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Modernizing and Revolutionizing Land Record Management with Blockchain

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Abstract: *In the modern era, access to land records has become essential, enabling individuals to verify land ownership for both personal and business purposes. In India, managing land records has proven to be a formidable challenge given the country's vast population. The current system has suffered from incomplete registries, which, in turn, has facilitated fraudulent activities. Moreover, the existing government system is plagued by inconsistencies and involves numerous intermediaries with access to the records, raising concerns about unauthorized alterations.*
With the increasing acceptance of blockchain technology, the government is actively exploring its implementation to address these issues. In a world moving towards Web 3.0, integrating land records into a blockchain offers significant advantages, primarily through enhanced transparency. This approach ensures that citizens have unhindered access to land records, complete with visual representations on maps, promoting greater inclusivity and accountability.

Keywords: Smart Contracts, POS, Blockchain, SHA-256

I. INTRODUCTION

To address the previously mentioned issues, we've implemented Ethereum Blockchain technology to replace the existing system. Our project encompasses the creation of two distinct smart contracts within the Ethereum Blockchain, which required the utilization of the Solidity programming language.

Our project serves two primary user categories: citizen users, who are granted read-only access to the data, and government officials, responsible for adding, updating, and accessing records. To facilitate these user interactions, we've developed a user-friendly website using React.JS, a powerful tool for Web 3.0 development.For visualizing land records on maps, we've integrated the Google Maps API, allowing us to create polygons that highlight specific land areas using geo coordinates. The Ethereum blockchain plays a central role in this system, guiding users through the following key steps:

Registry Officer Login: Administrative users log into the portal to perform actions such as adding new land registries, updating land records, and viewing existing property details.

Register Land: Administrative users input comprehensive details regarding the land and its owner if such data is absent from the current system.

Updating: Administrative users engage in document verification and complete the Know Your Customer (KYC) process to update the corresponding block in the blockchain.

View Land Records: Regular users visit the website to access land records. They can enter specific details such as plot numbers, state, district, and city to retrieve information about land ownership and property details.

User Profile Management: Users can manage their profiles, update personal information, and change preferences, enhancing the overall user experience.

By combining Ethereum Blockchain, Solidity, React.JS, and the Google Maps API, our project endeavors to enhance the transparency and efficiency of land record management while providing easy access for all users

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II. LITERATURE REVIEW

Year	Author	Title	Algorithm	Limitations	Literature Survey
2019	Nidhi Gupta et al. [5]	LandLedger : Blockchain-powered Land Property Administrating System	Merkle Patricia tree and SHA256	1) The paper does not address the costs and resource requirements for implementing and maintaining the LandLedger system.	The paper introduces "LandLedger," a blockchain system for transparent and secure property management using Merkle Patricia Trees, Proof-of-Authority consensus, and SHA256 property IDs. It's an innovative solution for improved land administration.
2019	Xinle Yang et at. [8]	Effective scheme against 51% Attack on Proof-of-Work Blockchain with History Weighted Information	Weighted Difficulty based Proof-of-Work (HWD-PoW)	1) It lacks a thorough examination of potential vulnerabilities in the HWD-PoW protocol. 2) it does not address additional attack vectors or security issues associated with HWD-PoW implementation.	In this paper it resolves the 51% attack problem in Proof-of-Work (PoW) blockchains. Using HWD-PoW method.
2020	Krishnapriya S et al. [1]	Securing Land Registration using Blockchain	SHA256 and Proof of Work	1) It does not provide information about scalability. 2) It does not provide case studies to support the effectiveness and efficiency.	The paper utilizes Blockchain to enhance land registration security through majority consensus, unique hash values, SHA256, and Proof of Work algorithms, bolstering overall integrity.
2020	Mahbub Alam Majumdar et al. [3]	Blockchain based Land Registry with Delegated Proof of Stake (DPoS) Consensus in Bangladesh	SHA256 And Delegated Proof of Stake	1) It does not give any explanation about the system. 2) It does not provide information on scalability.	The paper presents a blockchain-based land registry system for Bangladesh, enhancing transparency and security through a Delegated Proof of Stake (DPoS) model. It offers flexibility with scalable information and computational

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					nodes.
2020	Ameya Thosar et al. [6]	Land Registry Management using Blockchain	cryptographic protocols And SHA256	1) It does not provide analysis of security risks and vulnerabilities associated with implementing a Blockchain	In this paper they demonstrate the use of cryptography in blockchain and use of SHA256 Algorithms for hash creating.
2020	Md Sakibul Islam et al. [7]	A Novel Framework for Implementation of Land Registration and Ownership Management via Blockchain in Bangladesh	SHA256 Algorithm And Hybrid blockchain	1) It mentions Privacy concerns of stakeholders 2)It also mentions scalability issues.	It emphasizes the advantages of implementing a public and permissionless blockchain like Ethereum for large-scale land registration.
2020	L. W. D. C. Jayabodhi et al. [9]	Minimization of fraudulent activities in land authentication through Blockchain-based system	Cryptography And SHA256 Algorithm	1)It does not provide specific details about the consensus algorithm. 2) It does not address issues such as scalability, privacy, or regulatory considerations.	The paper created a working model using smart contracts, tested it with real users, and got good feedback for faster transactions. They mention using consensus algorithms in their blockchain, but they don't say which one they used.
2020	Meghali Nandi et al. [10]	A secured land registration framework on Blockchain	ERC20 (Ethereum Request for Comments 20) And SHA256 Algorithm	1) The system lacks a mechanism to verify whether the current owner willingly or involuntarily updates land ownership details. 2) The system does not provide verification for inconsistency in the updating of ownership details. 3) The paper doesn't thoroughly assess the system regarding space, transaction cost, and time	The system utilizes ERC20 tokens to map land segments and ensure consistency in ownership records.

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				complexity.	
2020	Arif Furkan Mendi , Kadir Kaan Sakaklı , Alper Çabuk et al. [12]	A Blockchain Based Land Registration System Proposal for Turkey	The paper does not explicitly mention any specific algorithms used in the development of the Blockchain-based land registration system for Turkey. However, the paper does mention the use of a smart contract infrastructure	Blockchain systems may face challenges in handling a large volume of transactions efficiently. Implementing a new technology like Blockchain requires significant changes to existing systems and processes, which may face resistance and challenges in adoption.	Lemieux highlights the potential of Blockchain technology to revolutionize land registration processes and mentions examples of Blockchain-based land registration practices in Brazil, Georgia, Honduras, Ghana, India, Japan, Sweden, and the pilot applications in these countries. Spielman suggests that managing land registration processes with Blockchain technology can increase efficiency, prevent fraud, ensure security, traceability, and transparency, and reduce sensitivity to disasters
2020	Disha Shinde, Snehal Padekar, Siddharth Raut, Abdul Wasay, S. S. Sambhare et al. [13]	Land Registry Using Blockchain - A Survey of existing systems and proposing a feasible solution	Inter Planetary File System (IPFS) and Proof of Work (PoW)	Implementing blockchain technology for land registry may require significant changes to existing systems and processes, which can be challenging and time-consuming. The scalability of blockchain systems can be a limitation, as the size of the blockchain grows with each transaction, potentially impacting performance and storage requirements.	The paper mentions the need for a secure and tamper-proof database for storing property papers, as well as the advantages of using blockchain technology for land registry, such as creating a decentralized, tamper-proof ledger and reducing future conflicts
2020	Rizwan Khan,	Blockchain	Cryptography	The paper does not	The system proposed a

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	Shadab Ansari, Saksham Sachdeva and Sneha Jain et al. [14]	based land registry system using Ethereum Blockchain	(CRYP), Ledger (LED), Distributed Transaction (DT)	explicitly mention any limitations or challenges faced during the implementation of the blockchain-based land registry system using Ethereum Blockchain. But the scalability must be studied of the system.	seamless, easy to use and hustle-free platform which can be used for making the land registration easy. There are many problems such as involvement of brokers or middleman, time delays, etc. This platform will eliminate the problems associated with land registration in India as well as in many parts of the world.
2021	R.C. Suganthe et al. [2]	Blockchain enabled Digitization of Land Registration	Merkle Tree Root hash And Proof of Work	1)User interface is very poor. 2) It does not provide information on scalability.	The paper proposes using Blockchain and Ethereum's smart contracts for efficient Land Registry Management in India, aiming to eliminate delays and fraud. It utilizes the Proof of Work (PoW) concept with gas fees for adding or updating blocks.
2021	Goran Sladi et al. [4]	A Blockchain Solution for Securing Real Property Transactions: A Case Study for Serbia	SHA256 and Proof of Work	1) It does not give any proof to support the effectiveness and efficiency.	The case study recommends using blockchain and smart contracts to automate land transactions in Serbia's Land Information System. It seeks to integrate this technology smoothly, with a focus on practical testing for validation.
2021	Sai Apurva Gollapalli, Gayatri Krishnamoorthy, Neha Shivaji Jagtap, Rizwana Shaikh et al. [11]	Land Registration System Using Blockchain	Business network definition (BND) to define the data model, transaction logic, and access control rules.	The need for a reliable and secure network infrastructure to ensure the integrity and availability of the blockchain system. The requirement for all participants to have access to the	The literature survey in the provided sources highlights the prerequisites for implementing blockchain in property-based applications like land registry systems, including identity solutions, digitized records, multi-signature

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				necessary technology and knowledge to interact with the blockchain system effectively.	wallets, accurate data, and training of professionals. It discusses the use of proof of existence, proof of audit, and proof of process for establishing permanent timestamped digital records in land registration systems.

III. PROPOSED MODEL OVERVIEW

Our project's core objective is to establish a versatile platform that grants efficient and transparent access to land records via blockchain technology, catering to a diverse user base. This innovative approach brings about a host of benefits:

Elimination of Intermediaries: The project endeavors to eradicate the need for intermediaries or brokers in land transactions, allowing direct access to precise land data and the relevant points of contact. This streamlined process is especially advantageous for individuals seeking land, eliminating unnecessary third-party involvement.

Enhanced Security: Our system leverages the inherent features of blockchain technology, reinforcing security significantly. It serves as a robust defense against fraudulent activities, the creation of false records, data breaches, and theft. Blockchain's decentralization and cryptographic principles create a secure environment.

Access to Authentic Historical Data: Blockchain's fundamental attributes, including consensus, decentralization, and cryptography, enable access to historically accurate land data. Users can trace the lineage of land records over the years, fostering trust and transparency within the system.

Future Advancements: Once deployed, this platform sets the stage for numerous advancements. It opens doors to streamlined transactions, digital registries, and the management of 3D assets. This technological evolution has the potential to propel India towards a genuinely secure and digitally advanced landscape.

Resilience: The system is designed to operate effectively even in challenging conditions, such as power outages or limited internet connectivity. It guarantees minimal downtime and ensures that land records remain accessible and dependable under various circumstances.

Unified Access Nationwide: The project's design guarantees a single mode of access throughout the entire country, promoting consistency and land management

Key Objectives:

To achieve these ambitious goals, our project is anchored in the following essential objectives:

Enhancing Efficiency: By harnessing blockchain technology, we aim to simplify the process of accessing land records, minimizing administrative obstacles, and enhancing the efficiency of land-related transactions.

Mitigating Fraud: The incorporation of robust security features and transparent record-keeping within the blockchain framework collaborates to reduce the prevalence of fraudulent land activities.

Augmenting Security: Blockchain's intrinsic features contribute to heightened security, ensuring the integrity and reliability of land records.

Promoting Transparency: The project places a premium on transparency by offering users unaltered historical data and providing accurate, up-to-date information on land records.

By weaving these objectives into our model, we aspire to revolutionize land record management, making it more accessible, secure, and efficient for all users across India.

User Profile Management: Users can manage their profiles, update personal information, and change preferences, enhancing the overall user experience.

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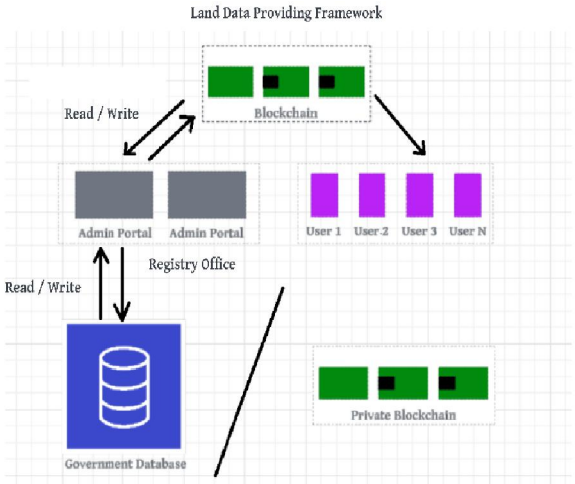
Our Proposed Model Architecture

Our system architecture comprises two distinct portals:

Admin Portal (Read/Write Permissions): This portal is intended for use at Government Registry Offices and is exclusively controlled by government operators. It serves as a platform to store and edit land data on the blockchain.

User Portal (Read Permission): The User Portal, accessible through our web application, is open to anyone interested in viewing land data stored on the blockchain.

In our blockchain model, land data is stored in JSON format, and users can retrieve this information via the RPC-JSON protocol. After deploying it on the blockchain mainnet, the data can be accessed using web3.js. The model contains various aspects of land information, including geolocation points, seller and buyer details, agreed-upon amounts, timestamps, and more. This structure ensures that the land data is securely recorded and readily accessible for authorized users while maintaining transparency and trust in the system.



Algorithm

To tailor blockchain technology to our specific project needs, it's essential to carefully select the tools and technologies that align with our objectives. Our choice for implementing this project centers on the Ethereum blockchain, a renowned platform recognized for its versatility and robust features. Within the Ethereum ecosystem, the Elliptic Curve Digital Signature Algorithm (ECDSA) is employed for secure transaction verification, and the Keccak-256 hash function is utilized to compute hash values for the provided data. It's important to note that Keccak-256 is an integral component of the SHA-3 standard, denoting Secure Hash Algorithm Version 3.

Furthermore, Ethereum adopts a consensus algorithm known as Proof of Stake (POS). In this mechanism, validators, often referred to as "stakers," are selected to generate new blocks and validate transactions based on the amount of cryptocurrency they hold and are willing to "stake" as collateral. This approach presents several advantages, including enhanced energy efficiency and scalability compared to the conventional Proof of Work (POW) consensus model.

By implementing our project on the Ethereum blockchain, utilizing ECDSA for digital signatures, Keccak-256 for hashing, and the POS consensus algorithm, we ensure the following:

Security: ECDSA digital signatures fortify the security of transactions, guarding against unauthorized modifications.

Data Integrity: Keccak-256 guarantees the integrity of data stored within the blockchain, rendering it tamper-resistant and dependable.

Efficiency: The POS consensus algorithm enhances network efficiency by eliminating the resource-intensive computational tasks associated with POW, resulting in reduced energy consumption and expedited transaction processing.

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This amalgamation of technologies and tools underscores our commitment to ensuring the security, integrity, and efficiency of our blockchain-based land record management system.

Terms Used :

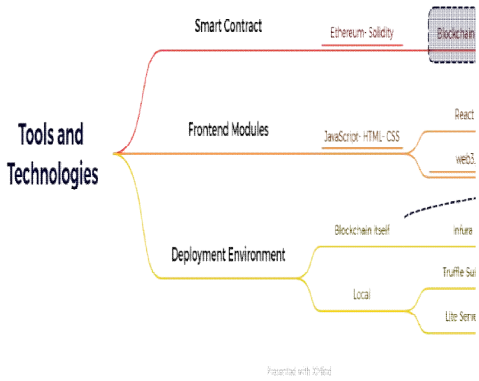
Ethereum Blockchain: Ethereum represents a decentralized blockchain network, freely accessible to anyone. It empowers users to create and deploy blockchain-based decentralized applications. Ethereum is an open-source project maintained by a global community, akin to Bitcoin. No single entity exercises control or ownership over Ethereum. It was designed with adaptability and versatility in mind, making it easy to develop new applications. Recent updates like Homestead have further bolstered the security of these applications.

Solidity: Solidity is a high-level, object-oriented programming language that draws inspiration from C++, Python, and JavaScript. Its primary use is in the creation of smart contracts, which are computer programs that dictate the behavior of accounts on the Ethereum blockchain. Solidity is statically typed and tailored for the Ethereum Virtual Machine (EVM).

SmartContracts: Smart contracts are straightforward programs employed to automate and streamline the execution of agreements on a blockchain, enabling all parties to interact without the need for intermediaries.

React JS: ReactJS stands as a front-end JavaScript library utilized for crafting user interfaces through open-source UI components. It enjoys support from Meta and a robust community of developers and businesses. React can be the foundational framework for constructing single-page, mobile, or server-rendered applications. In many cases, React applications require the use of additional frameworks for routing and client-side functionality.

Web3.js: Web3.js emerges as a JavaScript library that facilitates interactions with the Ethereum blockchain. It provides the means to connect and communicate with Ethereum-based decentralized applications (DApps) and smart contracts. Web3.js plays a pivotal role in the integration of Ethereum blockchain technology into web applications, enabling the retrieval of blockchain data and the execution of transactions.



IV. RESULT AND DISCUSSION

The Digital Land Records Modernization Program (DLRMP) addresses issues related to data loss, with its effectiveness contingent on the quality of data. This initiative aims to digitize India, reaching a 93% digitization rate. The next step involves placing existing documents on the blockchain to enhance record accuracy. Some states, like Maharashtra and Rajasthan, propose a framework for decisive titles, ensuring government compensation if titleholders default. This approach expedites digitization, incorporating blockchain via APIs connecting to state land registries. All states should prioritize decisive land titling. The government also initiated map digitization, reaching 69% in India. However, security concerns, including hacking and downtime, persist. Blockchain technology offers a solution, enhancing security and enabling continuous operation through web3. The proposed system allows universal access to land records, reducing fraud with immutable data. It also streamlines the Registry process, minimizing processing time

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Traditional Paper-based Land Records System	Digital Land Records Management Programme ("DLRMP")	Digital Land Records Management Programme ("DLRMP")
Wastage of investment in resources for maintaining physical records.	Lack of technical competency.	Hybrid Blockchain (Provide Privacy and Transparency).
Poor handling of records which leads to errors or missing records.	Lack of physical infrastructure - downtime.	Distributed Ledger which provides 24/7 service. No downtime.
Not Secured.	Chances of data loss or hacking.	Protected against Security Vulnerabilities.
Lack of technology to keep track of records.	Complex System with inaccurate information.	The smart contract verifies all the legal checks and the legal ownership & transfer of assets from one person to another.
	Multiple Web Portals with less synchronization.	Single-mode of access. (Synchronized)
	Multiple Bodies managing the current system.	Single Body can manage this system.

V. SCOPE OF RESEARCH

In the 21st century, as digitalization continues to reshape various aspects of our lives, it's imperative to address the significant disparity between India's traditional paper-based land registry system and the evolving Digital Land Record Management Program (DLRMP), which still involves some degree of paperwork. Both systems, the paper-based approach and the DLRMP, are susceptible to security and data loss concerns.

The DLRMP, although a step toward modernization, faces potential vulnerabilities, especially in the event of a database breach. Blockchain technology emerges as a compelling solution, offering a distributed ledger that is currently recognized as one of the most secure technologies available. In a blockchain, records are stored in a decentralized manner, making it an exceptionally secure method for storing sensitive land records. Moreover, blockchain technology provides immutability, ensuring that once data is recorded, it cannot be altered.

To store and access data from the blockchain, the use of smart contracts is essential. These self-executing contracts automate and facilitate transactions and operations on the blockchain. The programming language Solidity is employed to write these smart contracts.

In this research, the focus is on the development of two distinct smart contracts tailored to different user categories. Normal users are granted the privilege to access information from the blockchain, while government officials are equipped with the authority to add new records and access existing ones.

To enable users to view land records, a web portal is created using the Google Map API, which offers a visual representation of the land, highlighting specific areas using geocoordinates.

The scope of this research encompasses the following key areas:

Modernizing Land Record Management: The research seeks to modernize land record management in India by transitioning from traditional paper-based systems to a more secure and efficient blockchain-based solution.

Security Enhancement: Blockchain technology is explored as a means to enhance the security and immutability of land records, minimizing the risk of data loss or unauthorized alterations.

Smart Contract Development: The research involves the creation of two smart contracts, each catering to the distinct needs of normal users and government officials, ensuring proper access control.

User-Friendly Interface: A user-friendly web portal is developed, leveraging the Google Map API to provide visual representation and access to land records.

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Limitations and Future Scope:

India, despite its rapid growth, encounters certain limitations in fully transitioning to a digital land transfer process. The country's banking infrastructure is not yet fully developed, and a significant portion of the population lacks technical knowledge, posing challenges to complete digitalization. Additionally, government officials may lack the required understanding of the technology involved, contributing to their hesitancy in adopting it. The deficiency in training for government officials further complicates the successful implementation of digital land record management. Moreover, the project is restricted by the limited access to the official database, preventing efficient data integration and updates.

On the bright side, there is ample room for future expansion and improvements. If the government grants access to the official database, it could significantly enhance the project's efficiency. Potential enhancements include the incorporation of 3D assets such as flats, bolstering the system's robustness. As digitalization gains further ground in the land transfer procedures, the project can consider establishing a marketplace for citizens to buy and sell land efficiently. The potential use of cryptocurrency for transactions, once authorized by the Indian government through the Digital Rupee launched by the Reserve Bank of India (RBI), offers new possibilities. Furthermore, the development of machine learning models to predict the authenticity of records during the transfer from the current system to the blockchain system can enhance the accuracy and efficiency of record management, marking promising avenues for future development.

VI. CONCLUSION

Blockchain technology, particularly when implemented as a Hybrid Blockchain, offers a unique blend of privacy and transparency. Its application in the realm of land record management provides robust security by guarding against security vulnerabilities. The distributed ledger structure ensures uninterrupted 24/7 service, eliminating downtime concerns. The immutability of records within the blockchain safeguards land records against tampering, further enhancing their trustworthiness. Additionally, the use of smart contracts streamlines legal checks and establishes unequivocal ownership of land. In summary, blockchain technology proves to be an invaluable tool for efficiently tracking asset transactions as they change hands from one owner to another.

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