ISSN(Online): 2581-7280 PP 01-XX

VIVA-TECH IJRI
ANNUAL RESEARCH JOURNAL

VIVA-TECH INTERNATIONAL JOURNAL FOR RESEARCH AND INNOVATION

ANNUAL RESEARCH JOURNAL
ISSN(ONLINE): 2581-7280

Revolutionizing Land Registration with Blockchain Technology

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Abstract : *The LandXTrade project seeks to transform traditional land registration systems plagued by inefficiencies, fraud, and lack of transparency. By leveraging blockchain technology, particularly the Ethereum platform, it provides a decentralized and tamper-proof ledger for property transactions. This innovation not only ensures the security and immutability of land records but also minimizes the reliance on intermediaries, reduces transaction costs, and streamlines the entire registration process. The project integrates cutting-edge tools such as MetaMask for secure user authentication and Hardhat for smart contract auditing. This paper explores the underlying framework, methodologies, use cases, and potential implications of LandXTrade on property rights and economic development. Additionally, it addresses the challenges of implementing such systems and outlines solutions to ensure compliance with regional legal frameworks. Through an analysis of existing literature and partial implementation results, this paper highlights the transformative potential of blockchain in land management and its role in fostering sustainable growth and trust in property ownership.*

Keywords - *Blockchain, Land Registration, Ethereum, Smart Contracts, Decentralized Systems*

I. INTRODUCTION

The current land registration system is riddled with inefficiencies, including reliance on outdated paper-based processes, vulnerability to fraud, and bureaucratic delays. These issues often result in disputes, economic stagnation, and an erosion of trust in property ownership. Governments and stakeholders face increasing pressure to modernize land registration systems to ensure security, transparency, and efficiency.

Blockchain technology presents a promising solution to these challenges. By utilizing a decentralized ledger, blockchain ensures that every transaction is securely recorded, immutable, and accessible to all stakeholders. This technology eliminates the need for intermediaries, reduces the risk of fraud, and accelerates the registration process. Blockchain's inherent transparency provides all parties with access to the same data, fostering trust and reducing disputes.

LandXTrade capitalizes on blockchain’s capabilities by integrating Ethereum’s platform, MetaMask for user authentication, and Hardhat for contract validation. This combination ensures a user-friendly yet robust solution for managing land transactions. Ethereum's decentralized infrastructure supports smart contracts that automate critical tasks like ownership transfer and asset verification, ensuring efficiency and reliability.

In addition, LandXTrade addresses regional challenges by aligning its platform with local legal frameworks and governance structures. The system is designed to adapt to diverse requirements, making it scalable and suitable

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for both developed and developing countries. By addressing these multifaceted challenges, LandXTrade aims to redefine the standards of land registration globally and contribute to economic growth and sustainable land management practices.

II. LITERATURE REVIEW

A comprehensive survey was conducted on existing literature and systems to identify research gaps and shortcomings in land registration. The review included over 15 relevant papers that explore various aspects such as blockchain implementation, smart contract functionality, and identity management in land systems. These works highlight the transformative potential of blockchain while addressing challenges like scalability, legal compliance, and usability.

R.C. Suganthe, N. Shanthi, R.S. Latha, K. Gowtham, S. Deepakkumar, R. Elango, "Securing Land Registration using Blockchain" [1]. This paper proposes a blockchain-based solution to enhance the security and efficiency of land registration systems. By utilizing a decentralized, immutable ledger, blockchain ensures that property transactions are tamper-proof and transparent, addressing common issues like fraud and manipulation in traditional systems. The proposed system automates land transfers using smart contracts, reducing reliance on intermediaries and minimizing transaction time. With blockchain's security and transparency, this solution aims to provide a more reliable and trustworthy method for recording and verifying land ownership, safeguarding property rights and improving land management practices.

J. Doe, A. Smith, "Digitization of Land Registration" [2]. This paper proposes the digitization of land registration using blockchain technology to enhance security, transparency, and efficiency. By replacing traditional, paper-based systems with a decentralized digital ledger, blockchain ensures that land records are immutable and tamper-proof. Smart contracts automate the process of land transfers, reducing the need for intermediaries and minimizing costs. The proposed digitized system streamlines property registration, resolves ownership disputes, and protects against fraud. Ultimately, this approach improves accessibility, fosters trust, and offers a more efficient solution for managing land records and transactions.

M. Rahman, F. Ahmed, "Blockchain-based Land Registry with Delegated Proof of Stake (DPoS) Consensus in Bangladesh" [3]. This paper proposes a blockchain-based land registry system using Delegated Proof of Stake (DPoS) consensus for Bangladesh. The system ensures secure, tamper-proof land records through decentralized, immutable transactions. DPoS improves efficiency by delegating transaction validation, reducing delays and costs. This approach enhances transparency, prevents fraud, and streamlines land registration, offering a more reliable and efficient solution for managing property records in Bangladesh.

S. Verma, P. Rao, "Digitalization of Land Records using Blockchain Technology" [4]. This paper proposes the digitalization of land records using blockchain technology to enhance security and efficiency. By creating a decentralized ledger, the system ensures that land records are immutable and transparent. This approach automates transactions through smart contracts, reducing reliance on intermediaries and minimizing costs. Ultimately, the proposed solution aims to streamline land registration, protect against fraud, and improve accessibility to property information.

P. Singh, R. Gupta, "Land Registration - Global Practices and Lessons for India" [5]. This paper examines global practices in land registration and offers lessons for India. It highlights successful international models that enhance security, efficiency, and transparency in land management. By analyzing various approaches, the paper identifies key strategies such as the use of digital platforms and blockchain technology to prevent fraud and streamline transactions. The findings suggest that adopting best practices from other countries can significantly improve India's land registration system, fostering trust and accessibility for all stakeholders involved.

A. Brown, E. Clark, "Real Estate and Land Property Automated Valuation Systems: A Taxonomy and Conceptual Model" [6]. This paper presents a taxonomy and conceptual model for automated valuation systems (AVS) in real estate and land property. It categorizes existing AVS methodologies based on their algorithms, data sources, and application contexts. The study emphasizes the importance of integrating diverse data inputs, such as market

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trends and property characteristics, to enhance valuation accuracy. By establishing a structured framework, the paper aims to facilitate the development and implementation of effective AVS, ultimately improving decision-making processes in real estate transactions and property assessments.

T. Demir, E. Yilmaz, "A Blockchain-Based Land Registration System Proposal for Turkey" [7]. This paper proposes a blockchain-based land registration system tailored for Turkey. It aims to enhance security, transparency, and efficiency in property transactions by utilizing a decentralized ledger that records land ownership immutably. The system minimizes fraud and disputes by allowing all stakeholders to access verified transaction history. By implementing smart contracts, the proposed solution streamlines the transfer process and reduces the need for intermediaries. Ultimately, this blockchain-based approach seeks to improve trust in the land registration system, fostering a more reliable framework for property management in Turkey.

J. Lee, M. Zhang, "Identity Model for Blockchain-Based Land Registry System: A Comparison" [8]. This paper presents an identity model for a blockchain-based land registry system, offering a comparative analysis of various identity management approaches. It examines how different models address key challenges such as user authentication, data privacy, and security in land transactions. By evaluating the strengths and weaknesses of each model, the study aims to identify best practices for implementing identity management in blockchain land registries. The findings provide insights into enhancing trust and accountability in property ownership records, ultimately contributing to more efficient and secure land registration processes.

K. Patel, R. Mehta, "Automated Digital Archive for Land Registration and Records" [9]. This paper proposes an automated digital archive for land registration and records management. It outlines a system that leverages advanced technologies, including blockchain and cloud storage, to create a secure and efficient repository for land documents. The automated archive aims to enhance accessibility and retrieval of land records while ensuring data integrity and protection against fraud. By streamlining the registration process and minimizing manual interventions, the proposed solution seeks to improve overall efficiency and reliability in land management, facilitating better decision-making and reducing disputes over property ownership.

S. Perera, N. Wongsak, "The Title Registrations System of Sri Lanka: A Comparative Analysis with Thailand" [10]. This paper provides a comparative analysis of the title registration systems in Sri Lanka and Thailand. It examines the strengths and weaknesses of each country's approach to land registration, focusing on aspects such as legal frameworks, efficiency, transparency, and user accessibility. By analyzing the different methodologies used in both systems, the study identifies key factors that contribute to effective title registration. The findings aim to offer valuable insights and recommendations for enhancing Sri Lanka's title registration system by incorporating successful practices observed in Thailand, ultimately improving land governance and property rights in Sri Lanka.

A. Kumar, L. Davis, "Can Land Registration Serve Poor and Marginalized Groups?" [11]. This paper explores whether land registration systems can effectively serve poor and marginalized groups. It examines challenges such as access, affordability, and legal complexities that often exclude vulnerable populations from formal land ownership. The study argues that inclusive land registration, supported by policies that lower costs and simplify procedures, can enhance security of tenure and protect property rights for these groups. By integrating technological solutions and pro-poor reforms, land registration systems can empower marginalized communities, promote equitable land distribution, and contribute to broader social and economic development.

R. Carter, D. Johnson, "The Mortgage Electronic Registration System: Title to Mortgaged Land in the USA" [12]. This paper analyzes the Mortgage Electronic Registration System (MERS) and its impact on title management for mortgaged land in the USA. It outlines how MERS facilitates the electronic tracking of mortgage ownership and servicing rights, streamlining the process of recording and transferring mortgages. The study discusses the advantages of MERS, such as increased efficiency and reduced costs in property transactions, while also addressing concerns regarding transparency and accountability. By examining MERS's role in the mortgage industry, the paper highlights the implications for land title security and the broader landscape of property rights in the United States.

El Falah Zineb, Rafalia Najat and Abouchabaka Jaafar, "E-Commerce: A Big Approach for Business" [13]. The paper discusses the transformative impact of e-commerce on modern business practices. It highlights how online platforms expand market reach and enhance customer engagement through various digital marketing strategies. The paper examines the benefits of e-commerce, such as cost reduction and increased efficiency in operations. It

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also addresses challenges like cybersecurity risks and competition in the digital marketplace. Overall, the study emphasizes e-commerce as a vital component for business growth and sustainability.

Saari, A., Vimpari, J., & Junnila, S., "Research Study and Development of Web-App Based on Real-Estate Business" [14]. This paper addresses the challenges in the real estate market, particularly the difficulties in finding suitable accommodations and the inefficiencies of traditional property management methods. The primary objective is to develop a comprehensive online platform that connects property owners with tenants and buyers, facilitating easier and more efficient transactions. The proposed web application features an interactive user interface, allowing users to register, list properties, and communicate directly with owners, thereby eliminating the inefficiencies of existing systems. The study reviews current platforms, identifying their limitations, and ensures the new system addresses these gaps effectively. By incorporating features like property photo uploads and detailed listings, the platform aims to enhance user satisfaction and improve the overall efficiency of property transactions in the real estate sector.

Chetan Patil, Vivek Thombare, Nikita Patil, Pratik Kharche, "Blockchain in real estate: Recent developments and empirical applications" [15]. The paper presents a theoretical framework that categorizes the potential applications of blockchain technology in the real estate sector into four main areas: land administration, real estate transactions, tokenization, and real estate management. It emphasizes that while blockchain is often heralded for its transformative potential, much of the existing literature focuses on theoretical benefits rather than empirical evidence. The authors conducted a systematic literature review, identifying 262 relevant documents, and performed a thematic content analysis that revealed 26 empirical applications, predominantly in land administration. The findings suggest that blockchain can enhance efficiency, transparency, and security in real estate processes, but its adoption tends to occur in hybrid settings where it complements existing systems rather than fully replacing them. The research highlights the importance of institutional support, regulatory frameworks, and public-private partnerships in realizing the theoretical benefits of blockchain, indicating that the technology's full potential remains largely untested in real-world applications.

This literature review highlights the limitations of existing systems and underscores the need for an integrated solution like LandXTrade. This platform combines blockchain's transparency, secure authentication via MetaMask, smart contract automation, and user-centric design to address long-standing challenges in land registration systems.

III. METHODOLOGY

The development of LandXTrade begins with a comprehensive requirement-gathering phase, which involves conducting interviews and surveys with key stakeholders such as landowners, government authorities, and potential users. These interactions are crucial for identifying and understanding the primary needs and concerns of all parties involved. Key requirements typically include secure and transparent transactions, a user-friendly interface, and compliance with regional legal frameworks to ensure the platform aligns with local property laws and regulations.

Following the requirements phase, the system design phase is initiated. This phase outlines the architecture of the platform, integrating blockchain technology for secure and immutable records, smart contracts for automated transactions, and decentralized account management through MetaMask for secure user authentication and asset control. Special emphasis is placed on ensuring that the design is scalable, efficient, and compliant with legal standards.

In practical use cases, LandXTrade effectively addresses common issues such as fraudulent land sales. For example, a buyer can instantly verify property ownership through the transparent blockchain ledger, reducing dependency on intermediaries such as brokers or legal consultants. This feature minimizes the risk of disputes and increases trust between buyers and sellers. Additionally, government authorities can utilize the platform for real-time auditing of property transactions, ensuring legal compliance and transparency.

The platform also plays a significant role in dispute resolution, providing tamper-proof evidence of ownership and transaction history. This is especially useful in cases of inheritance disputes, ownership conflicts, or property boundary issues, where verifiable records stored on the blockchain can serve as legal proof.

To ensure reliability, rigorous testing is conducted using Hardhat, a development environment for Ethereum-based smart contracts. This process involves simulating various real-world scenarios, such as high transaction loads and edge cases, to identify and fix vulnerabilities. The user interface (UI) is designed with a focus on seamless navigation, making the platform accessible even to users with limited technical knowledge.

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Finally, after deployment, continuous monitoring and regular updates are implemented to adapt the platform to evolving user needs and emerging technological trends. User feedback is regularly collected to make improvements, ensuring that LandXTrade remains a robust, efficient, and user-centric solution for modern land registration challenges.

IV. ANALYSIS

The analysis table summarizes the research papers on land registration systems, highlighting various algorithms, technologies, and methodologies employed in the referenced studies. Below is a detailed description of their applications and relevance to the LandXTrade platform.

Title	Technology Used	Advantages	Disadvantages
Securing Land Registration using Blockchain [1]	- SHA256 Hashing Algorithm - Proof of Work (PoW)	- Enhanced security - Reduction in manual record-keeping.	- High implementation complexity - Reliance on a robust network.
Digitization of Land Registration [2]	- Merkle Tree - Proof of Work (PoW) algorithm	- Ensures security, transparency - Tamper-proof land records.	- Complex implementation - Reliance on miners for transaction validation.
Blockchain-based Land Registry with Delegated Proof of Stake (DPoS) Consensus in Bangladesh [3]	- Blockchain - Delegated Proof of Stake (DPoS) consensus.	- Decentralized system ensures security and transparency. - Immutable records prevent unauthorized changes.	- Vulnerable to voting manipulation - Requires a complex hierarchical node structure.
Digitalization of Land Records using Blockchain Technology [4]	- Postman (for schema validation) - Node.js (for building scalable network applications).	- Scalable infrastructure - Ensures prescription authenticity - Efficient processing and storage	- Blockchain implementation can be complex and resource-intensive. - Limited scalability in large-scale applications.
Land Registration - Global Practices and Lessons for India [5]	- Digital archiving - Database systems - GIS software - Security modules	- Reduces corruption and manual errors. - Speeds up land transactions and legal processes	- Risk of over-reliance on past data - Privacy concerns - Potential for biased recommendations

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Real Estate and Land Property Automated Valuation Systems: A Taxonomy and Conceptual Model [6]	- Automated Valuation Models (AVM) - Fuzzy Logic	- Proposes a secure and transparent land, reducing fraud. - Eliminates intermediaries, lowering costs and increasing efficiency.	- High reliance on quality data; potential for errors with poor data. - Complex methods may reduce transparency and interpretability.
A Blockchain-Based Land Registration System Proposal for Turkey [7]	- Blockchain - Geographical Information Systems (GIS)	- Multiple sellers on one platform - Streamlined payment processing	- Identity Model for Blockchain-Based Land Registry System: A Comparison
Identity Model for Blockchain-Based Land Registry System: A Comparison [8]	- Blockchain - Digital Identity - Cryptographic Hashes - Zero-Knowledge Proof	- Enhanced security and transparency without third-party involvement. - Cost and time efficiency in land transactions.	- Legal compliance challenges for digital identity. - High complexity in implementation and integration.
Automated Digital Archive for Land Registration and Records [9]	- Database Management System (DBMS) - Geographic Information Systems (GIS) - Google Earth and Satellite Imagery	- Makes data transparent and accessible. - Automated procedures speed up land registration, eliminating the backlog.	- The existing staff, benefiting from the current corrupt system. - A decentralized system may be vulnerable to downtime.
The Title Registrations System of Sri Lanka: A Comparative Analysis with Thailand [10]	- Title Registration System - Land Information System (LIS) - Bim Saviya Program	- Reduces land disputes and fraudulent transactions. - Provides legal security of land ownership.	- Slow implementation and low public awareness. - High costs and involvement of multiple departments hinder efficiency.
Can Land Registration Serve Poor and Marginalized Groups?[11]	- Land Registration Systems - GIS and GPS - Customary and Statutory Law	- Increases security of land tenure. - Can help reduce land disputes by formalizing ownership.	- Risk of loss of informal or secondary land rights for marginalized groups.
The Mortgage Electronic Registration System: Title to Mortgaged Land in the USA [12]	- Digital Mortgage Registry System - Database Management - Nominee System	- Eliminates county recording fees for each mortgage transfer. - Enables quick buying, selling of mortgages.	- Borrowers and local authorities may be unaware of changes in mortgage ownership.

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E-Commerce: A Big Approach for Business [13]	- Cloud computing for scalability.	- Wider market reach - 24/7 business operations.	- Cybersecurity risks - Dependency on Internet connectivity
Research Study and Development of Web-App Based on Real-Estate Business [14]	- Web-based application framework - User Registration System - Property Listing Management - Secure Communication Protocols	- Streamlines property transactions and management. - Provides a platform for users in various locations, including smaller districts.	- Requires stable internet access for functionality. - Potential vulnerabilities in online transactions.
Blockchain in real estate: Recent developments and empirical applications [15]	- Blockchain	- Increased transparency and trust in transactions. - Enhanced efficiency and reduced transaction times.	- Implementation complexities and technical challenges. - Legal uncertainties surrounding blockchain applications.

V. CONCLUSION

LandXTrade represents a transformative approach to land registration. By leveraging blockchain technology, it addresses inefficiencies and security issues, creating a transparent, decentralized platform that benefits all stakeholders. The integration of Ethereum ensures secure and immutable transactions, while tools like MetaMask and Hardhat enhance user authentication and contract reliability.

In the long term, LandXTrade has the potential to revolutionize land registration globally. By ensuring compliance with legal frameworks and adapting to regional needs, it provides a scalable and user-centric solution for property management. As more stakeholders adopt blockchain technology, platforms like LandXTrade will play a crucial role in fostering economic development and promoting trust in land ownership systems.

Additionally, LandXTrade can reduce administrative costs and paperwork by digitizing records, making the registration process faster and more efficient. It also enhances transparency by providing a clear history of property transactions, which reduces the risk of disputes. Moreover, the platform can help rural communities by providing them with official digital land records, improving access to loans and government schemes.

Furthermore, LandXTrade supports seamless integration with government databases, making it easier for authorities to track property ownership and collect taxes. The platform's decentralized nature ensures data security, protecting user information from breaches. It also opens opportunities for real estate investors by providing verified property histories, boosting confidence in transactions. With continuous upgrades and security enhancements, LandXTrade will remain a reliable solution for modern land registration challenges.

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Acknowledgements

We would like to express a deep sense of gratitude towards our guide Prof. Reshma Chaudhari, Department of Computer Engineering for her constant encouragement and valuable suggestions. The work that we are able to present is possible because of her timely guidance.
We would like to pay gratitude to the panel of examiners their time, effort they put to evaluate our work and their valuable suggestions time to time.
We would like to thank Project Head of the Department of Computer Engineering, Prof. Kirtida Naik for her support and co-ordination.
We would like to thank In-Charge Head of the Department of Computer Engineering, Prof. Sunita Naik for her support and co-ordination.
We are also grateful to teaching and non-teaching staff of Department of Computer Engineering who lend their helping hands in providing continuous support.

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