IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 10, October 2024

DOI: 10.17148/IJARCCE.2024.131016

Blockchain for Secure Land Ownership in India

Sumati Gaur[1], Dr. Shalini Lamba[2], Aakanksha Patel[3]

Scholar, National P.G. College, Lucknow, Uttar Pradesh, India[1]
Department of Computer Science, National P.G. College, Lucknow, Uttar Pradesh, India[2]
Scholar, National P.G. College, Lucknow, Uttar Pradesh, India[3]

Abstract : This paper examines the potential of blockchain technology to transform land ownership management by creating a secure, transparent, and efficient system for recording and transferring property rights. Blockchain's key features, including immutable records and decentralized validation, enhance the integrity and reliability of ownership data, reducing the risks of fraud and disputes. By centralizing historical ownership information, blockchain streamlines title searches, lowers transaction costs, and improves data accessibility, especially for marginalized communities seeking to establish or protect their land rights. The integration of blockchain with Geographic Information Systems (GIS) further enhances data clarity and spatial accuracy. The paper additionally discusses the broader outcomes for dispute resolution, global standardization, and innovations such as multi-party ownership and simplified inheritance processes. While blockchain-based land registries face legal and technological obstacles, their ability to update property management systems and eliminate fraud makes them a promising alternative for the future.

Keyword: Blockchain technology, Blockchain-based land registries, Land Administration, Smart Contracts.

INTRODUCTION

Land ownership management has long been an important part of economic stability and social structure. Traditional land registration procedures in India, on the other hand, have faced significant obstacles. Centralized registries and paper-based processes have struggled to meet the increasing expectations for transparency, security, and speed. [1] Land fraud was prevalent in the early 2000s, with statistics showing that approximately half of all land deals in urban areas contained some type of deception. High-profile examples of forgery, identity theft, and multiple sales sowed suspicion, eroding the legal system that governs property rights.

According to a 2008 study by the Ministry of Rural Development, approximately 30% of land disputes in India were linked to fraudulent ownership claims, resulting in significant economic losses and prolonged litigation. By 2015, this issue had not diminished; the National Crime Records Bureau reported that property disputes accounted for over 60% of all civil cases in the Indian judiciary. This exceptional statistic emphasizes the critical need for reform in land ownership management.
As populations rise and urbanization accelerates, the importance of dependable land ownership systems grows, not only for facilitating commercial transactions but also for protecting the rights of individuals and communities. Property-related fraud and disputes cost an estimated ₹1.5 lakh crore (roughly $20 billion) every year, highlighting the importance of a strong solution.

Blockchain technology has the potential to transform land ownership in India. Blockchain could address many of the issues with conventional land registries, including fraud and conflicts, by offering a safe, open, and decentralized method of recording property rights. [2] Its major features, such as immutable records and decentralized validation, increase the reliability of ownership data and lower the danger of fraud. [3]

Blockchain technology may also speed up and reduce the cost of title searches by providing quick access to verified ownership records.[4] This would benefit underserved populations, who frequently find it difficult to demonstrate ownership, as well as businesses. Transparent auditing and real-time changes would make it more difficult to conceal false claims.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 10, October 2024

DOI: 10.17148/IJARCCE.2024.131016

Beyond improving transactions, blockchain has a chance to improve solving conflicts and promote global standards. Though there are obstacles to blockchain adoption, such as legal concerns and a lack of technical skills, its potential to alter property management is obvious. Blockchain could help build a more equitable and transparent system, eliminating property conflicts as India attempts to modernize land ownership. [5]

CURRENT CHALLENGES IN LAND OWNERSHIP MANAGEMENT

Managing land ownership encounters various obstacles that impede effectiveness, transparency, and security. These challenges are frequently intensified by outdated methods and limited access to dependable information. [6]

A. Challenges with Conventional Land Registries

- 1. Fraud and Conflicts: Conventional land registries are susceptible to fraudulent activities, including the falsification of documents and unauthorized property transfers. The absence of a transparent system complicates the verification of ownership claims, resulting in conflicts between parties regarding property rights. This inefficiency can lead to transaction delays and increased frustration for everyone involved.

- 2. Inefficiencies in Title Searches: The process of conducting title searches can be lengthy and cumbersome. In many cases, individuals must navigate a maze of paperwork and historical records that may not be well-organized or easily accessible. This inefficiency can lead to transaction delays and increased frustration for everyone involved.

- 3. Enhanced Transaction Costs: The conventional process for land transactions typically involves several intermediaries, such as lawyers and notaries, which raises expenses. The fees associated with these intermediaries, along with the time needed for document processing and title searches, can render property transactions excessively costly for many individuals.

B. Impact on Marginalized Communities

These worries most frequently impact marginalized communities the most. Economic instability and disenfranchisement can come through unclear land tenure and a lack of access to reliable records. Many people in these areas face difficulty in proving their ownership, which can lead to a loss of their land rights and make them extra vulnerable to being displaced. These people may not be able to profit from land ownership and economic development due to entry hurdles caused by the complexity of existing institutions.

To sum up, there are many issues with land ownership management that jeopardize accessibility, efficiency, and security. All of these issues worsen inequality, particular among underprivileged groups, in addition to halting economic transactions. Addressing these issues is critical to ensuring a fair and efficient land ownership system.

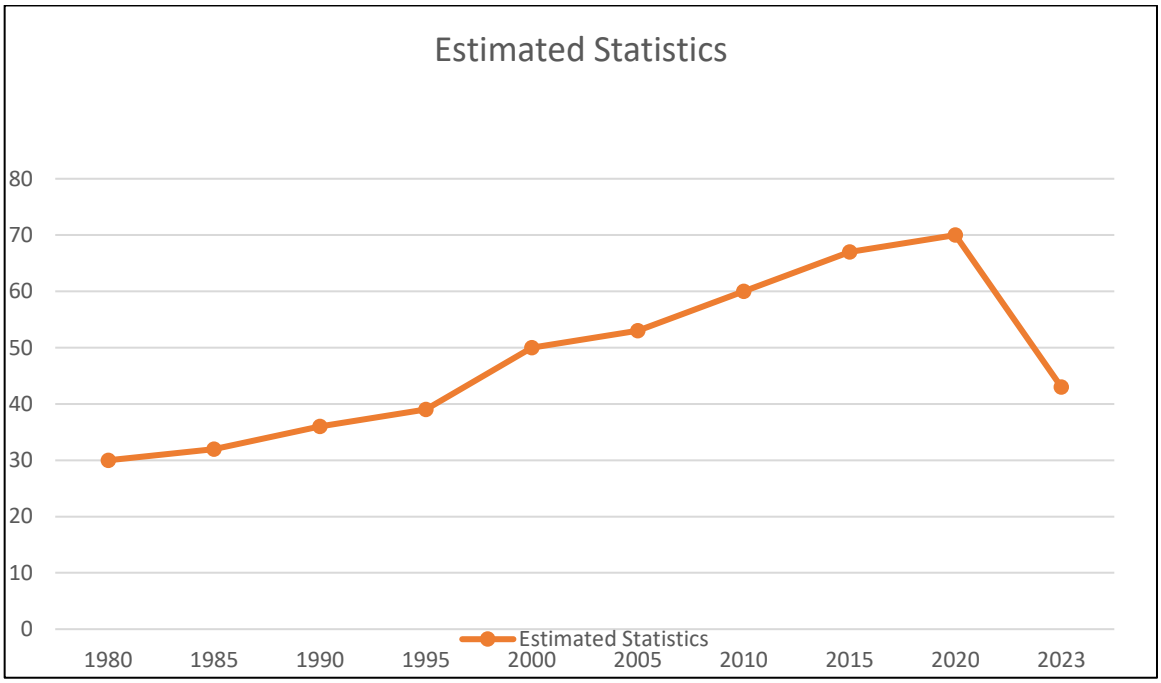
IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 10, October 2024

DOI: 10.17148/IJARCCE.2024.131016

Year	Estimated % of Property Fraud
1980	30
1985	32
1990	36
1995	39
2000	50
2005	53
2010	60
2015	67
2020	70
2023	43



Blockchain Technology Overview

With blockchain, a distributed ledger technology (DLT), several people can oversee a common database without a single point of control. Each transaction is recorded as a "block" that is linked to the ones before it, resulting in a secure chronological chain. This structure allows real-time data access while maintaining decentralized governance. [7]

A. Key Features of Blockchain

- Immutable Records: Blockchain makes sure that information cannot be changed or removed once it has been recorded. Every block contains a distinct cryptographic hash of the one before it, preventing tampering and maintaining data integrity, which is essential for land ownership since accurate records lessen conflicts.

- Decentralized Validation: Multiple participants verify transactions using consensus procedures such as Proof of Work (PoW) or Proof of Stake (PoS). This minimizes reliance on a single authority, lowers fraud risks, and promotes a

DOI: 10.17148/IJARCCE.2024.131016

democratic validation process.

B. Benefits of Blockchain for Land Ownership

- Enhanced Security: Blockchain uses cryptographic security and multiple backups to protect data from tampering, hacking, or loss. Even if one part of the system is compromised, the rest remains secure, which helps safeguard ownership records. [8]

- Transparent Transactions: With blockchain, everyone involved can see the property history and confirm that transactions are legitimate. The data can't be changed once it's entered, reducing the risk of fraud and ensuring reliable records. [9]

- Greater Visibility and Trust: Buyers, sellers, agents, and government officials can easily access property histories and transaction details. Because multiple parties verify each transaction, there's more confidence in the data's accuracy.

- Efficiency and Cost Savings: Blockchain cuts out middlemen with smart contracts—automated agreements that handle transactions faster and with less paperwork. This reduces delays and costs, making the real estate market more responsive and efficient.

Overall, blockchain could change how we handle land ownership by making transactions safer, more transparent, and more efficient. [10]

BLOCKCHAIN-BASED LAND SECURITY SYSTEM WORKFLOW

The proposed blockchain-based land security system aims to speed and safeguard land transactions, allowing both buyers and sellers to engage in a transparent, efficient, and tamper-proof process. The system is divided into multiple levels of user contact, each with its own role, resulting in a seamless and paperless procedure.

At the Seller Level, the process begins when the seller provides essential information about the land they wish to sell. A verified mobile application can be used to gather geographical data, such as latitude and longitude coordinates, photographs of the land, and scanned copies of official documents, such as the land title deed. To ensure its authenticity, this data is verified by a government employee or official. The land is given a unique reference ID after the verification process is finished, and this ID is used to identify the land during the transaction process. Since the buyer does not receive the seller's personal information until the buyer requests it using this reference ID, it is essential for privacy protection.

At the Buyer Level, the buyer begins by registering on the official platform, where they provide their identification and undergo a verification process, which may include biometric data such as iris scans, fingerprints, or photographs. This step ensures that the buyer's identity is authentic and secure. A buyer can only access detailed land information after receiving the reference ID from the seller. This ensures that the buyer is looking at the correct property, and the process maintains privacy for both parties. Once the buyer has received the reference ID, they can view the land's details, verify its authenticity, and, if everything is in order, proceed with the purchase.[11] All of this is done under the guidance of a Worker/Guide, a government-appointed official responsible for overseeing the transaction process.

The entire operation is conducted under the oversight of a Worker/Guide, a government-designated official tasked with supervising the transaction process. The Worker/Guide Level is a crucial phase in the system, where the government official serves as both a facilitator and a verifier. This official ensures that all necessary actions—such as identity verification through biometric data, document checks, and witness authentication—are performed accurately. This platform is restricted to authorized officials, thereby preventing any unauthorized access to the data. After the seller and buyer have completed all required verifications, the worker assesses the transaction details and forwards the information to the subsequent level for finalization.

At the Execution Level, officials from the government undertake a comprehensive review of the transaction, verifying that all essential documents are in order and that both parties involved—the buyer and seller—meet all legal standards for the transfer. Upon successful confirmation, the officials complete the land transfer, resulting in the addition of a new block to the blockchain that holds all information related to that transaction. This block is permanently recorded,

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

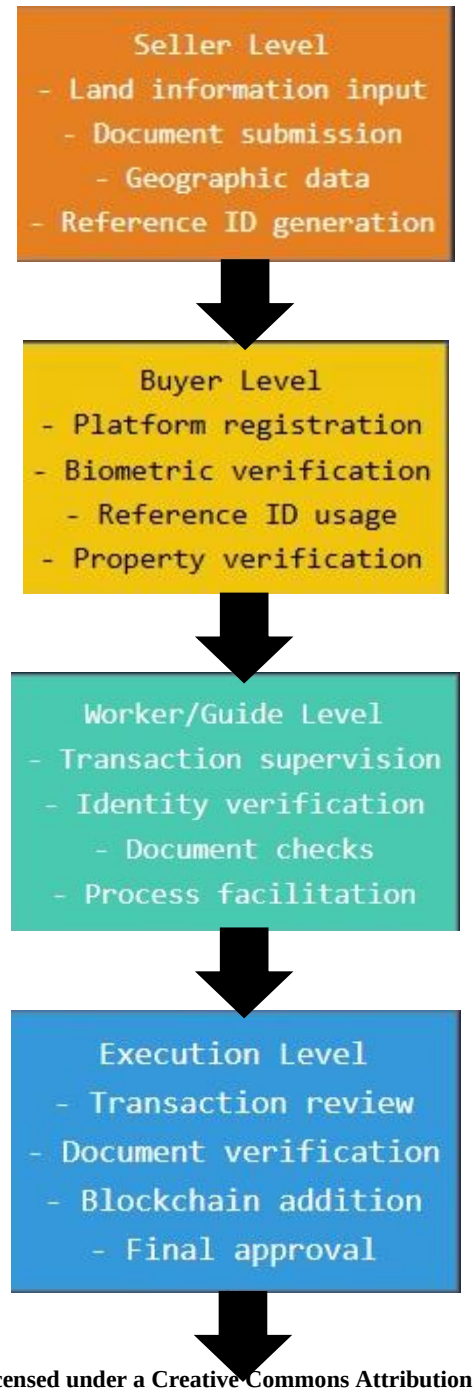
International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 10, October 2024

DOI: 10.17148/IJARCCE.2024.131016

ensuring that the transaction is immune to alteration or tampering. The blockchain's unchangeable nature provides a secure, transparent, and auditable record of the land transfer.

Ultimately, at the Government Level, all finalized transaction data is securely stored on a designated government server. This process is imperative for the effective long-term administration of land records, as it enables the tracking of each land parcel's historical transactions. The centralized database facilitates the development of a "land history tree," which encompasses a thorough documentation of ownership and transaction records, ultimately promoting transparency and traceability regarding land ownership. This information may serve various purposes, including audits, land governance, urban planning, and addressing potential future disputes regarding land titles. Furthermore, an unalterable record of all land transactions guarantees a distinct history for each land parcel, facilitating ownership verification and legal status assessment for prospective buyers, sellers, or governmental entities.



IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 10, October 2024

DOI: 10.17148/IJARCCE.2024.131016

Fig1: Explain the different stages of the system in work (in ascending order)

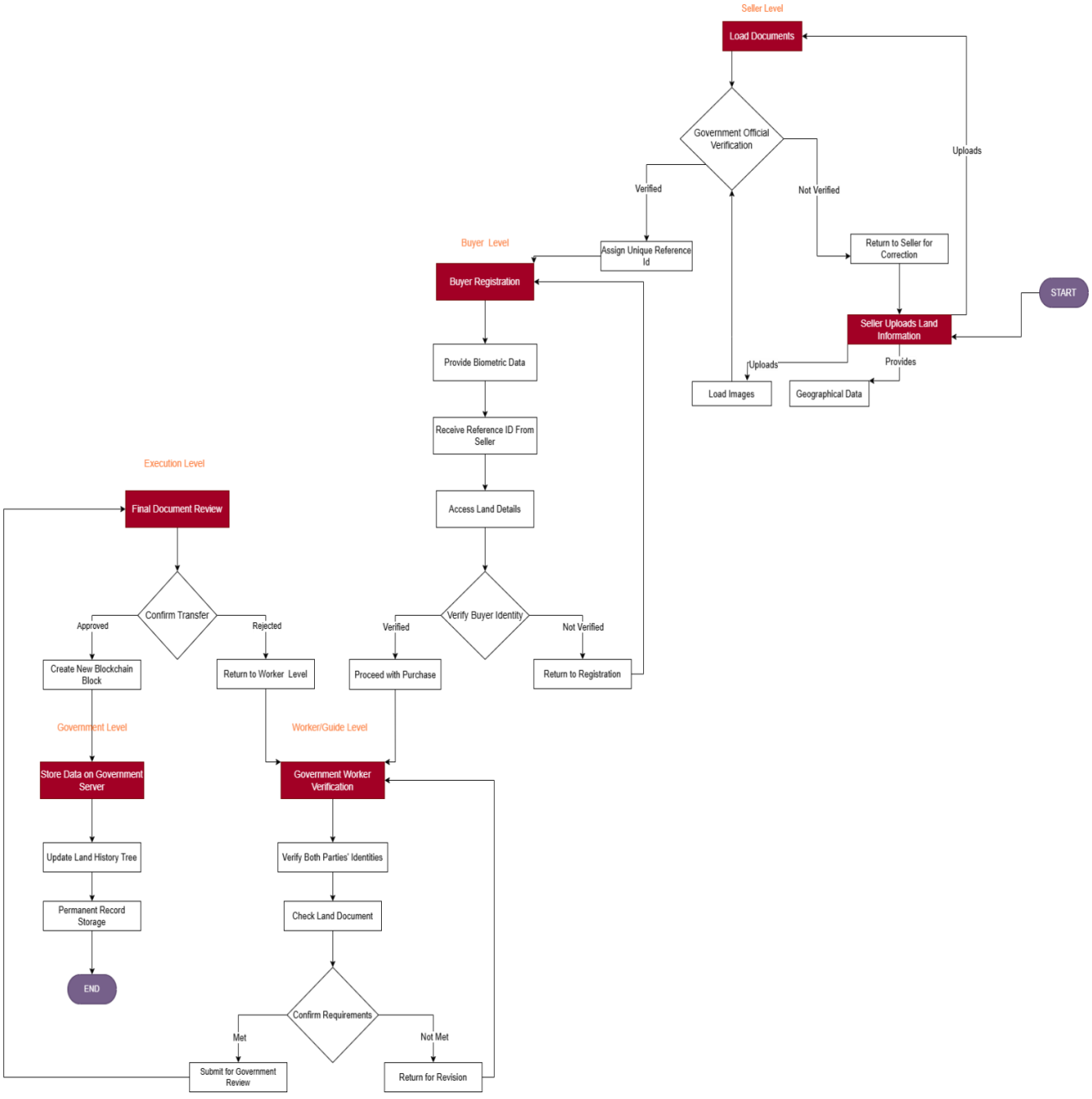


Fig 2: Working process

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 10, October 2024

DOI: 10.17148/IJARCCE.2024.131016

Algorithms to be used:

The blockchain algorithms and protocols proposed for the land security system are crucial for ensuring the system's security, transparency, and efficiency. Proof of Work consensus, digital signatures, Merkle trees, and encryption algorithms work together to create an immutable, decentralized record of land ownership and transactions, preventing fraud and enhancing trust. Smart contracts and randomness algorithms further automate and secure the process, while hash functions and zero-knowledge proofs maintain data integrity and privacy.

The proposed blockchain-based land security system will leverage the Proof of Work (PoW) consensus algorithm to maintain the integrity of the distributed land records. The PoW mechanism ensures that multiple nodes in the network must compete to validate transactions, providing a secure and decentralized way to maintain the integrity of the blockchain. This decentralized validation process aligns with the paper's mention of using a democratic validation approach, helping prevent a single authority from controlling the land records. The PoW consensus will create a transparent, auditable process for validating ownership and transaction details, enhancing the overall trust and reliability of the system.

Digital signatures will play a crucial role in authenticating the identities of the various participants in the land transaction process, including buyers, sellers, and government officials. By leveraging public-key cryptography, the digital signatures will ensure non-repudiation and data integrity, confirming that land-related documents and transactions have not been tampered with. This will be essential for enhancing the security and trust in the system, as each action will be cryptographically verifiable.

To efficiently organize and verify the vast amount of land-related documents, such as title deeds, property records, and transaction histories, the system will employ Merkle trees. This hash-based tree structure will enable the quick validation of individual documents without having to process the entire dataset. This will improve the scalability and performance of the system, especially as the volume of land records grows over time.

The use of Peer-to-Peer (P2P) protocols will enable the decentralized network of nodes, which may include government agencies and authorized officials, to communicate, share data, and collaborate on the validation of land transactions. This decentralized architecture will help distribute the workload, increase resilience, and eliminate single points of failure in the land security system. The P2P protocols will facilitate the seamless exchange of information and ensure the smooth operation of the system across multiple stakeholders.

Strong encryption algorithms, such as AES, RSA, or ECC, will be crucial for securing the transmission, storage, and processing of sensitive land-related data, including user credentials, property records, and transaction details. Encryption will protect the confidentiality of the information and prevent unauthorized access or tampering, which is essential for maintaining the trust and integrity of the land security system.

Smart contracts will automate the execution of predefined rules and conditions related to land transactions, ensuring transparency and enforcement of the agreed-upon terms. These self-executing contracts will help streamline the land transfer process, reduce the need for intermediaries, and minimize the risk of disputes or fraudulent activities. Smart contracts will also facilitate innovative features like fractional ownership and automated inheritance processes, as mentioned in the paper's section on future scope.

Cryptographic Random Number Generators (CRNGs) will be necessary to introduce unpredictability and secure randomness into various system processes, such as mining difficulty adjustments, transaction ordering, or the selection of validator nodes. Ensuring the integrity of randomness is crucial for maintaining the security and fairness of the blockchain-based land security system.

Secure hash functions, like SHA-256 or Blake2, will be used extensively throughout the system for document hashing, blockchain block hashing, and other data integrity checks. By creating unique digital fingerprints for land records and

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 10, October 2024

DOI: 10.17148/IJARCCE.2024.131016

transactions, hash functions will enable the immutability and traceability of information, a key requirement for the land security system.

Finally, Zero-Knowledge Proofs (ZKPs) could be employed to allow users (e.g., buyers, sellers) to verify specific claims about their land data without revealing the underlying sensitive information. This would help address concerns around data privacy and confidentiality in the land security system, enabling the verification of ownership or other land-related details while protecting the privacy of individuals.

The integration of these blockchain-based algorithms and protocols will provide a robust, secure, and transparent framework for the proposed land security system. By leveraging the key features of blockchain, the system will be able to effectively address the challenges of fraud, inefficiencies, and lack of trust in traditional land ownership management.

Working of application:

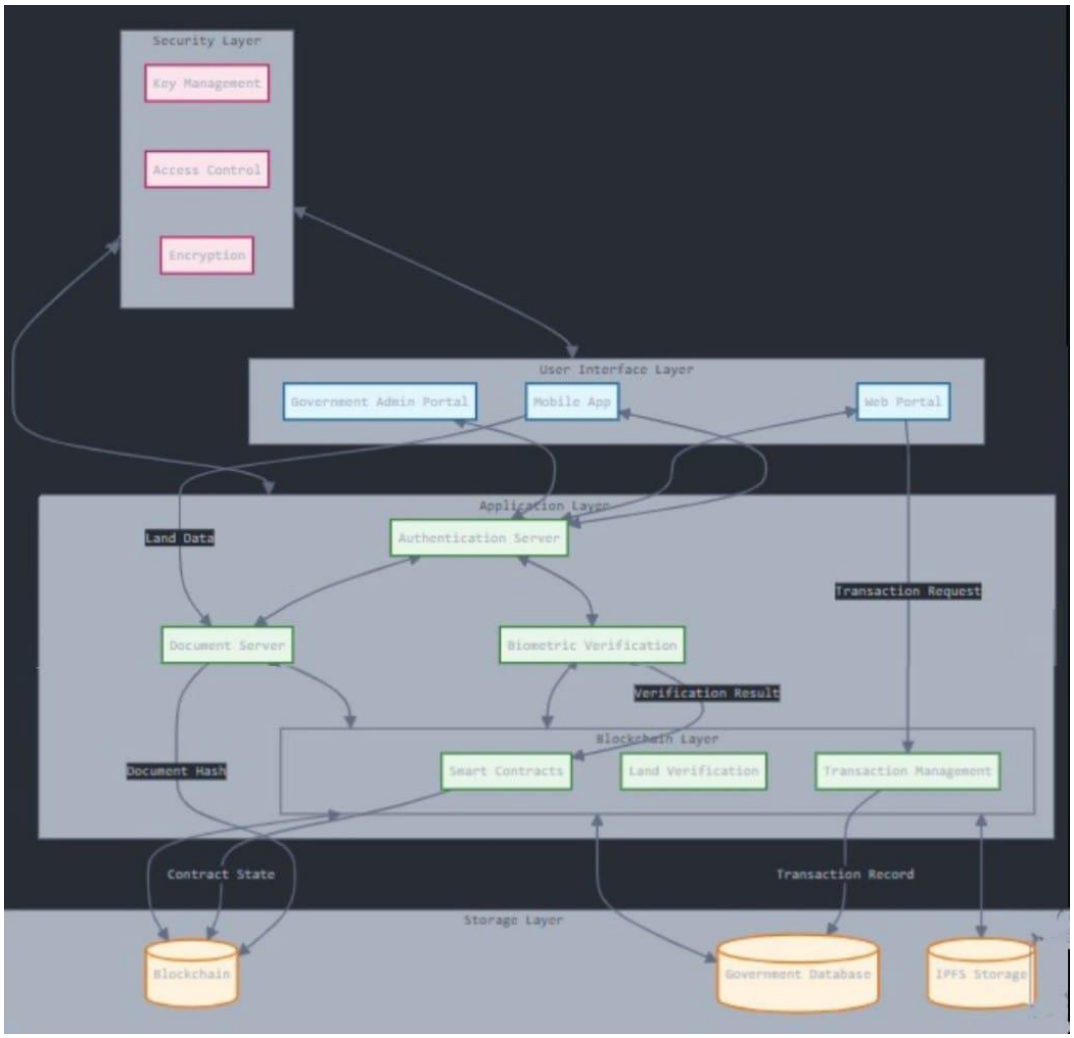


Fig3: Working on a system

The blockchain-based land security mobile application operates through a sophisticated five-layer architecture that ensures secure and efficient land transactions. At the topmost level, the Security Layer acts as the primary guardian, incorporating key management, access control, and encryption protocols to safeguard all data flowing through the

DOI: 10.17148/IJARCCE.2024.131016

system. This layer effectively creates a secure envelope around all operations, ensuring that sensitive land transaction data remains protected from unauthorized access or tampering.

The User Interface Layer serves as the gateway for all stakeholders, offering three distinct access points: a Government Admin Portal for officials overseeing transactions, a Mobile App for the primary users (buyers and sellers), and a Web Portal as an alternative access platform. These interfaces are designed to be user-friendly while maintaining robust security protocols inherited from the security layer above.

Moving deeper into the system, the Application Layer houses the core processing components. Here, the Authentication Server acts as the central verification hub, working in tandem with the Document Server and Biometric Verification system. This layer processes all incoming land data, handles transaction requests, and generates verification results. It serves as the crucial middleware that connects user interfaces with the blockchain infrastructure, ensuring that all data is properly validated before proceeding to the next stage.

The Blockchain Layer represents the technological heart of the system, where Smart Contracts, Land Verification, and Transaction Management processes reside. This layer handles the critical aspects of document hashing, maintains contract states, and manages transaction records. Smart contracts automatically execute predefined rules and conditions, while the land verification component ensures the authenticity of property details. The transaction management system orchestrates the entire transfer process, maintaining the integrity and transparency of each transaction.

Finally, at the foundation lies the Storage Layer, which utilizes three distinct storage solutions: the Blockchain for immutable transaction records, the Government Database for official land records and user data, and IPFS Storage for distributed document management. This comprehensive storage approach ensures that all transaction data is not only securely stored but also readily accessible to authorized parties while maintaining an unalterable record of all land-related transactions. The entire system operates in a seamless flow, where each layer communicates with adjacent layers through secure channels, creating a robust and reliable platform for land transactions that significantly reduces the possibility of fraud while enhancing efficiency and transparency in land dealings.

FUTURE SCOPE

Blockchain-based land registries are paving the way for a new era of property ownership, with innovative models such as fractional and collective ownership making real estate more accessible to a wide range of investors. Digital tokens and smart contracts introduce a transparent, automated way for fairly managing shared ownership, as well as expediting inheritance by allowing for ownership transfer upon death, lowering probate expenses and conflicts. Real-time usage data from AI and IoT integration could improve land management even more, but legal frameworks need to change to accept blockchain records as legally binding while maintaining security and privacy. All things considered, these developments suggest a more open, effective, and safe real estate market in the future.

CONCLUSION

Blockchain holds transformative potential for resolving property disputes and standardizing property rights across borders. By simplifying dispute resolution, establishing consistent ownership standards, and demonstrating successful real-world applications, blockchain technology can significantly reshape property management. As more nations and institutions adopt this technology, the future of property rights stands to become more transparent, efficient, and equitable, offering a promising shift toward a fairer global landscape in land ownership.

REFERENCES

[1] K. Vayadande, R. Shaikh, S. Rothe, S. Patil, T. Baware, and S. Naik, "Blockchain-based land record system," ITM Web of Conferences, vol. 50, p. 01006, Fourth International Conference on Advances in Electrical and Computer Technologies (ICAECT 2022), 2022.

DOI: 10.17148/IJARCCE.2024.131016

[2] S. Merukar, A. Deshmukh, P. Vadje, K. Bhosale, and P. D. Kad, "Land Registration System Using Blockchain," International Journal of Advanced Research in Science, Communication and Technology, Apr. 14, 2022.

[3] R. C. Suganthe, N. Shanthi, R. Latha, K. Gowtham, S. Deepakkumar, and R. Elango, "Blockchain enabled digitization of land registration," 2021 International Conference on Computer Communication and Informatics (ICCCI), pp. 1-5, 2021.

[4] I. Racetin, J. Kilić Pamuković, M. Zrinjski, and M. Peko, "Blockchain-based land management for sustainable development," Sustainability, vol. 14, no. 17, pp. 1-15, 2022.

[5] V. Thakur, M. N. Doja, Y. K. Dwivedi, T. Ahmad, and G. Khadanga, "Land records on blockchain for implementation of land titling in India," International Journal of Information Management, vol. 52, p. 101940, 2020.

[6] Government of India, Ministry of Electronics & Information Technology, "Case study on land registration," Blockchain Technology, 2023.

[7] Centre of Excellence in Blockchain Technology, National Informatics Centre (NIC), Ministry of Electronics & Information Technology, "Land Records P. B, "A Review on Blockchain Technology," International Journal of Scientific Research in Engineering and Management, vol. 8, pp. 1-5, 2024, doi: 10.55041/IJSREM34536.

[8] P. B, "A Review on Blockchain Technology," International Journal of Scientific Research in Engineering and Management, vol. 8, pp. 1-5, 2024

[9] S. A. Gollapalli, G. Krishnamoorthy, N. S. Jagtap, and R. Shaikh, "Land registration system using blockchain," in 2020 International Conference on Smart Innovations in Design, Environment, Management, Planning and Computing (ICSIDEMPC), Aurangabad, India, 2020, pp. 242-247.

[10] A. Saari, J. Vimpari, and S. Junnila, "Blockchain in real estate: Recent developments and empirical applications," Land Use Policy, vol. 121, p. 106334, 2022.

[11] S. Krishnapriya and G. Sarath, "Securing land registration using blockchain," Procedia Computer Science, vol. 171, pp. 1708-1715, 2020

