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Secure Blockchain-Enabled Property Lease And Mortgage Verification With Image And Map-Based Authentication

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Abstract:

Fraudulent land lease and mortgage approvals caused by tampering in centralized banking databases remain a major challenge in property management systems. Traditional centralized architectures are vulnerable to internal manipulation, enabling multiple loans to be issued on the same property and resulting in financial losses. To address this issue, this paper proposes a blockchain-based secure land lease and mortgage management system integrated with property image and geo-location verification. The proposed framework leverages Ethereum smart contracts to maintain immutable and transparent property lease records across decentralized nodes, thereby preventing unauthorized data modification and duplicate mortgage approvals. In addition to blockchain-based verification, the system stores property images and geographical location details to enable visual and map-based validation by banks and users before lease sanctioning. A smart contract-driven lease request algorithm validates previous loan existence and calculates eligible lease amounts automatically. Experimental results demonstrate that the proposed framework enhances transparency, improves verification efficiency, and significantly reduces fraud in land lease and mortgage management.

Index terms - *Blockchain, Smart Contracts, Land Lease Management, Mortgage Verification, Ethereum, Property Authentication, Geo-Location Validation, Fraud Detection, Decentralized Ledger, Property Image Verification*

1. INTRODUCTION

Land lease and mortgage management plays a crucial role in the banking and real estate sectors, where financial institutions provide loans against property documents submitted by owners. However, traditional property mortgage systems are primarily dependent on centralized databases, which are vulnerable to tampering, unauthorized modifications, and fraudulent activities by internal employees or external attackers. Such vulnerabilities enable fraudsters to mortgage the same property multiple times across different banks, resulting in duplicate loan approvals and significant financial losses.

To overcome these limitations, blockchain technology has emerged as a promising solution due to its decentralized, transparent, and tamper-resistant architecture. Blockchain stores data across multiple distributed nodes, making unauthorized modifications nearly impossible and ensuring data integrity through cryptographic hash verification. By leveraging blockchain in property management systems, banks can transparently verify whether a property has already been mortgaged or leased before approving new requests.

This paper proposes a blockchain-based secure land lease and mortgage management framework enhanced with property image and geo-location verification. The system stores property details, lease records, visual property images, and location coordinates on the blockchain to provide complete transparency and reliable validation. Smart contracts automate the mortgage verification and lease sanction process by checking existing loan status and calculating eligible loan amounts. The proposed framework improves trust, prevents duplicate mortgages, enhances property verification accuracy, and provides a secure and efficient approach for modern land lease and mortgage management.

2. LITERATURE SURVEY

i) Digitization of land record through blockchain-based consensus algorithm:

Currently, real estate markets account for a significant portion of any nation's GDP. Stamp duty collected from real estate sales flows straight into the government coffers. However, the absence of an effective, dispersed, fully digital system makes it vulnerable to fraudulent operations and land document counterfeiting. In order to reduce the possibility of document fabrication and other fraudulent activity, this study suggests a blockchain-based framework for digitizing real estate transactions. The volume of these transactions may eventually become excessive, leading to an increase in the number of blocks. Blockchain technology is the foundation of the suggested structure, which decentralizes the whole ecosystem. Every significant activity related to real estate transactions is included in the framework. The system smoothly integrates many area registry offices across the state or nation using the InterPlanetary File

System (IPFS), a Peer-to-Peer (P2P) swarm network. A consensus mechanism that cuts overhead broadcasts for multicasting nodes by around 50% is suggested to make it safe. Additionally, there is a 54.86% decrease in message exchange communication overhead. The consensus technique takes around 53.7% less time than the Proof-of-Work mechanism, where all nodes participate in consensus, and 10% less time than the current load-based method.

ii) Modernising legacy software as Internet of Things-based application:

The Internet of Things (IoTs) connects people, devices, services, and applications in intelligent systems and surroundings by combining networking, hardware, and software technologies. In the context of smart systems, businesses must make use of their long-running, sometimes out-of-date software and IT services—known as legacy applications—that lack IoT capabilities like connection, context-sensitivity, pervasiveness, and portability. This study suggests a method for updating historical software as an Internet of Things application, together with tool assistance and human interaction. Scenario-based usability of the modernization process and criteria-driven evaluation of the modernized application are demonstrated in a case study on linked and smart healthcare. By providing process, tool, and human decision support for reengineering historical software into IoT-based applications, the suggested approach extends current research and practices on software evolution.

iii) LandLedger: Blockchain-powered land property administration system:

Many nations, including India, have inadequate and corrupted records in their present land management systems. Document fabrication and inadequate verification result from the many land administration system departments keeping their own copies of the records. In this article, we introduce LandLedger, a blockchain-based land administration system that offers scalable, secure, transparent, efficient, and accountable land property management. Using specifically created transactions on a permissioned blockchain overseen by a number of departments, including the Registrar's office, the Income Tax Department, the Revenue Department, and others, the proposed architecture of LandLedger enables property verification, registration, and revocation. LandLedger effectively implements ownership verification and property history checking through the usage of Merkle Patricia Tree. When compared to the present practice employed in many nations, including India, the implementation of LandLedger demonstrates its practicality with improved capabilities.

iv) A novel framework for implementation of land registration and ownership management via blockchain in Bangladesh:

In developing nations like Bangladesh, the registration process for ownership, occupancy, or other rights for things like land is a laborious procedure. This article identifies concerns with manual land registration procedures, including transparency, centralization, legitimacy, dependability, etc., and suggests a better way to solve these issues with blockchain technology. This report also examines the comparability of Blockchain-based digital land record systems across several nations. Lastly, we have created a unique framework that employs the Blockchain technique to carry out the land registration procedure and give Bangladeshis genuine and unquestionable ownership rights.

v) Blockchain-based land record management in Pakistan

The literature has identified several problems with land record management. Severe Land Record Management problems, such as data tampering with land records, the inability to obtain a full history of property ownership, the operation of multiple related Land Record Management Systems in isolation, etc., are particularly prevalent in developing nations like Pakistan. Such problems are not addressed by common traditional land record management solutions. We suggest a blockchain-based land record management system for Pakistan to solve these problems. Details of the suggested system's design and implementation are provided in the article.

3. METHODOLOGY

A. Proposed Work:

The proposed work introduces a secure and transparent blockchain-based framework for land lease and mortgage management integrated with visual and geo-location property verification mechanisms. The system utilizes Ethereum blockchain and smart contracts to maintain immutable records of property details, lease transactions, and mortgage status across decentralized nodes, thereby eliminating the risk of unauthorized data tampering and duplicate loan approvals. When a bank receives a lease or mortgage request, the smart contract automatically validates whether the property already has an active loan and computes the eligible sanction amount if no previous mortgage exists.

To enhance the verification process beyond traditional document-based validation, the framework stores property images and geographic location details on the blockchain. This enables bank officials and users to visually inspect the property and verify its exact location through integrated map services before approving lease requests. The proposed work also

includes automated email notifications to inform users regarding loan sanction or rejection status. By combining blockchain transparency, visual verification, and geospatial validation, the system ensures secure, fraud-resistant, and efficient land lease and mortgage processing.

B. System Architecture:

The architecture of the proposed blockchain-enabled land lease and mortgage management system consists of four major layers: User Interface Layer, Application Processing Layer, Blockchain Layer, and External Validation Services Layer. The User Interface Layer provides separate portals for Admin, Bank, and User interactions, enabling secure login, property registration, lease requests, and property validation operations. The Application Processing Layer handles request processing, business logic execution, image management, email notifications, and communication between users and blockchain services.

At the Blockchain Layer, Ethereum smart contracts securely store property records, lease details, mortgage status, property images, and geo-location metadata in an immutable decentralized ledger. Smart contracts execute lease verification and sanction algorithms by validating whether a property already has an existing loan before approving any new mortgage request. The External Validation Services Layer integrates Google Maps for property location visualization and Email Services for notifying users about lease approval or rejection. This layered architecture ensures secure, transparent, tamper-proof, and efficient management of land lease and mortgage transactions.

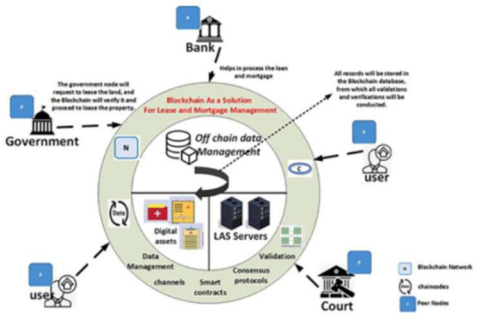

Fig 1Proposed Architecture

C. Modules:

a) **1. Admin Module**

The admin module is responsible for managing and registering all property details into the blockchain network. The admin uploads property information including property ID, owner details, address, property images, and geo-location coordinates. This module ensures that verified property records are securely stored in blockchain for future lease and mortgage validation.

b) 2. Bank Module

The bank module enables authorized bank officials to register, log in, and process lease or mortgage requests. Bank users execute the Request Lease algorithm by entering a property ID, after which the smart contract checks existing mortgage status, validates property details, and calculates the eligible sanction amount if no previous loan exists.

c) *3. User Module*

The user module allows property owners to register, log in, and validate their property details stored on the blockchain. Users can search using their property ID to view ownership information, mortgage status, uploaded property images, and geo-location details for transparency and verification.

d) *4. Smart Contract Management Module*

This module handles blockchain-based property and lease record storage using Ethereum smart contracts. It automates lease verification, mortgage checking, transaction recording, and loan sanction decision-making while ensuring immutability and tamper-proof data management.

e) *5. Property Image Verification Module*

This module stores and retrieves visual property images linked to each registered property. It helps bank officials and users visually inspect property conditions and verify authenticity before lease or mortgage approval.

f) *6. Geo-Location Validation Module*

The geo-location validation module stores property latitude and longitude coordinates and integrates map services for location visualization. This enables stakeholders to verify the exact physical location of the property and assess surroundings before approval.

g) *7. Notification Module*

The notification module sends automated email alerts to users regarding lease approval, rejection, sanction amount, or duplicate mortgage detection. It ensures real-time communication between the system and stakeholders.

4. EXPERIMENTAL RESULTS

The proposed blockchain-enabled land lease and mortgage management system was experimentally evaluated using multiple real-time test scenarios involving property registration, blockchain storage, lease request processing, duplicate mortgage detection, and property validation. The results demonstrate that the system successfully stores all property records, images, and geo-location details in Ethereum blockchain with immutable transaction logs, including block number, transaction hash, and gas usage for each operation.

During lease processing, the smart contract accurately identified whether a property already had an active mortgage before approving new requests. For

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properties without prior loans, the system correctly calculated and sanctioned eligible lease amounts while sending automated email notifications to users. When duplicate mortgage requests were attempted, the system effectively rejected them by returning zero sanctioned amount, thereby preventing double spending and fraudulent approvals. Additionally, the integrated property image verification and Google Maps location validation features improved property authentication accuracy and enhanced decision-making for bank officials. These results confirm that the proposed framework provides secure, transparent, and efficient lease and mortgage management compared to traditional centralized systems.

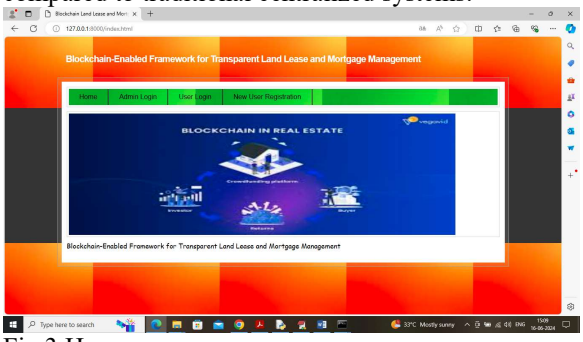

Fig 3 Home page

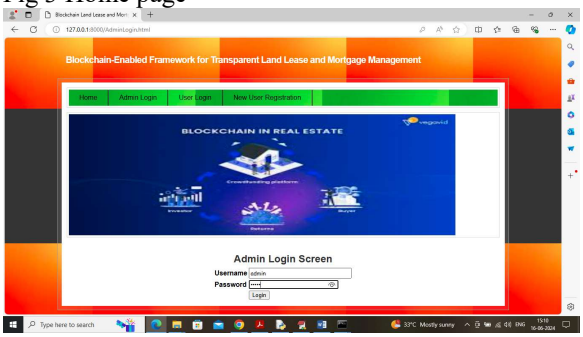

Fig 4 Admin Login Screen

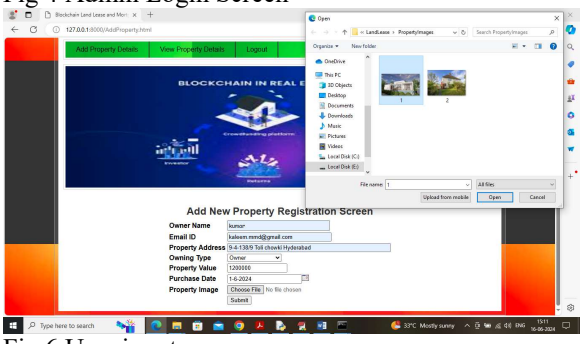

Fig 6 User input

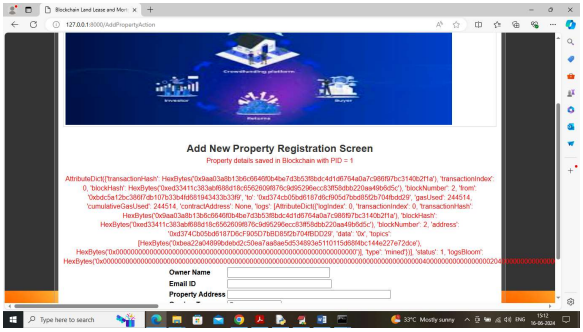

Fig 7 Predict result for given input

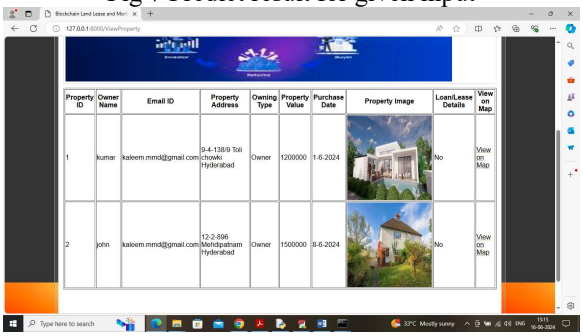

Fig. 6: View Registered Property Details Screen

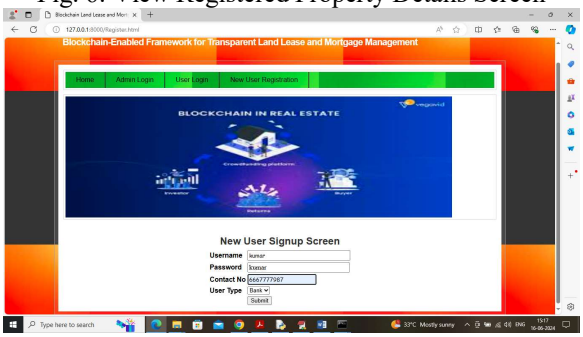

Fig. 7: Property Geo-Location Visualization Screen

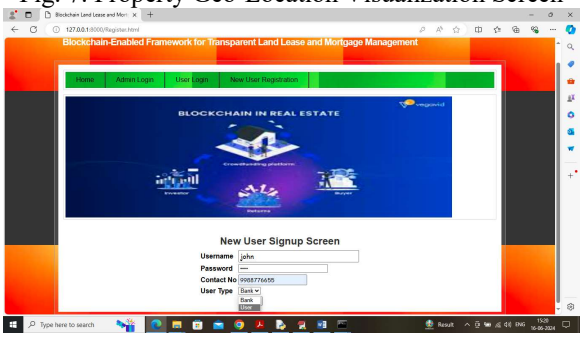

Fig. 8: New User Registration Screen

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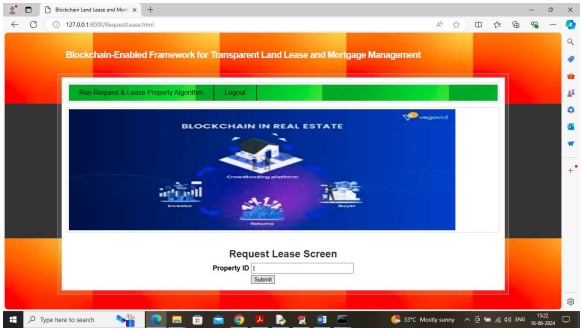

Fig. 9: Bank Request Lease Screen

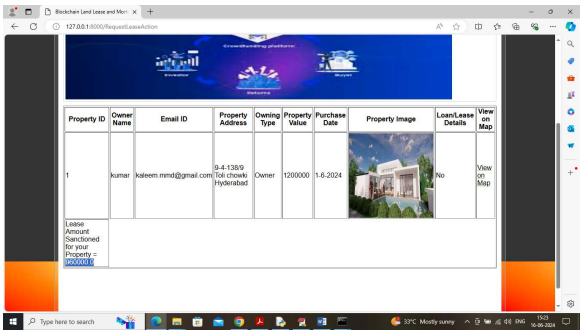

Fig. 10: Lease Amount Sanction Result Screen

5. CONCLUSION

The proposed blockchain-enabled framework for transparent land lease and mortgage management successfully addresses the limitations of traditional centralized property financing systems by providing a secure, decentralized, and tamper-proof platform for property record management. Through Ethereum smart contracts, the system ensures immutable storage of property, mortgage, and lease records, effectively preventing fraudulent duplicate mortgage approvals and unauthorized data manipulation.

The integration of property image verification and geo-location validation further enhances the reliability and authenticity of property assessment during lease sanctioning. Experimental results demonstrate that the proposed system improves transparency, automates loan verification, strengthens fraud prevention, and streamlines mortgage approval processes. Overall, the framework offers a robust and trustworthy solution for modern land lease and mortgage management applications.

6. FUTURE SCOPE

The proposed blockchain-enabled land lease and mortgage management framework can be further enhanced by integrating advanced technologies to improve automation, scalability, and intelligence. Future work may incorporate Artificial Intelligence and Machine Learning models for automated property valuation and fraud risk prediction during mortgage approval. Integration with biometric-based identity verification can strengthen user authentication and prevent impersonation during property transactions.

Additionally, the framework can be expanded into a government-level nationwide land registry platform by connecting multiple banks, registration offices, and legal authorities within a unified permissioned blockchain network. Future enhancements may also include mobile application support, IPFS-based decentralized image/document storage for large property files, and real-time analytics dashboards for monitoring property transaction trends and fraud patterns.

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Mr. Venkateswarhemaprasad is currently an M.Tech student at Bonam Venkata Chalamayya Engineering College, pursuing a Master’s degree in Computer Science and Engineering, He is passionate about Machine Learning, Deep Learning, Robotics, and Artificial Intelligence. He is proficient in C, C++, CNC Coding, and Python. His current research work focuses on a Secure Block chain-Enabled Property Lease and Mortgage Verification system with image and Map-Based Authentication.

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