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RESEARCH ARTICLE

LANDEX: BLOCKCHAIN-BASED LAND REGISTRATION SYSTEM

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ABSTRACT

In today's digital age, ensuring the use of strong and unique passwords across various online platforms has become a vital aspect of cybersecurity. Despite this need, research shows that many users still rely on weak or repeated passwords due to the difficulty of remembering complex ones. Although cloud-based password managers help by securely creating and storing passwords, they come with potential downsides such as unauthorized access, data breaches, and reliance on third-party services. To tackle these issues, this study introduces an offline Android-based password manager that operates without an internet connection to safely generate and store passwords. The application allows users to create high-entropy, random passwords tailored to specific preferences, including length, use of symbols, numbers, and letter cases. It also functions as a secure vault to store login details, usernames, and personal notes in an encrypted and hidden format. In contrast to cloud-based tools, this offline solution uses AES encryption along with Android's Shared Preferences for secure local data storage, preventing unauthorized access. An internal authentication system adds an extra layer of security by allowing access only to verified users. This project analyzes common password security issues, the use of encryption, and the reliability of offline storage in comparison to cloud services. Results demonstrate the offline manager's strengths, highlighting its improved security, minimized cyber threat exposure, and strong privacy safeguards. The goal is to promote the use of robust password habits through a reliable, user-friendly, and privacy-focused alternative to conventional password managers.

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INTRODUCTION

Conventional land registration systems face major challenges such as lack of transparency, inefficiencies, and vulnerability to fraudulent practices. These systems, often relying on paper-based documentation and manual human processes, are prone to errors, delays, and disputes, which reduce trust among stakeholders. The centralized nature of traditional registries further increases the risk of data tampering, making it difficult to establish a trustworthy and consistent record of property ownership and transactions. One of the biggest hurdles lies in verifying the authenticity of land records, as current systems do not provide a clear, unalterable ledger. As a result, issues related to data accuracy, privacy, and integrity affect not only property owners and buyers but also government bodies and stakeholders across the entire land records ecosystem. These limitations significantly hinder the effectiveness of land administration systems, thereby affecting economic development and discouraging confidence in real estate operations. The resulting inefficiencies and uncertainties contribute to delays and a lack of reliability, weakening overall public trust in property transactions. To overcome these drawbacks, a secure and transparent digital alternative has become increasingly essential.

LITERATURE REVIEW

Password Security and User Behaviour*:* As digital platforms become more integral to everyday life, the demand for robust authentication methods has grown. Despite this, research reveals that many individuals continue to use simple or repeated passwords across several platforms, increasing their exposure to online threats. A large-scale study by Florencio and Herley on user password practices found that most people prioritize ease of recall over security, frequently opting for predictable passwords [1]. This common behaviour creates major cybersecurity risks and underscores the importance of using password managers that create and securely store strong, distinct credentials for each account.

Secure Password Storage and Encryption Mechanisms*:* Best practices in securing land registration data stress the use of robust encryption techniques for safeguarding sensitive records. Industry standards, such as those suggested by

OWASP, advocate using advanced cryptographic methods like PBKDF2, ecrypt, or Argon2 to hash ownership data [2], thereby strengthening protection against unauthorized access and tampering attempts. Additionally, NIST's Digital Identity Guidelines recommend incorporating randomized, high-entropy credentials and multifactor authentication (MFA) to enhance security protocols [5]. Although various digital land systems adopt these practices, risks related to breaches and unauthorized data exposure continue to raise valid concerns.

Ethereum: Ethereum, introduced in 2015, operates as a decentralized blockchain platform without any central control. Unlike Bitcoin, it enables developers to build decentralized applications (dApps) more efficiently due to its flexible and resilient framework. Ether, Ethereum's native currency, is used to handle transaction fees and computational processes. The platform pioneered smart contracts—self-executing agreements coded with predefined rules—enabling innovations like decentralized finance (DeFi), non-fungible tokens (NFTs), and decentralized autonomous organizations (DAOs). With its Ethereum 2.0 upgrade shifting from PoW to PoS, it enhances scalability, reduces energy use, and increases security, reinforcing Ethereum's dominance in decentralized ecosystem advancements.

Evaluation of Password Manager Security: Secure land registration systems require strong local encryption and reliable key management to protect sensitive property data. Centralized approaches remain vulnerable, as flaws in synchronization can be exploited to alter or access land records. To address these challenges, a decentralized, blockchain-based method using ofline storage and robust encryption significantly reduces risks, offering a more secure alternative for maintaining the integrity of property ownership data.

Emerging Trends in Password Management: Beyond traditional land registration systems, new authentication methods are being explored to enhance security. Research investigates the use of biometric verification, decentralized identities, and multi-factor authentication to reduce reliance on traditional passwords. While these technologies promise better security, their adoption in land registration systems is slow due to compatibility challenges and resistance from users. Nevertheless, the shift towards more secure, passwordless verification methods is gradually shaping the future of property data management.

Summary of Findings: The reviewed literature underscores the importance of secure data management, strong encryption, and user-friendly systems in land registration. While centralized solutions offer convenience, decentralized blockchain-based approaches provide superior security and privacy, making them a compelling alternative. This research builds upon existing studies by developing a blockchain-driven land registration system that ensures secure, transparent property transactions without relying on central authorities.

METHODOLOGY

System Overview: The reviewed literature highlights key challenges in India's land registration system, such as broker involvement, corruption, and security risks, which can result in document tampering and loss. Blockchain-based solutions like smart contracts can address these issues by providing a decentralized, transparent, and secure method for land transactions. Hyperledger and other blockchain technologies ensure data integrity, reduced human error, and enhanced security for property records. While challenges like system complexity exist, blockchain offers a viable solution by leveraging digital transactions and cryptographic techniques to improve efficiency and reduce fraud. Furthermore, IPFS and Ethereum smart contracts can safeguard property documents by storing them securely and tamper-proof, enhancing the reliability of land registration systems and promoting transparency. Blockchain digitization and tokenization of land assets can help resolve ownership disputes and streamline property transactions, ensuring long-term security and compliance

System Architecture: The architecture of the proposed land registration system consists of multiple layers, ensuring security, transparency, and efficiency:

- **User Interface Layer**: Offers a user-friendly interface for property owners and registrars to interact with the system, facilitating easy submission and retrieval of land records.
- **Smart Contract Layer**: Utilizes blockchain-based smart contracts to automate and validate transactions, ensuring the integrity of land records and enforcing transparent, rule-based processes.
- **Storage and Retrieval Layer**: Leverages decentralized storage, such as IPFS, to securely store land documents. These documents are assigned unique hashes, which are stored on the blockchain, ensuring immutability and easy retrieval.
- **Authentication Layer**: Incorporates authentication mechanisms such as biometric recognition or PIN codes to
- restrict access, ensuring that only authorized individuals can modify or access sensitive land data.

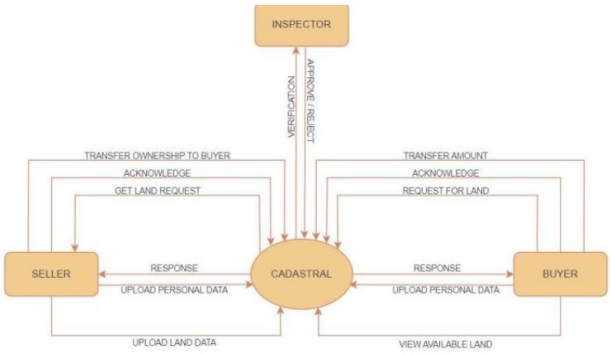

Fig. 1. System Architecture Diagram

Secure Password Generation: The document generation module uses blockchain-based smart contracts to ensure that land documents are created in a secure and tamper-proof manner. The user can define the following parameters to customize document details and customize password strength:

- Length of the password
- Inclusion of uppercase and lowercase letters
- Inclusion of numbers and Special characters

By incorporating blockchain-backed hashing techniques, the system ensures that every land document is uniquely verifiable and resistant to tampering or unauthorized alterations.

Secure Storage Mechanism: To safeguard sensitive land ownership records, the system applies AES-256 encryption before saving data. The encrypted documents are then securely stored using:

- InterPlanetary File System (IPFS) – Used for decentralized and tamper-proof document storage with unique hash generation.
- Ethereum Blockchain – Hash values generated by IPFS are stored on the Ethereum network through smart contracts to ensure immutability and traceability.

This design guarantees that land records are protected from unauthorized access, tampering, and data loss.

Application Security and Access Control: To ensure that only authorized parties can access land records, the system incorporates a robust authentication layer at the user interface level. Access to the application is restricted through:

- • PIN or password-based login
- • Pattern lock authentication
- Biometric verification (fingerprint or facial recognition) This access control mechanism ensures that even if the device or platform is compromised, unauthorized users cannot retrieve or tamper with sensitive land registration data.

Comparative Security Analysis: To assess the robustness of the proposed blockchain- based land registration system, a comparative evaluation is performed against traditional centralized land registry methods based on the following criteria:

- Security of stored land records
- Vulnerability to document tampering and unauthorized access
- User privacy and data integrity risks
- Accessibility, transparency, and system efficiency

This comparison highlights how the decentralized system significantly improves trust, security, and reliability in land transactions.

Implementation Tools and Technologies

The blockchain-based land registration system is developed using the following tools and technologies:

- Programming Language: Solidity (for writing smart contracts)
- Blockchain Platform: Ethereum (for decentralized record storage and smart contract execution)
- Storage System: IPFS (InterPlanetary File System) for decentralized document storage
- Development Environment: Remix IDE and MetaMask for smart contract testing.

RESULTS AND DISCUSSION

Implementation and Performance Analysis: The proposed blockchain-based land registration system was designed and evaluated to address inefficiencies in traditional registry models. It demonstrated enhanced decentralization, security, scalability, and cost-effectiveness. Decentralization was achieved by using a shared ledger, allowing all participants to view consistent, tamper-resistant records, in contrast to current systems. Smart contracts securely stored land data, with access restricted to verified participants—only inspectors could view land details directly, while buyers required seller permission.
To enhance security, the system included an inspector who verified user and property authenticity, acting as a second layer of verification and eliminating fraudulent entries. The removal of mediators (brokers) significantly reduced

transaction costs, making the process more transparent and direct. The system also scaled efficiently, with smart contract functions optimized to handle increased transaction volumes without performance degradation. Despite not featuring a centralized dispute resolution body, accountability was preserved through inspector-validated transactions, minimizing the risk of errors or tampering and ensuring reliable, dispute-free operations. The key findings are presented in Table 1.

Table 1. The following table showcases the differences in various parameters concerning the existing and our proposed system

Parameter	Existing	Existing
Decentralization	No	No
Security	Low	Low
Additional security	No	No
Mediator involvement	High	High
Accountability	Low	Low

The analysis of the blockchain-based land registration system highlighted several key advantages over traditional models. While traditional systems are prone to security risks, including tampering and corruption due to centralized record-keeping, the blockchain-based system provides a decentralized, tamper-proof solution.

User Experience and Practical Usability: A usability test was conducted to assess the effectiveness, security, and user experience of the blockchain-based land registration system. Participants, including land registrars and buyers, provided feedback on several aspects of the system:

Decentralization: Users appreciated the transparency and security offered by blockchain's shared ledger, reducing concerns over tampering or fraud.

Security: The use of smart contracts to store and manage land records was considered a significant improvement in ensuring the integrity and authenticity of property data.

Reduced Mediation: The elimination of brokers was seen as a cost-saving feature, streamlining the process while reducing commissions. usability test was conducted among a small group of users to evaluate the ease of use, security perception,

CONCLUSION

In conclusion, this research investigates the potential of blockchain technology to revolutionize the land registration system by addressing key challenges in traditional methods. By utilizing blockchain's decentralized structure, cryptographic security, and smart contracts, the system significantly enhances property transaction processes. The tamper-resistant

blockchain ledger ensures transparency, while smart contracts facilitate streamlined procedures, minimizing fraud and reducing the need for intermediaries. The inclusion of buyer and seller dashboards, combined with an essential inspector role, fosters a collaborative and secure environment for property transactions. As we envision a future where land records are securely stored in immutable blockchain blocks, this project marks a transformative step toward Web3 integration and building trust in property management systems.

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