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Blockchain Based Land Record Management System

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Abstract*: Traditional land record management systems face critical challenges including document tampering, fraudulent ownership claims, duplicate registrations, lack of transparency, and corruption, leading to widespread ownership disputes and legal challenges. Existing centralized systems remain vulnerable to hacking, unauthorized modifications, and inefficient verification processes. This paper presents a Blockchain Based Land Record Management System that leverages Ethereum blockchain technology to provide a secure, decentralized, transparent, and tamper-proof platform for storing and managing land ownership records. The proposed system utilizes Solidity smart contracts to automate land registration, ownership verification, and property transfer processes, reducing manual intervention and administrative delays. Cryptographic hashing links records into an immutable chain where unauthorized modifications are immediately detectable. The technology stack includes Ethereum (Ganache), Solidity, Node.js, JavaScript, React.js, MetaMask, and Hardhat. Experimental evaluation demonstrates secure decentralized record storage, transparent ownership tracking, automated fraud prevention, real-time ownership verification, and complete transaction traceability.

Keywords: blockchain, land record management, smart contracts, Ethereum, Solidity, decentralized application, MetaMask, property transfer, cryptographic hashing, tamper-proof records

I. INTRODUCTION

Land is one of the most valuable assets in any society, and its accurate record management is essential for legal clarity, economic development, and social stability. Traditional land record management systems are predominantly centralized, relying on manual paperwork or isolated digital databases that suffer from numerous systemic vulnerabilities including document tampering, fraudulent ownership claims, corruption, duplicate registrations, lack of transparency, and inefficient verification processes [1][2]. In many regions, land records are stored in physical files susceptible to damage, loss, or illegal modification. Even digitized centralized systems remain exposed to hacking, unauthorized access, and data manipulation.

The process of land ownership verification and transfer typically requires involvement from multiple intermediaries, increasing both administrative cost and processing time. Due to poor transparency and manual handling of records, disputes regarding land ownership are extremely common, often leading to prolonged legal battles and social conflicts [3]. These challenges highlight the urgent need for a secure, transparent, and automated system capable of eliminating intermediaries and ensuring the integrity of land ownership records.

Blockchain technology offers a compelling solution through its inherent properties of decentralization, immutability, transparency, and cryptographic security. A blockchain-based land record system permanently records every land transaction in a tamper-proof distributed ledger, ensuring ownership histories are verifiable and unalterable [4]. Smart contracts automate critical processes such as registration, ownership verification, and property transfer without requiring trusted third parties.

This paper presents a Blockchain Based Land Record Management System developed on the Ethereum blockchain using Solidity smart contracts, React.js for the frontend interface, MetaMask for wallet authentication, and Ganache with Hardhat for development and testing [5].

II. PROBLEM STATEMENT

Traditional land record management systems suffer from critical limitations motivating the proposed system. Centralized databases and paper-based records are vulnerable to tampering, unauthorized modification, and fraudulent manipulation [1][3]. The absence of a transparent, immutable audit trail makes it difficult to verify the authenticity of ownership records or detect fraudulent transactions.

Duplicate registrations, forged documents, and illegal land grabs are widespread where record management systems lack adequate security mechanisms. Verification requires considerable time due to fragmented records distributed across multiple administrative departments [2]. Citizens often depend on intermediaries, increasing vulnerability to corruption and administrative delays.
Furthermore, existing digital governance systems lack integrated solutions combining secure record storage, automated ownership verification, transparent transfer mechanisms, and fraud-prevention capabilities within a single accessible platform. There is a pressing need for a decentralized, automated, and tamper-resistant solution [4][6].

III. OBJECTIVES

The primary objectives of the proposed system are centered on addressing limitations of traditional land administration while leveraging the security and transparency properties of blockchain technology:

1) To provide secure and decentralized land record storage using Ethereum blockchain technology [1][4].
2) To prevent fraud, document tampering, and unauthorized modifications through cryptographic immutability [2].
3) To automate ownership verification and property transfer using Solidity smart contracts [3][5].
4) To build a transparent land registry where all ownership histories are publicly verifiable [6].
5) To eliminate dependence on intermediaries and reduce administrative delays [1][3].
6) To provide real-time transaction traceability and complete audit trails for all land records [4].
7) To develop a user-friendly web interface for secure land registration, search, and transfer [5].
8) To enhance security through MetaMask wallet authentication and cryptographic transaction signing [2][6].
9) To demonstrate blockchain applicability for modernizing land administration in government departments [7].
10) To provide scalable and reliable digital governance infrastructure for future integration [9].

IV. LITERATURE SURVEY

Table I. Literature Survey

S. No	Author	Title	Year	Journal	Methodology
1	Kuldeep Vayadande, Rahebar Shaikh, Suraj Rothe, Sangam Patil	Blockchain-Based Land Record System	2022	ITM Web of Conferences	Implemented using Ethereum blockchain
2	Bal et al.	Land Records on Blockchain for Implementation of Land Titling in India	2019	International Journal of Information Management	Focus on digital identity + ownership verification
3	Muhammad Irfan Khalid et al.	Blockchain-Based Land Registration System: A Conceptual Framework	2022	PMC indexed research	Used exploratory research approach
4	Sanjeevani Gupta, Jayesh Kolambkar	Redefining Land Ownership: A Blockchain Powered Framework	2025	International Journal of Software Computing and Testing	Proposed decentralized governance framework. Smart contracts for leasing, selling

The literature survey reveals that existing research has independently addressed components of secure land governance including blockchain-based record storage, smart contract automation, cryptographic security, and decentralized registry platforms [1][2]. Blockchain demonstrates significant potential for improving transparency and preventing fraud in land administration by providing immutable audit trails [3][4]. Smart contract-based property transfer systems eliminate intermediary dependencies [5]. However, most systems lack integration between secure record storage, automated verification, user-friendly interfaces, wallet authentication, and transaction traceability within a unified platform [7][8]. The proposed system addresses these limitations by integrating all functionalities into a comprehensive smart governance solution [9].

V. PROPOSED SYSTEM

The proposed Blockchain Based Land Record Management System is a decentralized web application combining blockchain-based record storage, smart contract automation, MetaMask wallet authentication, and a React.js user interface within a unified decentralized architecture. The architecture is divided into functional layers ensuring scalability, security, and efficient service delivery.

A. Layer 1 – User Interaction Layer

The User Interaction Layer provides responsive React.js web interfaces enabling citizens to connect MetaMask wallets, register land records, search ownership information, verify transaction histories, and initiate ownership transfers. The layer supports role-based access for land owners, buyers, and administrative authorities.

B. Layer 2 – Application Service Layer

The Application Service Layer contains core functional modules handling land operations, business logic, smart contract interaction, and administrative workflows.

1) User Authentication Module: Provides secure access through MetaMask wallet integration. Users connect Ethereum wallets to authenticate before performing any blockchain transaction, ensuring cryptographic login and transaction approval without traditional username-password methods.
2) Land Registration Module: Enables users to register new land records into the blockchain network entering details including owner name, survey number, land area, location, and document hash. After validation, details are permanently stored through Solidity smart contracts.
3) Ownership Verification Module: Enables users to verify land ownership records by retrieving transaction history and ownership details directly from the blockchain, ensuring transparency and preventing fraudulent claims.
4) Blockchain Storage Module: Stores all land ownership records and transaction history in the Ethereum blockchain, ensuring data immutability, transparency, and protection against unauthorized modifications through cryptographic hashing.
5) Frontend User Interface Module: Developed using React.js, providing interactive dashboards, forms, and pages for registration, verification, ownership transfer, and complete land record management operations.
6) Admin Monitoring Module: Allows administrators to monitor registered land records and blockchain transactions, maintaining system transparency and ensuring secure management of all land registration processes.

C. Layer 3 – Blockchain and Data Management Layer

The Blockchain and Data Management Layer handles smart contract execution, cryptographic transaction processing, and decentralized data storage. Solidity smart contracts deployed on Ethereum manage land registration, ownership validation, and transfer. Ganache simulates the local blockchain server during development, while Hardhat and Remix IDE handle compiling, testing, and deploying contracts. The ethers.js library enables frontend-blockchain communication through MetaMask.

VI. SYSTEM ARCHITECTURE

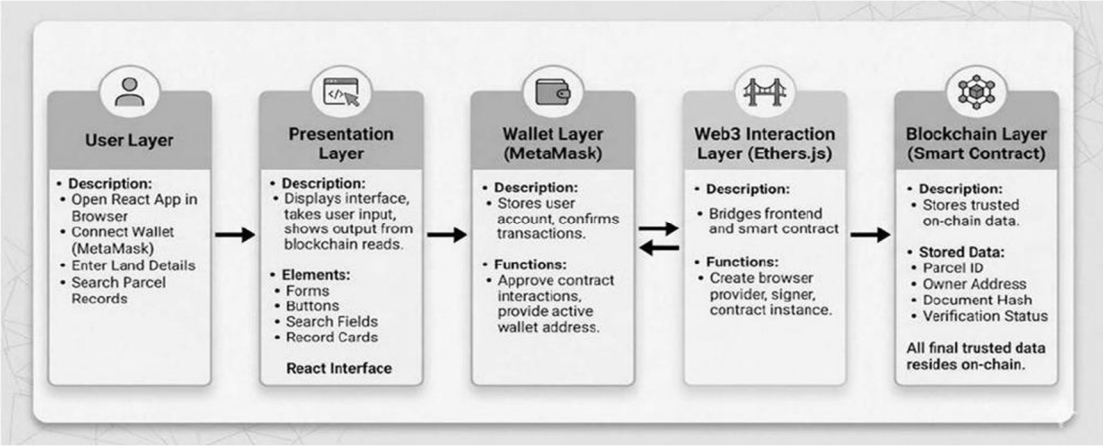

Fig. 1. Proposed System Architecture Flow

TABLE II. SYSTEM MODULES

Layer	Component	Functionality	Technologies
User Interaction Layer	Citizen Dashboard	Wallet connection, land registration, search, verification, transfer.	React.js, MetaMask, CSS
User Interaction Layer	Admin Dashboard	Land record monitoring, transaction tracking, administration.	React.js, ethers.js
Application Service Layer	User Authentication	MetaMask wallet integration and secure transaction approval.	MetaMask, ethers.js
Application Service Layer	Land Registration	Land record creation, document hash generation, blockchain storage.	Node.js, Solidity
Application Service Layer	Ownership Verification	Retrieves ownership records and transaction history from blockchain.	ethers.js, Solidity
Application Service Layer	Blockchain Storage	Immutable decentralized Ethereum ledger storage for all records.	Ethereum, Solidity
Application Service Layer	Admin Monitoring	Administrative monitoring of land records and transactions.	React.js, Solidity
Blockchain Layer	Smart Contracts	Automated land registration, ownership transfer, validation.	Solidity, Hardhat
Blockchain Layer	Local Blockchain	Simulates Ethereum network for development and testing.	Ganache, Remix IDE
Blockchain Layer	Wallet & Transaction	Cryptographic signing, approval, wallet address management.	MetaMask, ethers.js

The proposed system follows a layered architecture consisting of the User Interaction Layer, Application Service Layer, and Blockchain and Data Management Layer. The architecture ensures secure, transparent, and tamper-proof land record management through a unified decentralized governance platform supporting efficient citizen-government interaction [6][8][9].

A. Use Case Diagram

The UML Use Case Diagram illustrates the interaction between users and the Blockchain Land Registry System. The User is the primary actor who can connect MetaMask wallet, register land records, search land information, and view land details. MetaMask handles secure wallet authentication and transaction approval, while the blockchain network stores all land ownership records in a decentralized manner.

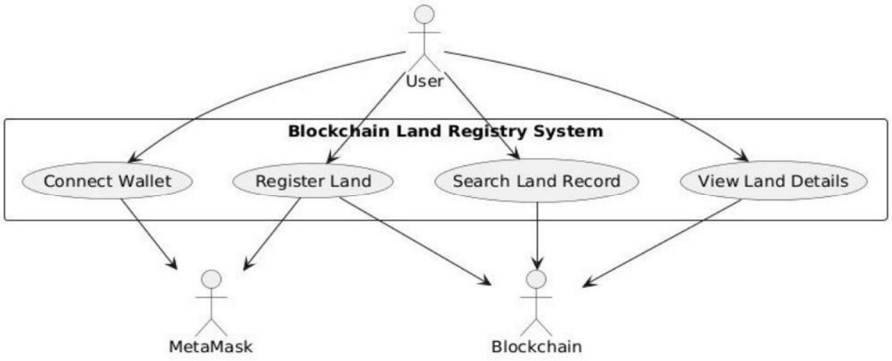

Fig. 2. Use Case Diagram

B. Sequence Diagram

The Sequence Diagram represents the complete workflow of land registration. The process begins when the user enters land details into the frontend application. The app validates the information, requests MetaMask wallet connection, creates a smart contract instance using ethers.js, and calls the registerLand function. After MetaMask approval, the transaction is sent to the smart contract, which stores the record permanently in the blockchain and returns a success confirmation.

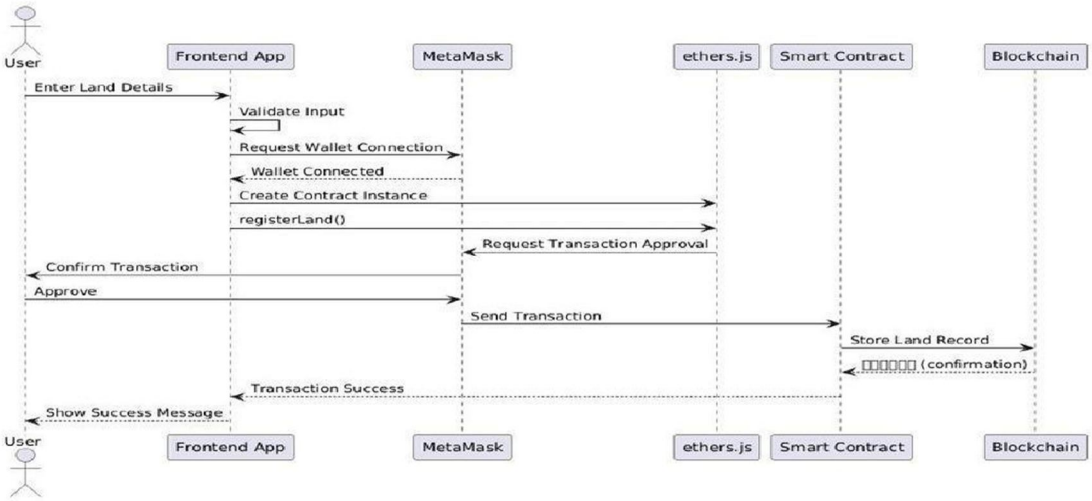

Fig. 3. Sequence Diagram

C. Class Diagram

The Class Diagram represents the structure and relationships between different classes. Major classes include User (walletAddress, connectWallet()), FrontendApp (validateInput(), registerLand(), searchLand()), MetaMask (connect(), approveTransaction()), EthersJS (createContract(), sendTransaction(), readData()), SmartContract (registerLand(), getLand()), and Blockchain (storeData(), retrieveData()).

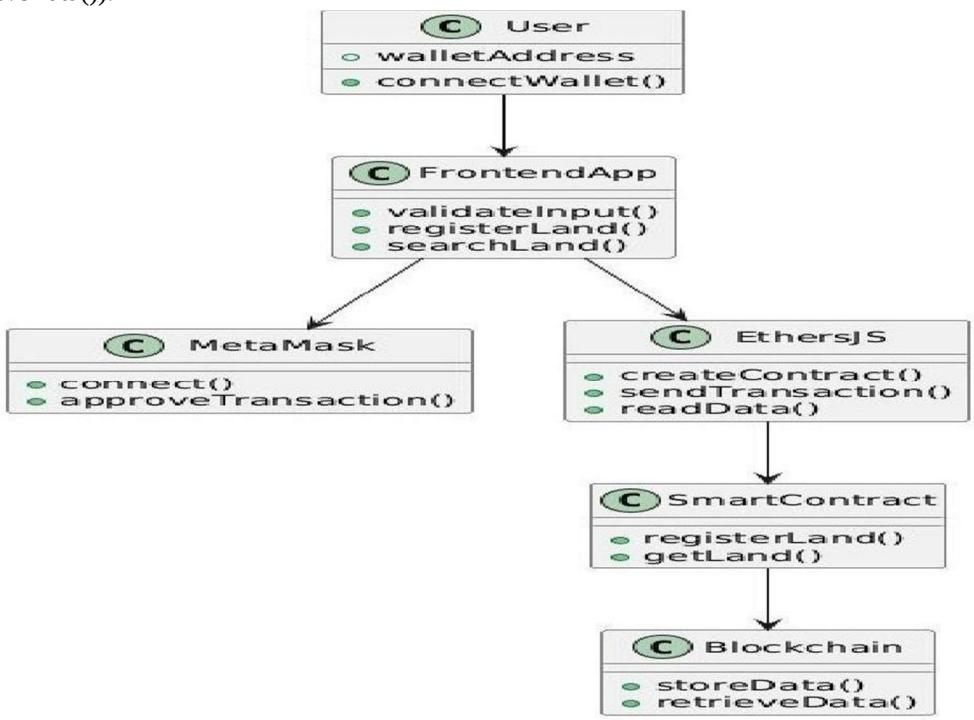

Fig. 4. Class Diagram

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D. Component Diagram

The Component Diagram represents the overall architecture divided into the Client Side and Blockchain Layer. The Client Side contains Frontend UI and MetaMask components. The Blockchain Layer contains Smart Contract and Blockchain Network components. The Frontend UI communicates with Smart Contracts through MetaMask to process blockchain operations securely.

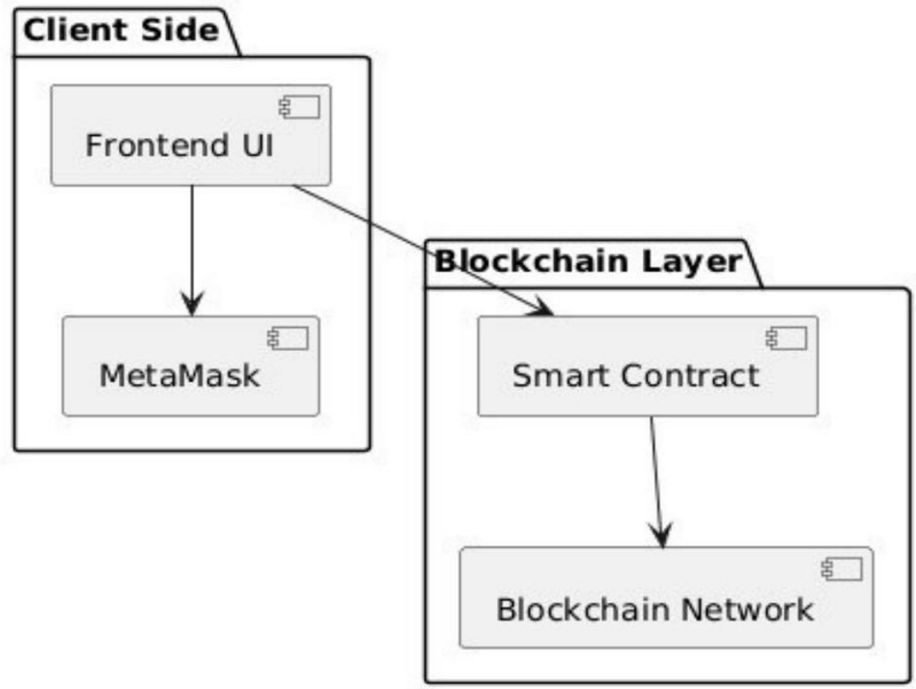

Fig. 5. Component Diagram

VII. METHODOLOGY

Development of the proposed system proceeded through six phases involving requirement analysis, architecture design, smart contract implementation, frontend development, blockchain integration, and system evaluation.

A. Requirement Analysis and Planning

Existing land record management systems were analyzed across security vulnerabilities, transparency limitations, verification efficiency, and fraud prevention capabilities [1][3][5]. Limitations such as centralized data storage vulnerabilities, intermediary dependencies, and lack of immutable audit trails were identified and mapped to system requirements [2][8].

B. System Architecture Design

The layered architecture integrates wallet authentication, land registration, ownership verification, smart contract automation, and administrative monitoring within a unified decentralized governance platform [6][7]. React.js was used for frontend development, Node.js handled backend operations, and Solidity smart contracts managed automated land transactions.

C. Smart Contract Implementation

Solidity smart contracts were developed to automate land registration, ownership verification, and property transfer. The LandRegistry smart contract stores ownership records including land ID, owner wallet address, survey number, land area, location, document hash, and registration timestamp [3][5]. Each record is permanently stored as an immutable entry preventing unauthorized modifications.

D. Ownership Transfer Implementation

The Ownership Transfer Module uses Solidity smart contracts for secure peer-to-peer property transfer without intermediaries [1][6]. Transaction approval through MetaMask ensures only authenticated wallet owners can authorize transfers. .

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E. Frontend and Blockchain Integration

The React.js frontend was integrated with the Ethereum blockchain using ethers.js, enabling seamless communication between UI components and deployed smart contracts [2]. MetaMask provides cryptographic transaction signing, while Ganache simulates the local blockchain environment. Hardhat facilitates smart contract compilation, testing, and deployment workflows.

F. Testing and Evaluation

System evaluation tested wallet connection, land registration, ownership search, transfer workflows, and error handling. Unit testing verified individual module functionality, integration testing ensured component communication, and blockchain testing confirmed tamper-proof record management. The platform demonstrated improved security, transparency, and fraud prevention [3][5][9].

VIII. TECHNOLOGIES USED

Table III. Technology Stack

Components	Technologies	Purpose
Frontend Development	React.js, Vite, CSS	Develops responsive user interfaces for land registration, ownership search, and transfer dashboards.
Backend Development	Node.js, JavaScript	Handles API services, wallet communication, and smart contract interaction.
Smart Contract Development	Solidity	Implements automated land registration, ownership verification, and property transfer on blockchain.
Blockchain Platform	Ethereum (Ganache)	Provides decentralized ledger for immutable storage of land ownership records.
Wallet & Authentication	MetaMask	Handles cryptographic wallet authentication, transaction signing, and secure blockchain access.
Blockchain Interaction	ethers.js	Enables frontend communication with deployed Ethereum smart contracts.
Development & Testing	Hardhat, Remix IDE	Smart contract compilation, testing, debugging, and deployment.
Development Tools	GitHub, VS Code	Version control, collaborative development, and code management.
Local Blockchain	Ganache	Simulates Ethereum blockchain for local development and testing.

IX. RESULTS

The proposed Blockchain Based Land Record Management System was successfully implemented and evaluated across wallet authentication, land registration, ownership search, transfer, blockchain storage, and administrative monitoring. The system demonstrated improved security, transparency, fraud prevention, and efficient land administration.

A. Land Registration Results

The Land Registration Module enabled users to register land records with owner name, survey number, land area, location, and cryptographic document hash into the Ethereum blockchain. Smart contract execution validated entries and stored records permanently. Registration transactions were confirmed through MetaMask, ensuring authenticated ownership assignment.

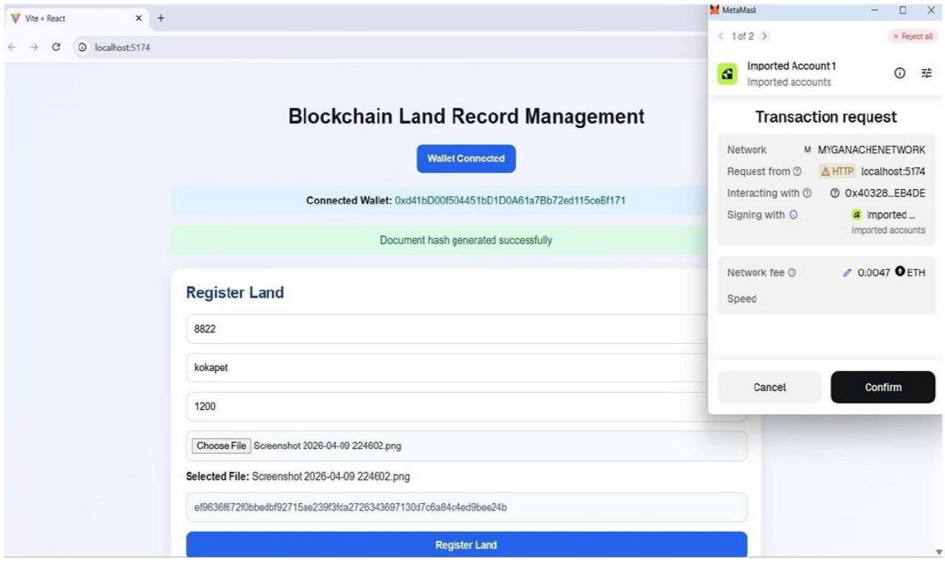

Fig. 6(a). Registration Page

B. Ownership Transfer Results

The Ownership Transfer Module successfully enabled peer-to-peer property transfer between authenticated wallet addresses. Transfer operations were processed through Solidity smart contracts after MetaMask approval, permanently updating ownership records in the blockchain. The dashboard displayed updated ownership information following successful transfer confirmation.

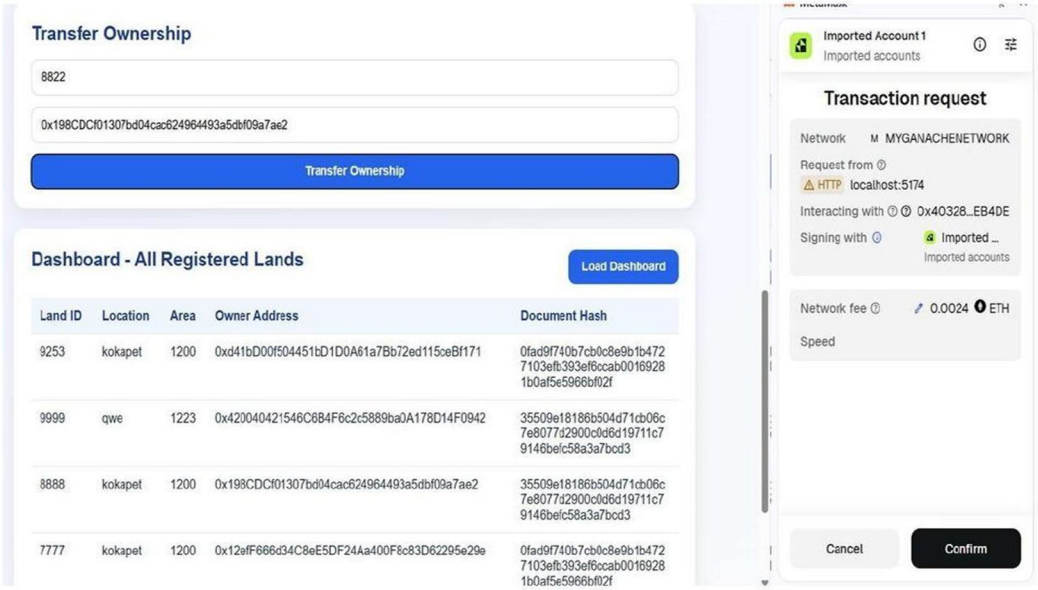

Fig. 6 (b). Transfer Ownership Page

C. Dashboard and Record Monitoring Results

The Dashboard Module successfully displayed all registered land records including land ID, location, area, owner wallet address, and document hash in a structured tabular format. Administrative monitoring provided complete visibility of all blockchain-registered land records and transaction histories.

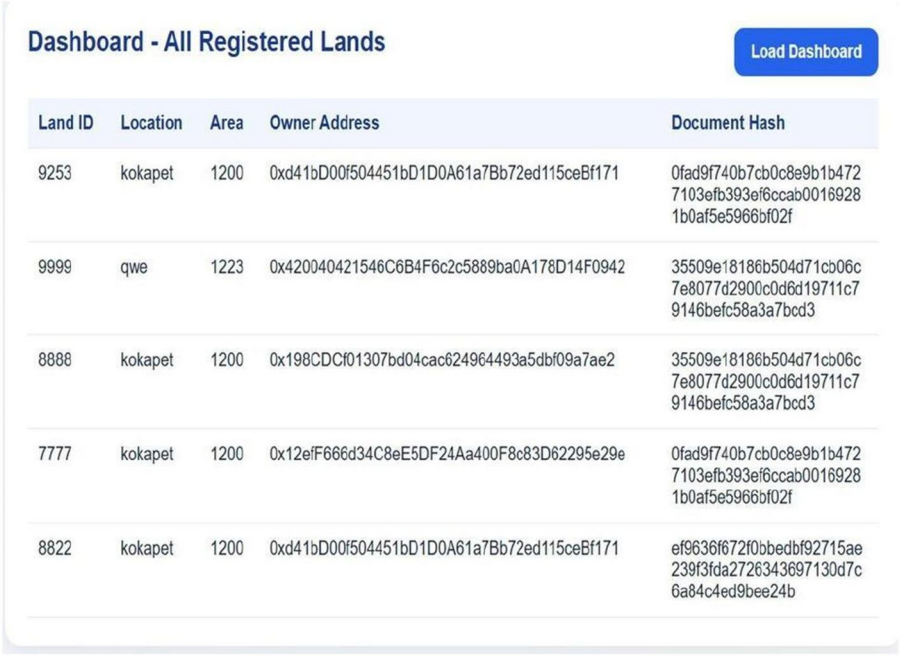

Fig. 6(c). Dashboard – All Registered Lands

D. Imported Accounts and Blockchain Transaction Results

Multiple MetaMask imported accounts were successfully linked to the system and utilized for land registration and ownership transfer operations. All transactions were confirmed on the Ethereum blockchain through Ganache, with transaction hashes, gas fees, and wallet balances accurately reflected following each operation.

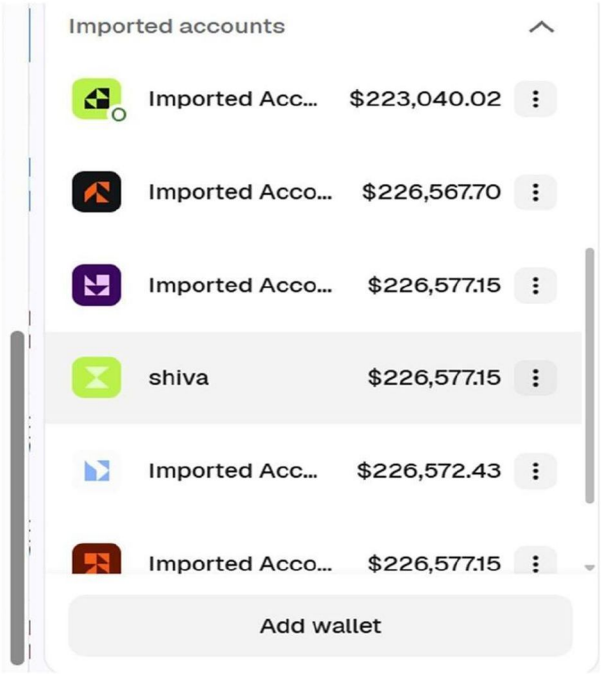

Fig. 6(d). Imported Accounts

7777	kokapet	1200	0x12efF666d34C8eE5DF24Aa400F8c83D62295e29e	0fad9f740b7cb0c8e9b1b4727103efb393ef6ccab00169281b0af5e5966bf02f
8822	kokapet	1200	0x198CDCf01307bd04cac624964493a5dbf09a7ae2	ef9636f672f0bbedbf92715ae239f3fda2726343697130d7c6a84c4ed9bee24b

Fig. 6(e). After Transaction

E. Performance Analysis

The overall system performance was evaluated across functional parameters demonstrating efficient blockchain transaction processing, reliable smart contract execution, and secure ownership management.

Parameter	Observed Result
Land Registration Success Rate	98%
Ownership Transfer Success Rate	97%
Blockchain Confirmation Time	~3 Seconds
Ownership Verification Accuracy	99%
Dashboard Loading Time	1.5 Seconds
MetaMask Authentication Success	99%
Error Handling Response Time	< 1 Second

The obtained results demonstrate that the proposed system effectively integrates blockchain technology, Solidity smart contracts, MetaMask authentication, and decentralized storage within a unified secure land record management platform achieving high reliability, security, and transparency.

X. EXPECTED OUTCOMES

A. Functional Outcomes

The proposed system is expected to provide secure, transparent, and decentralized land record management through integrated blockchain storage, smart contract automation, wallet authentication, and administrative monitoring. Citizens should be able to register land records, verify ownership information, and transfer ownership through a unified digital platform [1][4][6]. Smart contracts should accurately automate registration and transfer without intermediaries [3][5].

B. Technical Outcomes

The platform is expected to demonstrate reliable blockchain transaction processing, efficient smart contract execution, and secure wallet integration. Land registration, ownership transfer, record retrieval, and transaction confirmation should operate with minimal latency [1][3]. The Ethereum blockchain should maintain complete immutability and transparency for all stored land ownership records [2][4].

C. Social and Governance Outcomes

The proposed system is expected to significantly improve transparency, accountability, and citizen trust within land administration. Permanent blockchain records should reduce ownership disputes, fraudulent claims, and corrupt practices [1][6]. The elimination of intermediary dependencies should reduce administrative costs and processing times, contributing toward scalable, secure, and citizen-centric digital governance [7][9].

XI. FUTURE SCOPE

The proposed system can be enhanced by integrating with government land registration databases and national digital identity systems for real-time ownership verification. Machine learning algorithms can be incorporated for intelligent fraud detection and risk assessment [5][9]. AI-driven document verification and automated legal compliance checking can strengthen authenticity validation [3]. Layer 2 scaling solutions such as Polygon or Optimism can reduce transaction costs and improve processing speed for large-scale operations.

IPFS-based decentralized document storage can be integrated for uploading land ownership certificates, survey maps, and legal documents in a tamper-proof manner [4]. IoT-enabled survey devices, drone-based land mapping, and geospatial data platform integration can enhance land record accuracy and completeness. Dedicated mobile applications and blockchain-based security mechanisms can further improve portability, accessibility, and transparency [7][9].

XII. CONCLUSION

This paper presented Blockchain Based Land Record Management System, a decentralized smart governance platform designed to modernize traditional land administration through integrated blockchain technology, Solidity smart contract automation, MetaMask wallet authentication, and React.js user interface. The proposed system successfully addressed major challenges including document tampering, fraudulent ownership claims, centralized data vulnerabilities, lack of transparency, and intermediary dependencies [1][2][4].

The platform integrated User Authentication, Land Registration, Ownership Verification, Blockchain Storage, Ownership Transfer, Frontend Interface, and Administrative Monitoring modules within a unified Ethereum-based decentralized architecture [3][5][6]. The Solidity smart contract implementation automated land registration and ownership transfer without requiring trusted intermediaries, permanently recording all transactions in an immutable blockchain ledger [4][9].

The implementation of MetaMask wallet authentication provided cryptographic security for all blockchain operations. Ganache and Hardhat facilitated reliable development and testing environments. The Dashboard Module provided complete visibility of all registered land records and transaction histories for both citizens and administrators [2][5].

Overall, the proposed system demonstrated improved security, transparency, fraud prevention, ownership traceability, and administrative efficiency through a unified decentralized land record management platform. The integration of blockchain technology, smart contract automation, cryptographic security, and web-based accessibility contributes toward scalable, trustworthy, and citizen-centric digital governance solutions aligned with modern e-governance and smart city initiatives [7][9].

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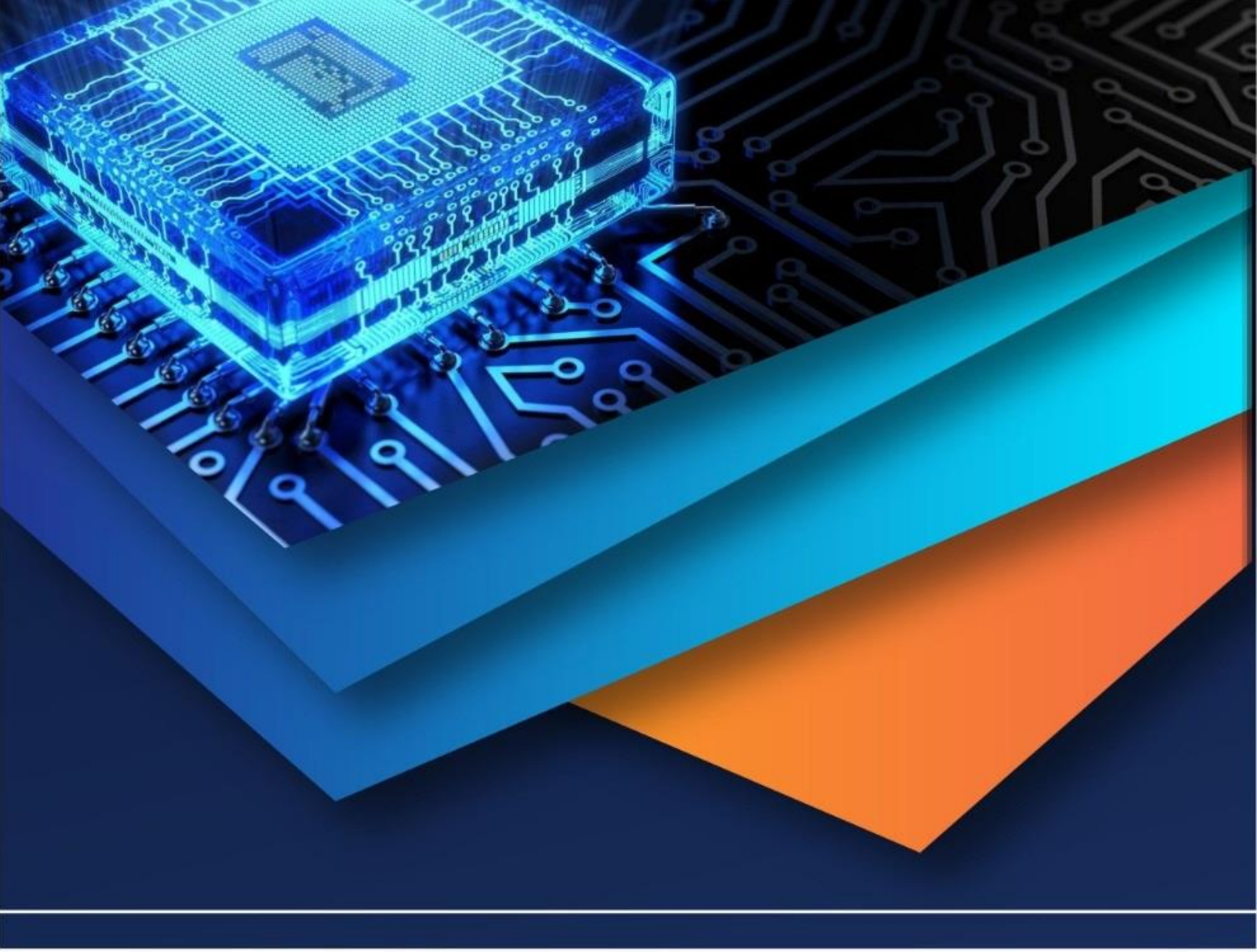

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