its authenticity.

b. Frontend Implementation :

- The frontend is built using React.js, which offers a fast and responsive user experience.
- The interface includes features for:
  - ➢ Product registration form with fields such as name, origin, date, and image upload.
  - ➢ QR code generation and display.
  - ➢ Scanning functionality using a QR reader library.
  - ➢ A verification page that shows details retrieved from the blockchain upon scanning.

c. Backend and Blockchain Integration :

- The backend is developed using Node.js and Express.js, providing APIs to handle user actions such as login, product submission, and updates.
- The blockchain component is implemented using Solidity smart contracts deployed on the Ethereum test network.
  - ➢ Each product's data is submitted to a smart contract, which records it on the blockchain.
  - ➢ The data includes product name, description, image hash, manufacturer ID, and a timestamp.
- Once stored, this data cannot be altered, ensuring immutability and trust.

d. QR Code Generation and Verification :

- Upon product registration, the system generates a QR code containing the product's unique ID or blockchain reference.
- This QR code is printed or attached to the physical antique.
- Customers can scan this code using the app, which sends the ID to the blockchain to fetch associated details.
- The details are then displayed in a readable format to confirm authenticity and ownership history.

e. Transaction Records and Security :

- Each activity whether it is adding a product or verifying one is recorded as a transaction on the blockchain.
- This ensures that:
  - ➢ The product's history is transparent and auditable.
  - ➢ Unauthorized alterations are impossible due to blockchain's distributed nature.
- The smart contract also defines access permissions, allowing only authenticated users to perform certain actions like adding or updating product data.

f. Testing and Evaluation :

- The system was deployed and tested on the Ethereum test network to simulate real-time usage without financial risk.
- Multiple scenarios were tested, such as:
  - ➢ Adding new products.
  - ➢ Updating ownership.
  - ➢ Scanning QR codes for verification.
- Results were evaluated based on:
  - ➢ Accuracy of data retrieval.
  - ➢ Speed of blockchain interactions.
  - ➢ User experience on the frontend.
- The system performed reliably, confirming its effectiveness in preventing counterfeit entries and ensuring traceable ownership.

5. Conclusion

The increasing threat of counterfeit antiques poses serious risks to collectors, sellers, and the overall heritage industry. This research presents a blockchain-based framework designed to enhance transparency, traceability, and trust in the antique supply chain. By leveraging the decentralized and tamper-proof nature of blockchain technology, the proposed system ensures that each antique item is uniquely registered, tracked, and verified through smart contracts and QR code integration.

The web-based platform enables manufacturers and sellers to securely add and update product information, while customers can easily verify the authenticity of antiques by scanning a QR code. Each interaction is recorded as an immutable transaction on the blockchain, eliminating the chances of forgery or data manipulation. The integration of frontend technologies like React.js with backend smart contracts creates a seamless user experience and robust backend logic.

Through testing and evaluation, the system demonstrated its effectiveness in preventing counterfeit entries and improving supply chain transparency. This approach not only addresses a critical challenge in the antique industry but also opens new possibilities for applying blockchain to other sectors where authenticity and provenance are crucial.

In conclusion, the proposed solution provides a scalable, secure, and practical method for combating antique counterfeiting and lays the groundwork for future innovations in blockchain-powered product verification.

6. Limitations

- **Dependence on Internet Connectivity :** The system relies heavily on internet access for interacting with the blockchain and web application. In areas with limited connectivity, real-time product verification and updates may not be feasible.

- **User Adoption and Training :** For the system to be truly effective, all stakeholders manufacturers, sellers, and customers must understand how to use the platform. Lack of awareness or technical knowledge may limit adoption.

References

[1] J. Leng, P. Jiang, K. Xu, Q. Liu, J. L. Zhao, Y. Bian, and R. Shi, ‘‘Makerchain: A blockchain with chemical signature for self-organizing process in social manufacturing,’’ J. Cleaner Prod., vol. 234, pp. 767–778, Oct. 2019.

[2] N. Alzahrani and N. Bulusu, ‘‘Block-supply chain: A new anti counterfeiting supply chain using NFC and blockchain,’’ in Proc. 1st Workshop Cryptocurrencies Blockchains Distrib. Syst. (CryBlock), 2018, pp. 30–35.

[3] M. Rosenfeld. (2012). [Online]. Available: https://bitcoil.co.il/ BitcoinX.pdf.

[4] (2018) Litecoin. [Online]. Available: https://litecoin.info/index.php/Main Page.

[5] (2019). Github. [Online]. Available: https://github.com/ethereum/wiki/ wiki/White-Paper

[6] G. Wood, ‘‘Ethereum: A secure decentralised generalised transaction ledger,’’ Ethereum Project Yellow Paper, vol. 151, p. 1–32, Apr. 2014.

[7] (2018). Hyperledger. [Online]. Available: https://www.hyperledger.org/

[8] (2018). Abra. [Online]. Available: https://www.abra.com/

[9] (2018). Tzero. [Online]. Available: https://www.tzero.com/

[10] S. Panikkar, S. Nair, P. Brody, and V. Pureswaran, ‘‘ADEPT: An IoT practitioner perspective,’’ IBM Inst. Bus. Value, New York, NY, USA, White Paper, 2015, pp. 1– 1.