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MediChain: A Blockchain-Based Medicine Traceability and Verification System Using QR Codes

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Abstract

Counterfeit and expired medicines create a need for reliable methods of medicine verification and traceability. Traditional record-based systems may make it difficult to verify medicine information independently and maintain a consistent history of supply-chain activities. MediChain is a blockchain-based prototype developed to provide medicine registration, QR-based identification, verification and supply-chain record tracking. The system uses a Solidity smart contract deployed on a local Ethereum-compatible blockchain environment, with a React/Vite web application and MetaMask for blockchain transactions. During registration, medicine information including product name, batch number, manufacturer name, manufacturing date, expiry date, price and certificate number is recorded through the smart contract. A QR-based identifier is associated with the medicine record and can subsequently be entered or scanned for verification. The application retrieves the corresponding blockchain record and identifies whether the medicine record exists and whether its expiry date has passed. The system also provides a supply-chain module for recording participant role, name and location along with blockchain timestamp and wallet information. The implemented prototype demonstrates the use of blockchain and QR-based identification for medicine verification and traceability.

INTRODUCTION

The pharmaceutical supply chain involves multiple stages through which medicines move before reaching consumers. Maintaining reliable information about medicines during these stages is important for identifying unregistered, expired and potentially counterfeit products. Conventional systems may depend on centralized records or disconnected databases, which can make verification and traceability difficult. Blockchain technology provides a distributed ledger for recording transactions and enables applications to retrieve previously recorded information. Smart contracts can be used to define the operations through which medicine records are registered and accessed. Recent research has therefore investigated blockchain for pharmaceutical traceability and counterfeit-product detection. The IEEE study Counterfeit Product Detection in Supply Chain Management with Blockchain investigated blockchain and QR codes for identifying genuine and counterfeit products. The proposed approach connects a unique QR code with blockchain information and compares the code supplied by the consumer with blockchain records. (IEEE Xplore) Amarasinghe et al. proposed SUPPLYDECK, a blockchain-based pharmaceutical supply-chain management approach addressing problems including limited transparency, supplier verification and drug traceability. The work examines blockchain, smart contracts, authentication and additional technologies for pharmaceutical supply-chain management. (RDA SLIIT) Manoharan et al. investigated blockchain-based drug supply-chain management for improving transparency and traceability. Their system combines Hyperledger blockchain, IoT sensors and smart contracts for drug-supply-chain monitoring. (IEEE Xplore) Another 2024 IEEE study investigated blockchain-based authentication and supply-chain integration for combating counterfeit drugs, further demonstrating the application of blockchain to medicine authentication and pharmaceutical traceability. (IEEE Xplore) Motivated by these problems, MediChain implements a focused prototype combining blockchain-based medicine registration, QR-based identification, medicine verification and supply-chain record tracking. The current implementation concentrates on the blockchain and web-application components rather than attempting to implement additional technologies such as IoT.

LITERATURE SURVEY

A. Counterfeit Product Detection Using Blockchain The 2022 IEEE paper Counterfeit Product Detection in Supply Chain Management with Blockchain investigates the use of blockchain for product authenticity. QR codes are used to provide a unique product identifier, which can be compared with blockchain records during verification. The work demonstrates the suitability of combining QR identification with blockchain-based records for consumer-level

verification. (IEEE Xplore) MediChain applies the same general principle to medicines by associating a QR-based value with a medicine record stored through a Solidity smart contract.

B. Pharmaceutical Supply-Chain Management SUPPLYDECK addresses pharmaceutical supply-chain problems involving transparency, traceability and verification. The proposed approach uses blockchain as a distributed ledger and considers smart contracts, authentication and other technologies for improving pharmaceutical supply-chain management. (RDA SLIIT) MediChain implements the core blockchain traceability concept through medicine records and supply-chain entries.

C. Blockchain-Based Drug Traceability Manoharan et al. proposed a blockchain-based drug supply-chain management system using Hyperledger, IoT sensors and smart contracts. Their work focuses on transparency, traceability and security within drug distribution. (ResearchGate) MediChain differs in implementation by using a Solidity smart contract with an Ethereum-compatible local blockchain environment. The current prototype does not include IoT-based monitoring.

D. Blockchain Authentication for Counterfeit Drugs The 2024 IEEE study Blockchain-Powered Authentication and Supply Chain Integration to Combat Counterfeit Drugs focuses on combining authentication with pharmaceutical supply-chain information to address counterfeit drugs. (IEEE Xplore) MediChain implements a similar core objective through blockchain-backed medicine records, QR identification and consumer verification.

Table I — Comparison of Related Work

Work	Year	Main Focus	Main Technology	Relation to MediChain
Counterfeit Product Detection in Supply Chain Management with Blockchain	2022	Counterfeit detection	Blockchain + QR	QR-based verification
SUPPLYDECK	2022	Pharmaceutical traceability	Blockchain + Smart Contracts	Supply-chain traceability
Manoharan et al.	2024	Drug supply-chain transparency	Hyperledger + IoT + Smart Contracts	Blockchain-based tracking
Blockchain-Powered Authentication and Supply Chain Integration	2024	Counterfeit-drug authentication	Blockchain	Medicine authentication
MediChain	Current	Medicine verification and traceability	Solidity + Blockchain + QR	Implemented prototype

METHODOLOGY

MediChain is implemented as a web-based blockchain application. The main components are the React/Vite frontend, Solidity smart contract, local blockchain environment, MetaMask wallet and QR-based identification.

The implemented process consists of three main operations:

1. Medicine registration.
2. Medicine verification.

Medicine Registration

The manufacturer enters medicine information through the web application. The current smart contract registration function accepts:

- QR hash
- Product name
- Batch number
- Manufacturer name
- Expiry date
- Manufacturing date
- Price
- Certificate number

The information is submitted to the registerMedicine() smart-contract function. The medicine record maintained by the current contract contains the following fields:

Field	Description
Product Name	Name of the medicine
Batch Number	Medicine batch number
Manufacturer Name	Manufacturer information
Expiry Date	Medicine expiry timestamp
Manufacturing Date	Manufacturing timestamp
Price	Stored medicine price
Certificate Number	Certificate identifier
Manufacturer	Blockchain address
Scan Count	Number of recorded scans
Exists	Indicates whether the record exists

These fields are present in the current MedicineVerification contract interface.

QR-Based Identification

A QR value is associated with the medicine record during registration. The consumer verification interface supports both manual QR-value entry and QR scanning.

The decoded QR value is passed to the verification function and used to retrieve the corresponding medicine record from the blockchain. The current implementation uses a QR scanner component integrated into the React application.

Medicine Verification

The verification module calls getMedicine() to retrieve the medicine record.

The current implementation performs this as a read-only blockchain operation, rather than creating a new transaction.

The application first checks the exists value returned by the contract.

If the record does not exist, the system returns:

INVALID_MEDICINE

If the record exists, the application compares the stored expiry date with the current date.

The result is then classified as:

- AUTHENTIC — existing medicine record that has not expired.
- EXPIRED — existing medicine record whose expiry date has passed.
- INVALID_MEDICINE — no corresponding medicine record exists.

This verification logic is implemented in the current consumer-verification component.

CONCLUSION

MediChain presents a blockchain-based prototype for medicine registration, verification and traceability. The system uses a Solidity smart contract to record medicine information including product name, batch number, manufacturer, manufacturing date, expiry date, price and certificate number. A QR-based identifier is used to retrieve the corresponding blockchain record through a React/Vite web application.

The implemented verification module supports manual QR entry and QR scanning and classifies registered medicines as authentic or expired, while unknown records are identified as invalid. The system also provides supply-chain record management using participant role, name and location together with blockchain timestamp and wallet information.

The work is motivated by recent research applying blockchain to counterfeit-product detection and pharmaceutical traceability. (IEEE Xplore) The current implementation demonstrates these core concepts as an academic prototype using Solidity, blockchain, QR identification and a web-based interface.

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