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NFT Based Land Registry System Using Blockchain

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Abstract- ***In recent years,Land registration systems in many countries faces various challenges such as duplicate property, forgeries in documents, ownership conflicts, and unauthorized resale of property. Traditional systems are vulnerable to human errors, tampering of data, corruption which leads to lack of transparency and trust between buyer and seller. To overcome these issues,blockchain technology offers an immutability and transparency land registration system, but blockchain alone fails to ensure ownership integrity during transfer. This paper proposes a Blockchain and Non-Fungible Token (NFT)-based land registration system which ensures unique ownership of property , prevents duplicate registration of land , and reduces fraudulent during transactions. Each land parcel is represented as a unique NFT deployed on a blockchain network, which acts as an blockchain-based land title. Smart contracts enables ownership verification and allow land transfer only by the authorized owner.Land- related documents are stored using the InterPlanetary File System (IPFS), ensuring data integrity and decentralized storage. The proposed system ensures security, transparency and tamper proof while allowing ownership transfer. Experimental implementations and evaluation of implementations establish that the system effectively prevents duplicate land titles, fake ownership of property , and resale of already sold land. The solution provides a scalable and reliable approach for modernizing land registry systems using decentralized technologies.***

Index Terms- ***Blockchain, Landregistry System, Non-Fungible Tokens, Smartcontracts, Interplanetary File System, Decentralized storage.***

I. INTRODUCTION

1.1 OBJECTIVE OF THE PROJECT

Land ownership is the important component for both individuals and governments, as it represents economic stability, identity, and social security. However, current land registration systems mostly rely on manual methods and government authorities, making them prone to inefficiencies and malicious activities. This traditional system mostly involve paper-based records which may lead to document forgery, unauthorized modifications of documents .It results in ownership conflicts and legal disputes which reduces public trust in land registration systems. Several issues occurs in current land registration system that includes duplicate land titles, fraudulent ownership, and the unauthorized resale of land that has already been transferred. These problems occurs mostly due to the absence of real-time ownership verification and the lack of transparent, tamper-proof of land transactions. In current systems, a single point of control is followed which increases the risk of corruption and tampering of data , which results in the disputes and delays in ownership validation.To overcome these problems Blockchain technology has been introduced as an approach for securing land records from duplicates and fraudlent.This system is used due to its transparency,decentralization and immutable storage of records. By using an distributed ledger, blockchain makes sure that once land records are stored, they cannot be deleted or altered without consensus from network .This increases data integrity throughout the process. However, while blockchain protects land records from unauthorized tampering, it does not guarantee ownership uniqueness or enforce secure and rule-based asset transfer during land transactions. Ownership validation and transfer logic often remain dependent on external or application-level implementations, which can still be prone to logical flaws or misuse.

To overcome all these limitations, Non-Fungible Tokens (NFTs) is introduced that can be utilized to digitally represent land tokens.NFTs are unique non-replicable tokens deployed on blockchain networks, making them easier for representing real-world assets such as land titles. When the NFT is used to tokenize the land parcel, it becomes much easier to verify the ownership of the land parcel which leads to non-

duplication of land records. The transfer of ownership from seller to buyer is done by smart contracts, which ensures that only owner can start and end the process.

This paper proposes a decentralized land registration system that integrates the blockchain technology with NFTs to establish a secure, transparent, and tamper proof system for land ownership management. In the proposed system, each land parcel is uniquely represented as an NFT token .The NFT makes sure to maintain the single ownership, transfer of land from seller to buyer securely , and immutable recordmaintenance. By eliminating the various intermediaries involved in the process , this method prevents the various fraudulent activities involved such as duplicate land registration, multiple ownership of the land records , and the illegal transfer of land ownership. This system also increases the trust among buyers, sellers, and authorities.

II. RELATED WORK

Several researchers have explored the application of blockchain technology to overcome the limitations of traditional land registration systems, focusing on security, transparency, and efficiency.

Gupta et al. [1] proposed a blockchain-based land registry framework to address fraud and unauthorized modification of land records. Their system leverages the decentralized nature of blockchain to ensure tamper resistance and transparency. While the approach demonstrates improved security over conventional systems, the study does not extensively address legal recognition or integration with existing government land databases, which are critical for real-world adoption.

Kumar et al. [2] investigated the use of smart contracts in automating land registration and ownership transfer processes. Their work highlights how automation can reduce human intervention, minimize processing delays, and lower transaction costs. However, the study assumes the correctness of initial data input, and it does not provide mechanisms to handle disputes or rectify erroneous records once they are permanently stored on the blockchain. Privacy concerns related to storing sensitive ownership data are also not thoroughly discussed.

Patel and Shah [3] presented a decentralized land registration approach aimed at preventing ownership conflicts and duplicate registrations. By maintaining an immutable transaction history, their system improves traceability and trust among stakeholders. Despite these benefits, the authors acknowledge challenges related to user adoption, scalability, and interoperability with legacy systems. The lack of standardized legal frameworks for blockchain-based land records further limits the applicability of the proposed solution. advantages in terms of transparency, security, and automation.

Kaczorowska [4] provided a comprehensive analysis of blockchain-based land registration systems, emphasizing both opportunities and challenges. The study highlights immutability as a key advantage in preventing data tampering but also identifies it as a potential drawback, as correcting erroneous or fraudulent entries becomes difficult. The paper further discusses concerns related to reduced intermediary oversight, which may impact legal validation and dispute resolution processes.

Cruz et al. [5] examined blockchain adoption in land registration systems within developing regions. Their research underscores the potential of blockchain to reduce corruption and enhance transparency in land governance. However, the authors identify significant barriers, including inadequate digital infrastructure, limited internet accessibility, and low levels of digital literacy. Socio economic and governance challenges are also highlighted as factors that influence the effectiveness of blockchain-based land registry implementations.

Mehta and Jain [6] proposed an NFT-based land registry model in which land parcels are represented as unique digital tokens. This approach ensures clear ownership identification and improves asset traceability. Nevertheless, the study notes that NFT-based land ownership lacks legal recognition in most jurisdictions and involves high implementation and maintenance costs. Interoperability with existing government systems also remains a challenge.

Singh et al. [7] analyzed blockchain-based land governance models with an emphasis on transparency and accountability. Their work highlights the role of blockchain in reducing corruption and enhancing public trust. However, the authors point out governance and regulatory challenges, noting that decentralized systems may conflict with existing centralized administrative structures. The absence of clear dispute resolution mechanisms is another limitation discussed in the study.

Verma and Rao [8] focused on using blockchain to eliminate corruption in land administration systems. Their work demonstrates how immutable records can reduce manipulation by intermediaries. Despite these advantages, the study lacks a detailed implementation framework and does not evaluate system performance using real-world datasets. Security analysis of smart contracts is also limited. Alketbi et al.

[9] proposed a decentralized land registry architecture using blockchain and distributed storage technologies. The system improves data integrity and availability; however, the authors identify scalability issues, high computational overhead, and transaction latency as major concerns. Energy consumption associated with blockchain networks is also discussed as a potential limitation.

[10] Nair and Menon [10] explored the integration of blockchain with the InterPlanetary File System (IPFS) for secure storage of land-related documents. Their approach ensures document integrity and decentralization. However, the study does not sufficiently address long-term data persistence in IPFS or access control mechanisms for sensitive land documents.

[11] Wang et al. [11] examined blockchain-based governance frameworks for land administration. The study emphasizes improved auditability and transparency but highlights institutional resistance, lack of technical expertise, and regulatory uncertainty as major obstacles. The authors conclude that blockchain alone cannot resolve disputes arising from incorrect or disputed initial ownership claims. Overall, the reviewed literature demonstrates that blockchain-based land registry systems offer significant However, unresolved challenges related to legal recognition, scalability, privacy, error correction, infrastructure readiness, and governance persist. These limitations reveal a clear research gap, emphasizing the need for a comprehensive, legally compliant, and scalable blockchain-based land registry framework that integrates secure document storage, automated verification, and effective dispute resolution mechanisms.

III. PROBLEM STATEMENT

The legal asset for organizations, governments and individuals is economic .Eventhough global digitilization advancements in the areas of land registration systems and digital records management across many regions uses and dependent entirely on manual verification process and centralized architectures, despite the advantages these process gave they also highly vulnerable to fraud, data manipulation due to human interventi of and inefficiency.

As a result these leads to the recurring issues that occurs persistently such as forged ownership documents, unauthorized resale of land, duplicate land titles and prolonged legal disputes.In the Traditional and the exiting Land registry systems are lacking due to the absence of reliable mechanism to guarantee ownership uniqueness and enforce secure ownership transfer is the major critical challenge. In centralized The existing systems used to store all their land records,databases as editable entries, that leads to the cyberattacks where unauthorized modifications by insiders. The Blockchain Technology which is known for its Decentralized ,transparent nature is employed to store immutable land records, but it alone not enough for enforcing Ownership. By implementing Ownership verification and transfer rules as application-level logic, that can be manipulated, or bypassed, misconfigured.The major problems in the current existing Land Registration system involves the double land titles and double selling. In the existing system multiple times the same land parcel can be registered using different identifiers .

On the otherhand the already sold land is repeatedly sold to multiple buyers due to ownership updates

delays and time consuming real-time verification. Which are prone to severe financial losses for buyers and undermines trust in land governance systems also during the land transfer process the buyer have only limited visibility into the land parcel complete ownership history, which complecating the authenticity verification before the purchase of the land parcel by the buyer.The disputes that arose while using the Traditional land registration system contains physical documents such as papers and digita; files that are stored across centralized storage systems cab be easily duplicated, modified,altered or destroyed which leads high mistakes regarding land boundaries, ownership rights, and transaction legitimacy. As a result Document forgery and tampering of the documents remain prevalent challenges. Particularly in the regions with high levels of administrative corruption the problems such as lack of transparent and tamper-proof storage mechanisms exacerbates 1. Uniqueness of land hash is verified. Additionally, the absence of automated and trustless ownerships transfer reduces the efficiency by the involvement of third-parties also known as the intermediaries, such as government officials, notaries, and legal agents are involved in the existing land registration and transfer process. This dependence leads to increased transaction costs, creates opportunities for corruption, introduces delays and bias.

3.1Methodology

This section presents the proposed Blockchain and Non- Fungible Token (NFT)-based land registration and ownership transfer methodology, designed to eliminate duplicate land titles, prevent fraudulent resale, and ensure transparent ownership verification. The methodology integrates blockchain immutability with NFT-based ownership enforcement to provide a secure and decentralized land registry system.

3.2 Overview of the Proposed Framework

- The proposed system tokenizes each land parcel as a unique Non-Fungible Token (NFT) that is deployed on the blockchain network. In traditional blockchain-based storage systems, the land ownership is represented as the mutable data entries,where the proposed methodology represent the land ownership as NFTs. Each NFT acts as an digital land parcel, which represent an single land parcel and its correct owner.
- Blockchain technology makes sure immutability and transparency of transactions, while NFTs enforce the ownership uniqueness of each land parcel. It also makes sure to secure the transferability at the protocol level. Smart contracts will govern the entire lifecycle of the land registration, verification, and the ownership transfer.

3.2.1 Land Identification and Hash Generation

In the land identification each land parcel is uniquely identified using an hash generated from immutable land attributes such as survey,geographic coordinates such as the latitude and longitude,land area.
The land hash is computed as:

LandHash=H(SurveyID||GeoCoordinates)$Coordinates$

This hash generated will serve as a unique id for each land parcel and prevents the duplicate registration of the same land under different id.

3.2.2 NFT-Based Land Registration (NFT Minting)

Once the land is successfully by an authority, the land registration system mints the Non-Fungible Token (NFT) using ERC 721 standard.NFT is created by the below steps:

1. Uniqueness of land hash is verified.
2. New NFT is minted to the verified land parcel.
3. NFT ownership is assigned to the land owners blockchain wallet.
4. Each NFT is always (token ID cannot be replicated), Immutable (non-altered data), Traceable (recorded ownership history). This method makes sure that one-to-one mapping is done between land parcels and NFTs, therefore eliminates the possibility of duplicate land parcels.

3.2.3 NFT Metadata and Document Storage

Various land-related documents such as owner details,land area are stored in a decentralized storage system using InterPlanetary File System (IPFS). Then the hash generated from IPFS file is stored within the NFT data.This makes sure the integrity and

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authenticity of land document.This IPFS reduces the storage costs The NFT data structure includes the details such as the hasf of the land parcel,IPFS document hash,registered timestamp and current owner address details.

3.2.4 Ownership Verification Using NFTs

Verification of ownership is done by querying the NFT ownership data directly from the blockchain network. Any sbuyer or seller can verify land ownership by checking: This method eliminates rely on centralized authorities and ensures transparent, real-time ownership verification. Since the NFTs are managed by standardized token ownership rules,fraud ownerships are automatically rejected by blockchain network. 3.6 Role of Blockchain in the Proposed System Blockchain plays an foundational trust infrastructure of the system. The primary responsibility of blockchain is to ensure immutability of data ,decentralization, and transparency. Blockchain is used to maintain an immutable ledger of land registration and transfer transactions on the neework,store hashes of land data and documents,provide tamper-proof records,allows public verification of transaction history and eliminates the rely on centralized authorities for verification..Blockchain alone guarantees once a record is written, it cannot be altered,transaction history is auditable and data forgery is also detectable in the network.

3.2.5 Limitation of blockchain alone

Blockchain network stores the records, but it does not guarantee uniqueness of ownership at the asset level. Here land ownership is represented as data entries, which will lead to complex logic to prevent misuse of data. 3.8 Role of NFT in the Proposed System To overcome this limitation,NFTs introduced ownership enforcement and uniqueness that blockchain alone will not guarantee. Here each land parcel is represented as a Non-Fungible Token, which will act as a digital land title deed. NFT is used to represent land as a unique, non- duplicable digital asset,and ensures one-to-one mapping between land and owner,It also enables secure and single ownership transfer,prevents double selling at the protocol level 3.9 What NFT guarantees: A land parcel can have only one owner at any time,ownership transfer is automatic and irreversible,unauthorized sale is impossible,land cannot be duplicated or cloned

3.2.6 Role of NFT in the Proposed System

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3.2.7 What NFT guarantees

A land parcel can have only one owner at any time,ownership transfer is automatic and irreversible,unauthorized sale is impossible,land cannot be duplicated or cloned.

Traditional System	Blockchain Only	Blockchain + NFT
Land record file	Immutable record	Legal digital asset
Ownership entry	Hash mapping	Token ownership
Sale	Manual update	Token transfer
Fraud risk	Medium	Near zero

3.2.6 ERC-721 Algorithm

ERC-721 is the non-fungible token standard that is designed to represent unique and the indivisible digital assets. In the land registry system, each land parcel is represented to a single ERC-721 token, which will act as an digital title deed.In contrast to fungible tokens, ERC-721 tokens cannot be duplicated or divided, that making them suitable for land ownership management.

3.2.7 Suitability of ERC-721 for Land Registry System:

ERC-721 is particularly suitable for land registry system due to the various properties such as:

- Each land parcel is represented in the form of unique and non-interchangeable.

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- Ownership is always exclusive and it is not divisible.
- Land assets cannot be split without legal intervention which is an added advantage.
- Ownership history must always be transparent and traceable.

ERC-721 establishes these constraints on blockchain protocol level, thereby reducing the rely on complex external validation mechanisms.

3.2.8 Advantage of using ERC-721 over ERC-1155

Feature	ERC-721	ERC-1155
Token type	Always Non-fungible	Fungible and also non-fungible
Asset uniqueness	Guaranteed	Optional
Token structure	One token per asset	Multiple token types per contract
Ownership model	Single owner per token	Multiple balances possible
Primary use cases	Land, property, certificates	Gaming assets, bulk tokens
Duplication prevention	Protocol-enforced	Requires additional logic
Ownership enforcement	Built-in	Semi-manual
Transfer	Single-asset	Batch transfers
granularity	transfer	
Suitability for land registry	High	Moderate

IV. PROPOSED WORK

This section presents the detailed implementation of the proposed Blockchain and NFT-based Land Registration System, describing the technologies used, system modules, smart contract logic, and operational workflow. 4.1 Technology Stack The land registration system is implemented using an decentralized architecture which is composed of blockchain, smart contracts, NFT, storage, and an web based interface.

4.1 Technology Stack

The land registration system is implemented using an decentralized architecture which is composed of blockchain, smart contracts, NFT, storage, and an web based interface.

4.2 System Modules

The system is divided into the following major modules:

1. User Interface Module
2. Smart Contract Module
3. NFT Management Module
4. IPFS Storage Module
5. Blockchain Network Module

4.3 User Interface Module

The user interface acts as an bridge between users and the blockchain network. It allows the land owners, buyers, and government authorities to perform various system operations.

Functionalities:

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The various functionalities of the user interface layer are land registration,,Ownership verification,Buy/sell land transactions,Viewing ownership history,Wallet authentication is done using MetaMask. User requests are signed using the user's private key and forwarded to the blockchain.

Layer	Technology Used
Blockchain Network	Ethereum(Test Network)
Smart Contracts	Solidity
NFT Standard	ERC-721
Decentralized Storage	IPFS
Frontend	HTML, CSS, JavaScript
Wallet Integration	Metamask
Development tools	Remix IDE

4.4 Land Registration Implementation

4.4.1 Land Data Processing

When a user submits land details, the system now extracts immutable land detai l s such as Survey number of land parcel,geographic coordinates like latitude and longitude and land area.This hash makes sure that same land cannot be registered by more than one person.

A cryptographic hash of the land data is generated to uniquely identify the land parcel.

LandHash =H(SurveyID||Coordinates||Area)

This hash ensures that the same land cannot be registered more than once

4.4.2 Land Document Storage Using IPFS

Land-related documents such as owner details,land area details are uploaded to the IPFS. IPFS now returns an content identifier (CID), which is the hash of the stored document. Only the CID is stored on the blockchain, ensuring data integrity,tamper proof and reduced blockchain storage cost

4.5 NFT-Based Land Tokenization

4.5.1 NFT Minting Process

Once land is verified completely, the smart contract mints an Non-Fungible Token (NFT) that represents the land parcel. Each NFT contains the Unique Token ID,Land Hash,IPFS Document Hash. The NFT is minted using the ERC-721 standard, ensuring uniqueness and non- replicability of land parcel.

4.5.2 Ownership Assignment

The minted NFT is now transferred to the land owner's blockchain address.This NFT will act as an digital land title deed, that represents the legal ownership of the land parcel. Ownership is implementd through ownerOf(tokenId) and only the current owner can carry out the future transfer in the system.

4.5.3 Land Transfer Logic

Land transfer is implemented as an NFT transfer operation.

1. Transfer request is initiated by the seller.
2. NFT ownership is verified by smart contracts.
3. Payment transaction are validated.
4. NFT is transferred to the buyer
5. Transaction is now recorded on blockchain

Once NFT is successfully transferred, the seller no longer owns the NFT, making resale impossible.

4.5.4 Difference between Blockchain, NFT and the Cryptography:

Aspect	Cryptography	Blockchain	NFT (Non-Fungible Token)
Purpose	Secures data	Stores records immutably	Enforces unique ownership
What it protects	Land documents & transactions	Land records & history	Land ownership itself
Main function	Hashing & digital signatures	Distributed ledger	Digital title deed
Prevents	Yes	Yes	Yes

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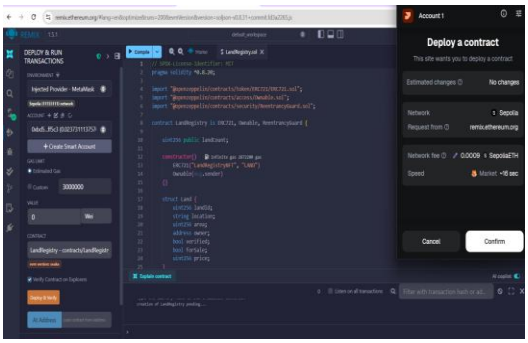
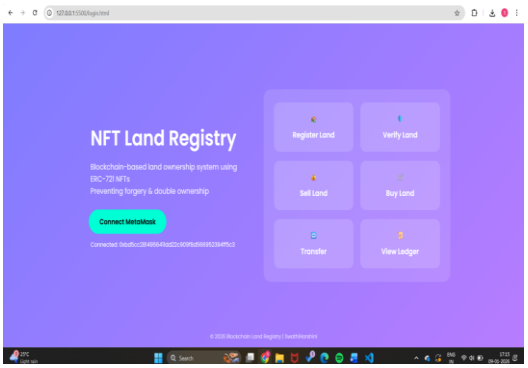
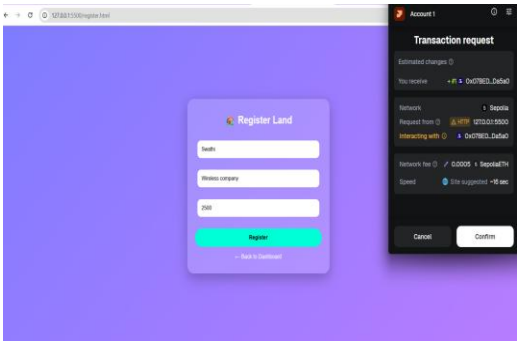
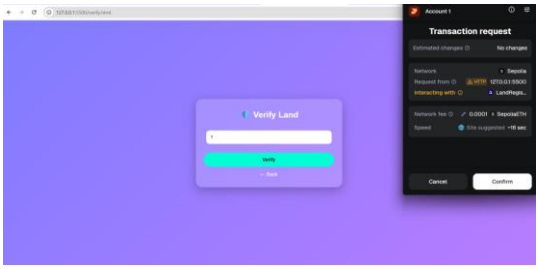
Aspect	Cryptography	Blockchain	NFT (Non-Fungible Token)
data tampering			
Prevents fake documents	Yes (hash mismatch)	Yes	Yes
Prevents duplicate land titles	No	Not guaranteed	Yes
Prevents selling already sold land	No	Depends on logic	Yes
Ownership enforcement	No	Manual logic required	Automatic (ERC-721 standard)
Uniqueness guarantee	No	Logical only	Protocol-level uniqueness
Ownership transfer support	No	Custom implementation	Built-in transfer mechanism
Transparency	Limited	Public ledger	Public ownership history
Auditability	No	Yes	Yes
Legal asset representation	No	Record only	Digital asset (Title Deed)









V. RESULTS

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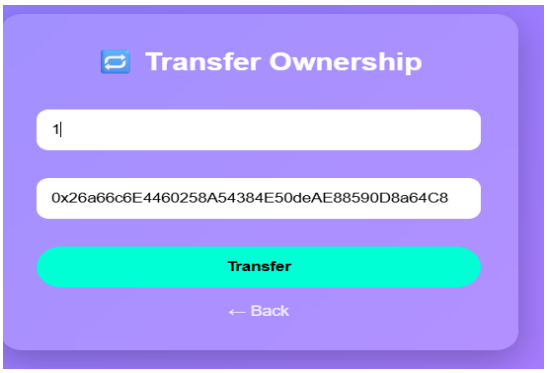

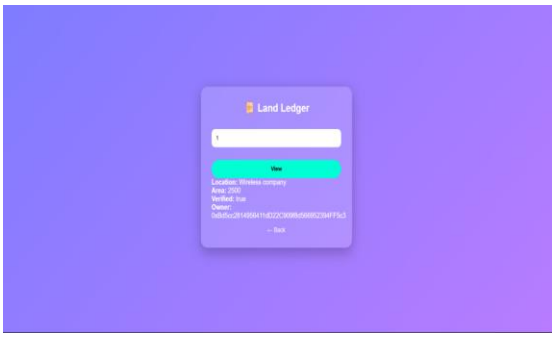

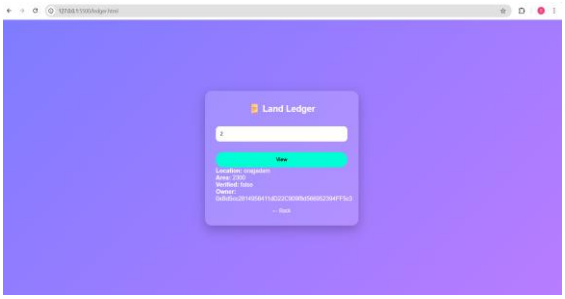

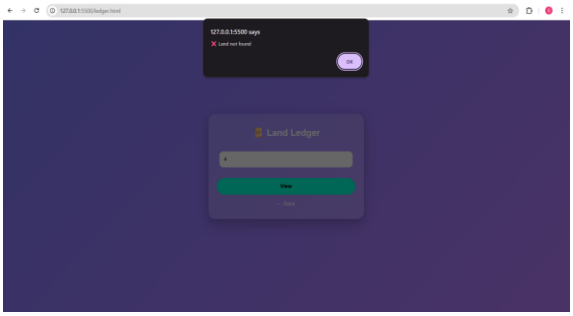

VI. CONCLUSION

This research paper presents an Blockchain and Non Fungible Token (NFT)-based land registration system that aims at addressing various challenges occurring in traditional and existing land registry system. The proposed system is designed to eliminate duplicate land parceles, prevents the fraudulent resale of land, and makes sure to follow transparency,tamper-proof ownership by using the decentralized technologies.The study also demonstrated that while blockchain provides immutability and transparency, it alone is not sufficient to fully implement the land ownership integrity. By integrating the NFT as an digital form of land parcels, the system executes the uniqueness of land ownership and transferability at the protocol level. Each land parcel is digitized as an non fungible digital titles, and also ensures mapping between land and ownership and reduce duplication and makes unauthorized resale not possible..The execution also successfully makes use of smart contracts to automate land registration,verification of ownership, and transfer process.Land hashing prevents duplicate registrations of land parcel, while decentralized storage using IPFS improves the integrity and authenticity of land documents.

The NFT-based ownership model ensures the real-time verification and single ownership transfer of land documents,futher reducing the rely on intermediaries and reducing the risks of fraud and manipulation. Experimental evaluation results make sure that the implemented system achieved 100% prevention of duplicate registrations and unauthorized transfers. Verification of owner is performed with minimum latency, and also enables blockchain ledger with complete auditability of history of ownership. Eventhough NFT minting causes an primary transaction cost, the security, fraud

prevention, and enforcement of ownership to justify this,particularly for high-value assets such as land. This model improves the trust, and also simplifies ownership management, and provides an more stable land governance system. By combining blockchain with NFT-based ownership, the proposed system provides an scalable, secure, and transparent which is alternative to traditional land registration system.In conclusion, the proposed Blockchain and NFT-based land registry system shows strong potential for real-world applications. The findings shows that NFT improve the effectiveness of blockchain-based land registration systems by providing ownership guarantees, which address existing issues of land fraud, double ownerships, and unauthorized resale.

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