PROPCHAIN: A Blockchain-Based Real Estate Platform

Abhijith N S[1], Abilash P S[2], Aiswarya P S[3], Anitta Mariya Shajan[4], Anaswara Dinesh[5]

[1,2,3,4] *Student, CSE, IES College of Engineering, Kerala,*

[5] *Assistant Professor, CSE, IES College of Engineering, Kerala*

Email_id: nsabhijith29@gmail.com, abilashps37@gmail.com, aiswaryachi04@gmail.com, anitta2004mariya@gmail.com, anaswara@iesce.info

Abstract

The real estate sector faces numerous challenges, including lack of transparency, fraudulent transactions, and delays in property registration. Traditional land record systems are often paper-based and centralized, making them vulnerable to tampering and data loss. To address these issues, a blockchain- based real estate management system has been proposed. This system ensures secure and tamper-proof property records by leveraging the decentralized nature of blockchain technology. Smart contracts are used to automate property transactions, reducing the need for intermediaries and minimizing human error. Every transaction is stored permanently on the blockchain, ensuring transparency, traceability, and trust among all parties involved. By eliminating middlemen and enhancing security, the proposed system creates a more efficient and reliable platform for property buying, selling, and ownership transfer.

Keywords: Blockchain Technology, Smart Contracts, Transparency, Real Estate, Fraud Prevention, Decentralized System.

DOI: https://doi.org/10.5281/zenodo.18428108

1. Introduction

In a world where digital transformation is redefining industries, the real estate sector continues to face persistent challenges such as fraud, data manipulation, lack of transparency, and delays in property registration. Traditional land record systems are often paper-based or centralized, making them vulnerable to tampering, unauthorized access, and loss of critical ownership data. These inefficiencies not only slow down property transactions but also reduce public trust in existing real estate management systems. Blockchain technology offers a revolutionary solution to these challenges. With its decentralized, immutable, and transparent structure, blockchain ensures that property ownership records and transactions remain secure and verifiable. Every transaction is recorded on a distributed ledger, eliminating the risk of forgery and enabling stakeholders to track property details with complete confidence. The integration of smart contracts automates the buying and selling process, reducing dependence on intermediaries, minimizing errors, and ensuring that agreements are executed only when pre-defined conditions are met.

1.1 Blockchain Network

The core component of the system is the blockchain network, which records all property-related data and transactions on a decentralized ledger. This ensures immutability and transparency, as every record is time- stamped and verified by multiple participants. The network operates as a permissioned blockchain, where only verified users such as

property owners, buyers, and administrators can access and update records, maintaining both privacy and authenticity.

1.2 Smart Contracts

Smart contracts form the foundation of secure and automated property transactions within the system. These are self-executing digital agreements that automatically enforce transaction terms when specific conditions are met, such as payment confirmation or ownership verification. By removing intermediaries like brokers and legal agents, smart contracts streamline operations, reduce costs, and eliminate the possibility of human error or manipulation.

1.3 User Interface (UI)

The system features a user-friendly web-based interface that allows buyers and sellers to interact seamlessly. Users can register, list properties, view verified listings, initiate transactions, and check ownership records. The intuitive design ensures accessibility for non-technical users while maintaining a smooth and secure transaction experience for all stakeholders.

1.4 Verification and Audit Module

An integrated verification and audit module is included to ensure data integrity and compliance. This module continuously monitors transactions and compares them with blockchain records to detect inconsistencies or unauthorized modifications. It provides a transparent mechanism for auditing property transactions, ensuring accountability and reliability throughout the system.

2. Literature Survey

K. M. Alam, J. M. Ashfiqur Rahman, Ayesha Tasnim, and Anjuman Akther (2022) [1] proposed “Blockchain-Based Land Title Management System for Bangladesh.” Their study introduced a three-phase Ethereum-based land title management model using smart contracts. The system ensures transparency, reduces fraud, and synchronizes data across different departments, thereby improving the efficiency of land registration and ownership verification. The study also emphasized the importance of integrating multiple governmental databases for seamless property management.

Muhammad Imran Khalid, Javed Iqbal, Abdulrahman Alturki, Saeed Hussain, Abdulaziz Alabrah, and Shahbaz Sharif Ullah (2022) [2] presented “Blockchain-Based Land Registration System: A Conceptual Framework.” This work focused on developing a decentralized and trustable model for land registration using a private blockchain network. It emphasized reliability and transparency in property record management, though it remained at a conceptual stage without full implementation. The paper highlighted potential scalability challenges for large-scale deployment.

Milorad Stefanovic, Darko Przulj, Sasa Ristic, Dragan Stefanovic, and Dejan Nikolic (2022) [3] proposed “Smart-Contract Application for Managing Land Administration System Transactions.” The authors developed smart contract–based solutions to handle land-related processes such as joint ownership, inheritance, subdivision, and merging. Their model increased transaction efficiency, reduced intermediaries, and ensured secure and traceable ownership records. The study further discussed automated dispute resolution mechanisms embedded within smart contracts.

S. Soner and Ramesh Litoriya (2021) [4], in their paper “Exploring Blockchain and Smart Contract Technology for Reliable and Secure Land Registration and Record Management,” integrated blockchain with smart contracts to design a secure and tamper-proof system for land registration. The approach reduced human intervention, improved data accuracy, and ensured quick, transparent property transactions. Their work also recommended combining blockchain with cloud storage for large-scale record management.

K. S. and G. Sarath (2021) [5] developed "Securing Land Registration Using Blockchain," which applied SHA-256 hashing and Elliptic Curve Cryptography (ECC) for enhanced data protection in property registration systems. Their method improved security and trust by ensuring data immutability and preventing unauthorized changes to land records. The paper highlighted ECC's advantages in reducing computational overhead for real- time verification.

Anju R. Krishnan, Mufeeda Fathima, and R. V. Nair (2021) [6] presented "Blockchain-Based Land Asset Management System." The system uses a role-based access control mechanism over a private blockchain network to store and verify land data securely. It reduces fraudulent record alterations and provides fast, verifiable title checks for property ownership. The study also explored audit trail features to ensure accountability in administrative workflows.

Neha Sharma and Priya Jain (2021) [7] discussed "Smart Land Records Management System Using Blockchain." Their approach utilized a permissioned blockchain with smart contracts and role-based access control. This structure ensures that only authorized personnel can record or modify property data, improving the security and reliability of land management operations. The study further recommended real-time notification systems for transaction alerts to enhance transparency.

Vishal Thakur and M. N. Doja (2020) [8] introduced "Land Records on Blockchain for Implementation of Land Titling in India." The study employed Ethereum-based smart contracts to establish tamper-proof ownership records. It also reduced disputes and manual delays by providing automated and transparent property transfer mechanisms. The authors highlighted the potential for integrating GIS mapping to further improve property verification.

Ankita Arora and Richa Mehta (2020) [9] presented "Digital Land Records on Blockchain for Transparent Governance." Their system aims to digitize rural land records using blockchain to ensure secure and transparent access. It supports government initiatives by minimizing corruption, ensuring authenticity, and enhancing data accessibility for citizens. The study also emphasized training local authorities for system adoption.

Mohammed Shuaib and Syed M. Daud (2020) [10] proposed "Blockchain-Based Framework for Secure and Reliable Land Registry System." Their research outlined a blockchain framework for securing land data, reducing fraud risks, and maintaining the accuracy and reliability of registry information in decentralized databases. The paper highlighted the importance of integrating digital signatures to validate user actions.

Milorad Stefanovic and Sasa Ristic (2018) [11] explored "Possible Application of Smart Contracts in Land Administration." This study examined how smart contracts can automate real estate transactions and prevent double spending, thereby improving transaction speed and system reliability in digital land management. The authors also discussed potential legal and regulatory considerations for smart contract adoption.

M. M. E. Peck (2017) [12] discussed "Application of Blockchain in Real Estate Transactions." The paper introduced one of the earliest blockchain-based models for real estate, highlighting how decentralization and automation can streamline property transfers and safeguard data integrity without relying on intermediaries. The study provided foundational insights into using blockchain for secure property documentation and transfer processes.

An overall examination of the reviewed studies shows that researchers have applied a range of technologies to make land registration and real estate systems more transparent, secure, and efficient. Most works are built on blockchain networks that store ownership details in an immutable ledger, ensuring that every transaction is traceable and tamper-proof. Several implementations use Ethereum platforms and smart contracts to automate property transfers, while others

rely on private or permissioned blockchains to provide controlled access for verified users.

Cryptographic algorithms such as SHA-256 and Elliptic Curve Cryptography are frequently used to protect sensitive property information, and role-based access controls with audit modules enhance accountability and detect unauthorized changes. Distributed ledger technology (DLT) is often employed to synchronize data among participants and eliminate record manipulation. Though each approach differs in design, all share a common goal of reducing fraud, increasing transparency, and improving efficiency in property transactions. Collectively, these technologies form the foundation for developing a secure, reliable, and tamper-proof blockchain-based real estate management system.

3. Review Of Methodology

3.1 System Design:

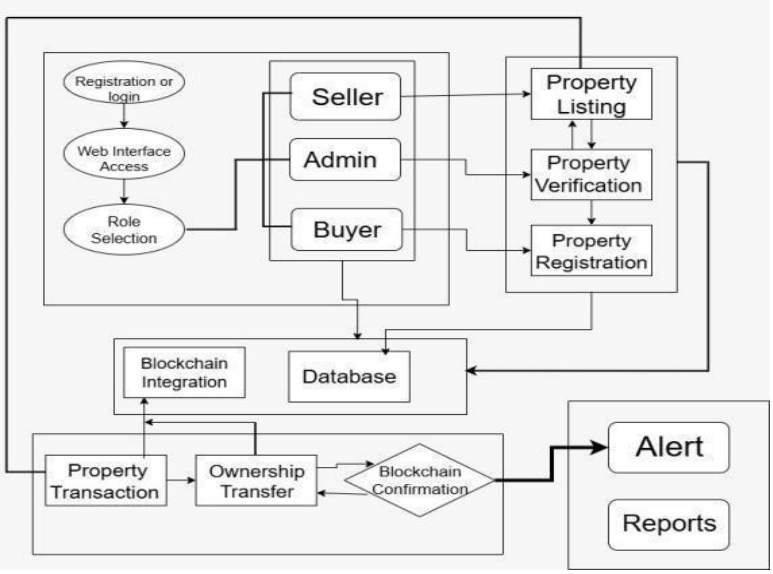


Figure 1: System Design

The proposed blockchain-based real estate management system is developed to ensure transparency, security, and immutability in property transactions. It integrates a web-based platform with blockchain technology to eliminate fraudulent practices and promote trust among stakeholders. The system primarily involves three users: Seller, Buyer, and Admin, each with distinct roles and permissions. The seller lists properties, the buyer verifies and purchases them, and the admin oversees verification, validation, and overall platform control.

As illustrated in the block diagram, the process begins when a user registers or logs into the system through the web interface. After successful authentication, the user selects their role; either seller, buyer, or admin to access their respective dashboards and functionalities. Each operation performed by these users interacts with a centralized database that stores property data, user credentials, and transaction information.

Once the Seller lists a property, it is submitted to the admin for document and ownership verification. After approval, the property becomes visible to buyers. The buyer can then verify all details stored on the blockchain, ensuring authenticity and preventing tampering. When the buyer initiates a purchase, a smart contract is triggered to automatically

execute the transaction based on predefined conditions such as payment confirmation and document validation.

The Blockchain Integration Module records these transactions immutably and confirms ownership transfer. Once confirmed, the system generates alerts and reports that notify stakeholders and provide an auditable trail for transparency. Overall, the system's design integrates blockchain, database management, and smart contracts to ensure a fully automated, secure, and verifiable property management process.

3.2 Seller Module

The Seller Module provides property owners with a secure platform to manage and list their properties. Sellers begin by registering and logging in with unique credentials, ensuring only authenticated users gain access. Once logged in, they can list properties by entering details such as property ID, title deed, location, area, market price, and supporting ownership documents.

Before the listing becomes visible to buyers, it is sent to the admin for verification. This process ensures that only legitimate properties enter the system. After verification, the Seller can monitor the status of their listing through the dashboard, which displays updates such as "Under Review," "Approved," or "Listed." Additionally, Sellers receive real-time alerts about buyer inquiries and transaction progress. This module minimizes fraudulent activity by verifying ownership before any property is published for sale.

3.3 Buyer Module

The Buyer Module enables users to securely browse, verify, and purchase verified properties. Buyers begin by registering and logging into their account. They can then view all verified listings displayed on the dashboard. Each property listing is linked to blockchain-stored records, allowing buyers to check ownership history, previous transactions, and authenticity of documents.

When a Buyer decides to purchase a property, a smart contract is initiated. This self-executing contract handles payment verification, seller authentication, and ownership transfer automatically without requiring intermediaries. The system also provides real-time tracking of the transaction process, displaying updates and blockchain confirmations to both parties. Once the transaction is completed, ownership details are permanently stored on the blockchain ledger, giving buyers full assurance of the property's legitimacy and preventing disputes or duplication of ownership.

3.4 Admin Module

The Admin Module acts as the central authority for managing users, verifying documents, and maintaining data integrity within the system. The admin is responsible for validating the identity and documents of sellers and buyers, as well as verifying property records before they are listed. This ensures that only trusted and verified users can engage in property transactions.

In addition to verification, the admin has access to tools for monitoring activities, managing complaints, and handling alerts generated by the blockchain or system events. The admin also oversees dispute resolution between buyers and sellers when necessary. Furthermore, the system allows the admin to generate comprehensive reports summarizing

property transactions, ownership changes, and system activities. These reports serve as audit logs that help maintain transparency and accountability across the platform. By managing all these operations, the admin ensures that the platform remains reliable, compliant, and secure for all participants.

3.5 Blockchain Integration Module

The Blockchain Integration Module serves as the technological backbone of the entire system, connecting user operations to the blockchain ledger. It performs several critical functions, including smart contract execution, immutable record storage, and transaction verification. Whenever a property transaction occurs, the blockchain module automatically triggers a smart contract that governs the transfer of ownership once the payment and verification processes are completed.

All transaction records, property details, and ownership histories are stored on the blockchain as immutable data, ensuring they cannot be altered or deleted. This immutability guarantees the transparency and traceability of every transaction. The module also handles blockchain confirmation, validating each transfer before finalizing ownership status. Additionally, it supports real-time audit and verification, allowing any stakeholder to trace historical transactions if required for dispute resolution or system review.

Through this integration, the Blockchain Module eliminates data manipulation, builds user trust, and provides a tamper-proof and verifiable property management lifecycle. It ensures that every interaction, from property listing to final ownership transfer remains securely recorded and permanently accessible for auditing and regulatory purposes.

3.6 Review of Datasets

A review of datasets for a blockchain-based real estate management system ensures that the data incorporated within the platform aligns with the objectives of transparency, accuracy, and immutability. Each dataset plays a crucial role in enabling secure property transactions, verifying ownership, and maintaining trust among buyers, sellers, and administrators. Proper organization and validation of these datasets ensure the integrity and reliability of the entire system.

3.7 Property Data

The Property Data contains essential details about each property listed on the platform. This includes attributes such as property ID, title deed number, owner information, location, area, type, and relevant legal documents. These details form the foundation for ownership verification and transaction recording. By storing property data on the blockchain, the system ensures that every record is immutable and tamper-proof, preventing duplication or fraudulent modification. The completeness and consistency of this dataset are vital for ensuring transparency in property dealings and reducing disputes.

3.8 User Data

The User Data represents all participants in the system, including buyers, sellers, and administrators. Each user record consists of user ID, name, contact information, authentication credentials, and access privileges. Role- based access control is implemented to restrict unauthorized operations and safeguard sensitive information. Storing verified user details on the blockchain enhances accountability and ensures that only authenticated individuals participate in property transactions. Maintaining this dataset's accuracy is essential for secure and traceable interactions across the platform.

3.9 Transaction Data

The Transaction Data captures every property-related transaction occurring within the system. Each record includes transaction ID, property ID, buyer and seller IDs, transaction date, amount, and status. Every transaction is linked

to a corresponding smart contract, which automatically executes the ownership transfer once all conditions are met. Recording these transactions on the blockchain guarantees immutability and auditability, enabling stakeholders to verify the complete history of property exchanges and ensuring transparency at every stage.

3.10 Complaint and Communication Data

This dataset stores user complaints, messages, and communication logs exchanged between buyers, sellers, and administrators. Each entry contains message ID, sender and receiver details, timestamps, and message content. By keeping this information securely stored, the system ensures accountability and supports conflict resolution. Proper management of complaint data strengthens user trust by ensuring that all grievances are traceable and handled fairly.

3.11 Verification and Audit Data

The Verification and Audit Data is used by the system's audit module to maintain consistency and detect irregularities. It contains logs of system operations, property verifications, and user activity records. This dataset supports continuous monitoring of all blockchain entries to confirm their validity and identify discrepancies. The inclusion of audit data enhances transparency and assures stakeholders that every operation adheres to system protocols and legal standards.

3.12 Implementation of A Blockchain-Based Land Registry System

The implementation of the blockchain-based land registry system establishes a secure, decentralized, and transparent framework for managing property records and ownership transfers. The system combines blockchain technology, smart contracts, and a web-based platform to overcome challenges of fraud, data tampering, and inefficiency in conventional land registration. By digitizing property management through blockchain integration, the system ensures that every transaction is authenticated, traceable, and irreversible, thereby promoting trust among users and authorities.

3.13 System Architecture

The system architecture follows a layered model that integrates a user interaction layer, a processing layer, and a blockchain layer. The user interaction layer enables stakeholders: buyers, sellers, and administrators to access system features through a secure web interface. The processing layer manages user authentication, property verification, and communication with the blockchain. The blockchain layer records verified transactions and ownership details as immutable data blocks. This architecture ensures seamless coordination between the database, blockchain network, and user operations while maintaining data integrity and privacy.

3.14 Blockchain Integration

Blockchain acts as the core component ensuring decentralization and data security. The system utilizes a private Ethereum blockchain environment to record property-related transactions. Each transaction block contains encrypted details such as property ID, owner information, timestamps, and digital signatures. The Ganache tool provides a local blockchain setup for development and testing, while Truffle Suite manages smart contract deployment and monitoring. The blockchain's immutable nature ensures that every property registration or transfer is permanently recorded and easily auditable, eliminating the possibility of manipulation or duplication.

3.15 System Modules

The system is structured into three main modules that work collaboratively to ensure transparent and secure property management. The Seller Module allows property owners to register and list their properties by uploading valid ownership documents, which are verified before approval. Sellers can view property details, verification status, and

ongoing transactions through their dashboard. Once the admin approves the listing, it becomes publicly available for buyers. The Buyer Module enables users to browse verified properties, review ownership history, and initiate purchase requests. Smart contracts handle payment and ownership transfer verification automatically, ensuring that transactions are completed securely and efficiently. Upon successful completion, the buyer receives a digital proof of ownership securely stored on the blockchain. The Admin Module oversees system operations, including user verification, property validation, and transaction monitoring. It also manages complaints, generates detailed transaction reports, and ensures compliance with established verification protocols. The admin dashboard includes monitoring and analytical tools that help maintain the integrity and authenticity of blockchain records, ensuring smooth and trustworthy operation of the entire platform.

3.16 Smart Contract Execution

Smart contracts form the backbone of automated operations. Written in Solidity, these contracts handle all transaction logic, ensuring that ownership transfer occurs only when pre-set conditions are met—such as payment completion, document approval, and property validation. Once executed, the contract updates the blockchain with a new ownership record. This automated process eliminates the need for third-party intervention, minimizing errors and ensuring transparent and instantaneous ownership changes.

3.17Database and User Interface

The system uses MySQL for maintaining supplementary data such as user credentials, login details, and metadata not stored directly on the blockchain. The front-end interface, developed using HTML, CSS, and JavaScript, offers a responsive and accessible design compatible with both desktop and mobile browsers. The back-end, built with Node.js, ensures efficient communication between the front-end and blockchain network through secure APIs. The interface provides dashboards for all roles: buyers, sellers, and administrators enabling easy access to listings, transaction history, and alerts. Security and Data Integrity

The system incorporates multiple layers of security to safeguard user data and transaction details. All records are hashed and stored using cryptographic algorithms to prevent tampering or unauthorized modifications. Role- based access control restricts user permissions according to their roles, and blockchain's consensus mechanism ensures the authenticity of every transaction. Periodic audit logs are maintained to verify system activity and detect potential anomalies. The immutable nature of blockchain guarantees permanent storage of ownership data, reinforcing transparency and long-term trust.

4. Requirements

The development of the blockchain-based land registry system requires both hardware and software configurations that support secure transactions, blockchain integration, and efficient database operations. This chapter outlines the hardware, software, functional, and non-functional requirements essential for implementing the system effectively.

4.1 Hardware Requirements

Processor: Intel Core i5 or higher to ensure smooth and efficient execution of all blockchain operations, including transaction validation, smart contract execution, and real-time data synchronization. A multi-core processor enhances system responsiveness and supports concurrent user activities.

Primary Memory: 8 GB RAM is required to maintain stable performance during simultaneous property transactions and blockchain interactions. Adequate memory ensures fast loading times for the web interface, efficient query execution, and smooth operation of blockchain nodes without lag or delay.

Storage: A minimum of 500 GB hard disk is needed to store blockchain data, user credentials, smart contract logs, property records, and system backups. The storage also accommodates cached data, temporary files, and audit logs necessary for long-term maintenance and traceability.

Additional Requirements: A stable and high-speed internet connection is essential for continuous blockchain synchronization and communication between nodes. Consistent connectivity ensures that property transactions are validated in real time and recorded securely across the distributed network without disruption.

4.2 Software Requirements

Operating System: Windows 10 or higher is used for its robust support of development frameworks, compatibility with blockchain tools, and high system stability. It provides the necessary environment for running virtual blockchain nodes, compilers, and integrated development tools efficiently.

Front-End Development: HTML, CSS, and JavaScript are employed to design an interactive, responsive, and user-friendly interface. HTML structures the content, CSS enhances visual appeal, and JavaScript ensures dynamic page updates, seamless form handling, and smooth user navigation across all modules.

Back-End Development: Node.js is used to handle the server-side logic, process blockchain requests, and connect users to the database. MongoDB serves as the backend database, storing non-blockchain data such as user details, verification records, and system configurations. This combination ensures high flexibility, fast data retrieval, and smooth scalability.

Blockchain Tools: Ganache provides a local Ethereum blockchain environment that allows developers to deploy and test smart contracts securely before going live. Truffle Suite assists in smart contract compilation, deployment, and debugging, ensuring accuracy and consistency in contract execution. Together, these tools streamline blockchain integration during development and testing phases.

Smart Contract Language: Solidity is used for coding Ethereum-based smart contracts that automate property transactions and ownership transfers. Its object-oriented syntax supports conditional execution, validation checks, and event triggers, making it ideal for managing complex real estate agreements on-chain.

IDE / Editor: Visual Studio Code serves as the primary Integrated Development Environment, offering features like syntax highlighting, debugging tools, version control integration, and plugin support for Solidity and Node.js. This facilitates faster development, efficient testing, and smooth coordination between blockchain and application layers.

4.3 Functional Requirements

a. User Authentication and Role Management:

The system provides secure authentication through unique login credentials and encrypted passwords. Users are categorized as sellers, buyers, or administrators, each granted specific access privileges. Role-based access control ensures that only authorized users can perform critical actions such as property listing approval or transaction confirmation. Authentication tokens and session management prevent unauthorized logins, ensuring data protection and system reliability.

b. Property Management:

The property management function allows sellers to upload property details including title deeds, survey numbers, location, and ownership certificates. The admin verifies the authenticity of documents before approving listings. This process prevents the entry of fraudulent data into the system. Verified property information is stored on the

blockchain, providing a permanent and transparent record accessible to all users.

c. Transaction Management:

Smart contracts handle the entire transaction workflow, including payment validation, ownership verification, and automatic title transfer. Once all conditions are met, the blockchain permanently records the transaction, ensuring that ownership details cannot be altered. This automation reduces human error, enhances transparency, and speeds up the overall registration process.

d. Verification and Alerts:

Every verification process such as user approval, document validation, and transaction confirmation is logged in the system for audit purposes. Automated alerts notify users via the interface about transaction progress, approvals, or discrepancies. The system also generates regular reports for administrators to monitor activities and identify any anomalies in real time.

4.4 Non-Functional Requirements

a. Performance:

The system is designed to process multiple concurrent property transactions efficiently, maintaining minimal latency between transaction initiation and confirmation. Optimized backend logic and efficient database indexing ensure quick response times even under heavy workloads.

b. Reliability:

High reliability is ensured through redundant data storage and blockchain's inherent fault tolerance. Since each transaction is validated by multiple nodes, the risk of data loss or corruption is minimized. Backup and recovery mechanisms further safeguard system availability.

c. Usability:

The platform features an intuitive and visually appealing interface that simplifies complex operations for users of varying technical backgrounds. Clear navigation menus, responsive layouts, and guided prompts enhance the overall user experience.

d. Security:

Advanced cryptographic techniques are employed to protect sensitive information. Blockchain immutability ensures data integrity, while encryption safeguards user credentials and transaction data. Access control and real- time monitoring helps detect and prevent unauthorized activities.

e. Scalability:

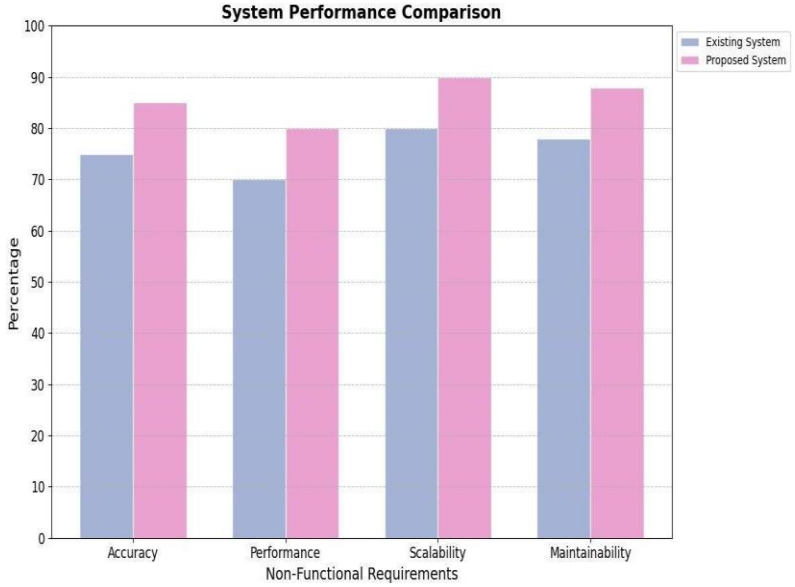
The system architecture is scalable to accommodate a growing number of users, transactions, and property records. Modular coding practices and cloud-based integration options allow expansion without affecting system performance. Blockchain nodes can also be added dynamically to handle increased transaction volume.

5. Result And Discussion

The proposed blockchain-based real estate management system offers major improvements over traditional property registration methods. Its decentralized and tamper-proof structure ensures transparency, security, and trust among all participants. Every property transaction and ownership record is permanently stored on the blockchain, preventing fraud and unauthorized alterations.

Smart contracts automate property verification and ownership transfer once predefined conditions are met, removing the need for intermediaries and reducing time and cost. The system's role-based access and user- friendly interface allow buyers, sellers, and administrators to manage their respective operations efficiently while maintaining data confidentiality.

Although initial implementation costs and regulatory uncertainties pose challenges, the advantages of this system such as enhanced transparency, reduced disputes, and secure data handling outweigh these limitations. Overall, the integration of blockchain technology in real estate management creates a more reliable, efficient, and tamper- proof environment for property transactions.



6. References

[1]. K. M. Alam, J. M. A. Rahman, A. Tasnim, and A. Akther, "A Blockchain-Based Land Title Management System for Bangladesh," Journal of King Saud University – Computer and Information Sciences, vol. 34, no. 6, pp. 2613–2624, June 2022.

[2]. M. I. Khalid, J. Iqbal, A. Alturki, S. Hussain, A. Alabrah, and S. S. Ullah, "Blockchain-Based Land Registration System: Conceptual Framework," International Journal of Advanced Computer Science and Applications (IJACSA), vol. 13, no. 9, pp. 241–247, 2022.

[3]. M. Stefanovic, D. Przulj, S. Ristic, D. Stefanovic, and D. Nikolic, "Smart Contract Application for S. Soner and R. Litoriya, "Exploring Blockchain and Smart Contract Technology for Reliable and Secure Land Registration and Record Management," International Journal of Engineering and Advanced Technology (IJEAT), vol. 10, no. 4, pp. 29–35, 2021.

[4]. K. S. and G. Sarath, "Securing Land Registration Using Blockchain," International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), vol. 8, no. 2, pp. 52–58, 2021.

[5]. A. R. Krishnan, M. Fathima, and R. V. Nair, "Blockchain-Based Land Asset Management System," International Research Journal of Modernization in Engineering Technology and Science (IRJMETS), vol. 3, no. 8, pp. 1654–1659, 2021.

[6]. N. Sharma and P. Jain, "Smart Land Records Management System Using Blockchain," International Journal of Computer Applications, vol. 183, no. 33, pp. 1–5, 2021.

[7]. V. Thakur and M. N. Doja, "Land Records on Blockchain for Implementation of Land Titling in India," IEEE International Conference on Inventive Computation Technologies (ICICT), pp. 1050–1055, 2020.

[8]. A. Arora and R. Mehta, "Digital Land Records on Blockchain for Transparent Governance," International Journal of Research in Engineering, Science and Management (IJRESM), vol. 3, no. 5, pp. 27–31, 2020

[9]. M. Shuaib and S. M. Daud, "Blockchain-Based Framework for Secure and Reliable Land Registry System," International Journal of Recent Technology and Engineering (IJRTE), vol. 8, no. 6, pp. 963– 968, 2020.

[10]. M. Stefanovic and S. Ristic, "Possible Application of Smart Contracts in Land Administration," International Journal of Engineering and Technology (IJET), vol. 7, no. 4, pp. 215–220, 2018.

[11]. M. M. E. Peck, "Application of Blockchain in Real Estate Transactions," IEEE Spectrum, vol. 54, no. 10, pp. 26–31, 2017.