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# Blockchain based Land Registry Management System

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A  
*Synopsis Report*  
*Submitted in Partial Fulfillment of the Requirements*  
*for the Degree*  
*of*  
**Bachelor Of Technology**

*by*

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## Preface

This project report is submitted in partial fulfillment of the requirements for the award of the degree of "Bachelor of Technology (Computer Science and Engineering)." The project report is prepared for the project completed during the course of B.Tech (CSE), 8th semester undertaken at the Institute of Engineering and Rural Technology, Prayagraj. The project report includes the study of currently running land registry systems and identifies their advantages as well as challenges. It then proposes a blockchain-based land registry management system to address some of these challenges. The purpose of this report is to compile under one cover a sufficient body of knowledge about the management and development of a successful project. The following quotes outline the basic idea behind this technical report. This report assembles various functions such as planning, organizing, designing, testing, and implementation of the "BLOCKCHAIN BASED LAND REGISTRY MANAGEMENT SYSTEM" developed during the training. This report is about the adaptation of project development techniques and reflects the practices and methods applied in this project.

## Acknowledgement

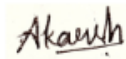
We would like to express my gratitude and appreciation to all those who gave us the possibility to complete this report. Special thanks is due to my supervisor Dr. Vimal Mishra and Dr.Rohit whose help, suggestions and encouragement helped us in all time of fabrication process and in writing this report. We also sincerely thanks for the time spent proofreading and correcting our many mistakes.

We would also like to acknowledge with much appreciation for the crucial role of my batch mates as well as the staff in Computer Science and Engineering department who allowed me to use the lab equipment and giving a permission to use all the tools in the laboratory.

## Declaration

We hereby declare that the project work entitled “BLOCKCHAIN BASED LAND REGISTRY MANAGEMENT SYSTEM” submitted to the Institute of Engineering and Rural Technology, Prayagraj, is a record of an original work done by us under the guidance of Dr. Rohit, Head of the Department of Computer Science & Engineering, Institute of Engineering and Rural Technology. This project work is submitted in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Computer Science & Engineering.

We also certify that this project has not previously been submitted for assessment in any academic capacity, and that we have not copied or otherwise plagiarized the work of other persons. We hereby confirm that we have taken reference from a YouTube channel- Dapp University for the establishment of some fundamental concepts. We confirm that we have identified and declared all possible conflicts that we may have. The results embodied in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.



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## Abstract

The process of storing and managing data related to land ownership transfers is termed land registry management. The recording of land ownership details and transactions is done in centralized databases, which are maintained by government agencies. The public can request the land records and search for information about specific properties or landowners. The conventional land registry management system faces challenges such as inefficiency, inaccuracies and susceptibility to fraud.

Blockchain technology can have a transformative impact on land registry management due to its immutable, transparent, and decentralized nature. The proposed system has implemented non-fungible tokens (NFTs) to represent different land assets. NFTs are digital assets that verify the validity of a unique item. NFTs provide unique and irreplaceable representations of attributes, which can be used for transfer ownership. Integrating NFTs into the land registry system improves security and efficiency for property transactions. This modern and technologically advanced solution addresses the challenges of traditional land registry administration systems.

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# Chapter 1

## Introduction

Land registry management is critical to real estate administration. The procedure includes recording and managing property ownership and transactions. A typical land registry management system provides a framework for registering and managing property rights. The land registry administration structure is based on established processes and rules, ensuring a consistent approach. Traditional land registration systems rely on manual processes to record land transactions and update ownership information[1]. Conventional approaches have various obstacles due to their manual nature. This leads to inefficiencies, delays, and inaccuracies in recording and processing transactions. Manual methods lead to inconsistencies in land records, making it harder to establish ownership. Furthermore, the integrity and security of land registry data are compromised due to centralized databases' tendency to fraud, corruption, and tampering[2]. Inadequate recordkeeping and transaction processing are just two of the many flaws in the traditional land registration administration system that can cause delays and administrative bottlenecks. Unfair property ownership rights could arise from restricted public accountability and transparency about land registration data. Furthermore, the accuracy and dependability of land registration data are jeopardized by the widespread fraud and corruption in conventional procedures. Physical records present data security risks because they can be lost, damaged, or accessed by unauthorized parties. The legal structure pertaining to land registry maintenance is intricate and demands a high level of expertise to navigate effectively [3]. Furthermore, attempts to create and modernize land register systems are hampered by resistance to change within long-standing bureaucratic structures.

Blockchain technology has the potential to transform land registry management[4]. Blockchain's immutability makes it a secure, transparent, and trustworthy platform for recording transactions. A blockchain-based land registry system keeps land records on a network of interconnected computers or nodes that authenticate and record transactions in a tamper-proof way.

In 2017, the Republic of Georgia established a blockchain-based land registration system that registers land ownership using the Bitcoin blockchain, boosting transparency and reducing the danger of corruption[5]. Similarly, Honduras, which has long plagued with corruption and insecurity in property title claims, has collaborated with Factom, a blockchain technology firm, to create a blockchain-based land registration system. This project aimed to eliminate corruption by utilizing blockchain's transparency, immutability, and decentralization. The transparent ledger makes all transactions and changes in land ownership clear and verifiable, eliminating the possibility of fraud. Immutability prevents changes or deletions to records, ensuring their accuracy and reliability. Decentralization distributes control over numerous nodes, making it more difficult for a single participant to alter records without being detected. With this collaboration, Honduras aims to prevent corruption while also improving the security and dependability of property ownership data[6].

Blockchain technology offers several significant features that make it ideal for improving land registration

administration[7]. For starters, its decentralized design eliminates the need for a central authority, lowering the risk of single-point failures or data manipulation. Second, blockchain technology ensures immutability. This means that once recorded, transactions cannot be altered. This blockchain technology ensures the accuracy of land records by lowering the possibility of fraud or illegal changes. The proposed blockchain-based land registration system uses NFTs to speed up ownership transfers by offering a secure, tamper-proof, and transparent environment. Each unit of land or property can be represented as an NFT[8]. It contains all necessary information, such as boundaries, ownership history, and legal status. It is simple to transfer this NFT between parties, and because the transaction is recorded on the blockchain, ownership records are updated in real time and are immutable. Smart contracts automate and enforce property transaction norms, reducing reliance on intermediaries and accelerating property rights transfers. This technology has the potential to transform property rights management by improving efficiency, transparency, and security in real estate transactions. Governments, businesses, and people are all looking into blockchain to improve land registry processes and overcome the drawbacks of traditional systems. To ensure seamless integration and general acceptability, legal, regulatory, and technical considerations must be carefully considered.



## Chapter 2

# Proposed Solution

The proposed solution for land registry management system using blockchain technology involves transitioning from traditional, paper-based methods to a decentralized, digital ledger system. NFTs will be used to digitalize the property assets and perform seamless transactions. By leveraging blockchain, each property transaction is recorded as a secure and immutable "block" on a distributed network, ensuring transparency and tamper-proof records. Smart contracts embedded within the blockchain can automate and enforce property transfer agreements. It also reduces reliance on intermediaries and fastens the process of transfer of ownership rights.

### 2.1 Scenarios

- **Uploading metadata to IPFS and NFT Minting-** Property minting as NFTs involves creating a unique digital token on a blockchain to represent a specific property. This process captures detailed information such as ownership, location, and identifiers, creating a secure digital representation of real-world assets.

Property details are uploaded to the InterPlanetary File System (IPFS), ensuring decentralized and immutable storage. This includes documents, images, and other relevant data.

- **Ownership Transfer-** Ownership transfer using NFTs enables secure property transactions on a blockchain. When a property's NFT is transferred, smart contracts automatically update ownership details, ensuring efficient and transparent transactions without intermediaries.

The NFT representing the property is transferred from the current owner to the new owner. This transfer is recorded on the blockchain, ensuring a transparent and immutable record.

Smart contracts automatically update ownership details during the transfer. This eliminates the need for intermediaries, reducing the potential for fraud and enhancing transaction efficiency.

## 2.2 Use Case Diagram

The use case diagrams given below illustrate the process of registering a property on the blockchain and transferring ownership. They depict interactions between users, such as property owners and the blockchain system, and detail steps like property verification, token creation (NFT), and ownership transfer via smart contracts.



Figure 2.1: Level-0 Use Case Diagram

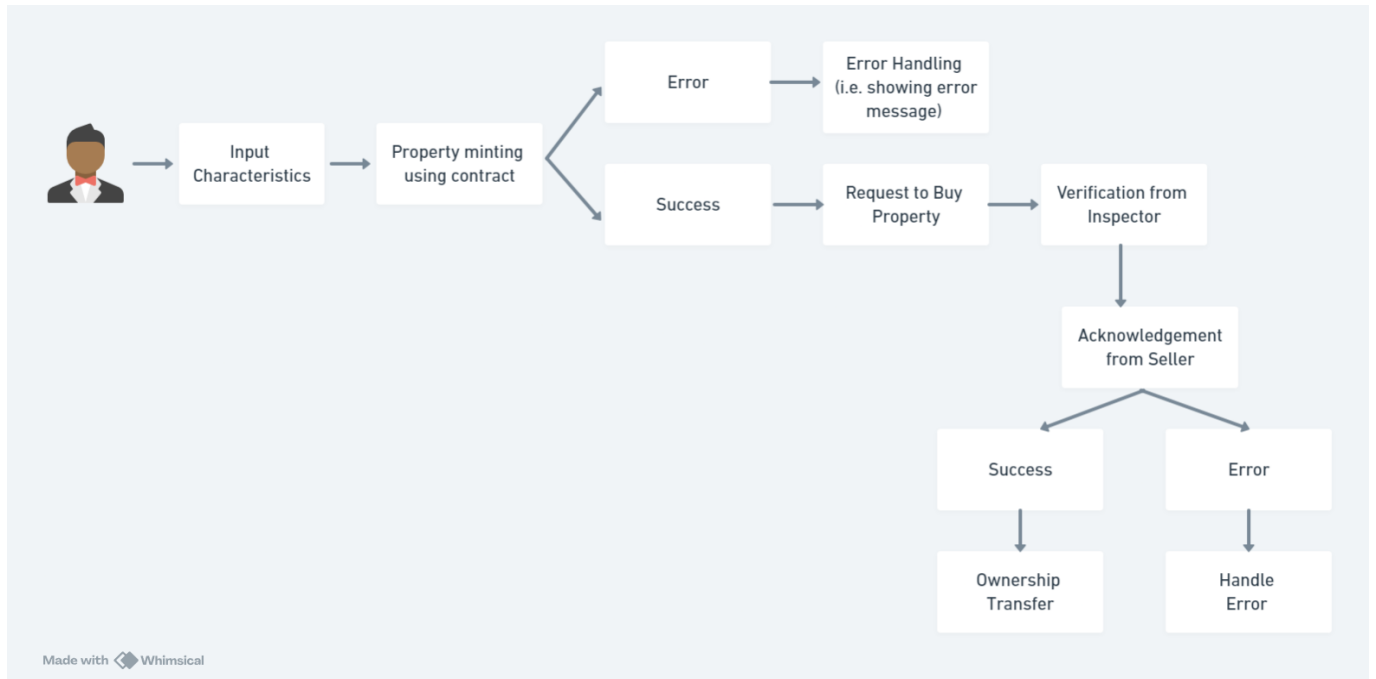


Figure 2.2: Level-2 Use Case Diagram

## 2.3 Architecture of Proposed System

The architecture diagram of the proposed system is shown in Figure 2.3. The explanation of the processes of the architecture diagram are given below :

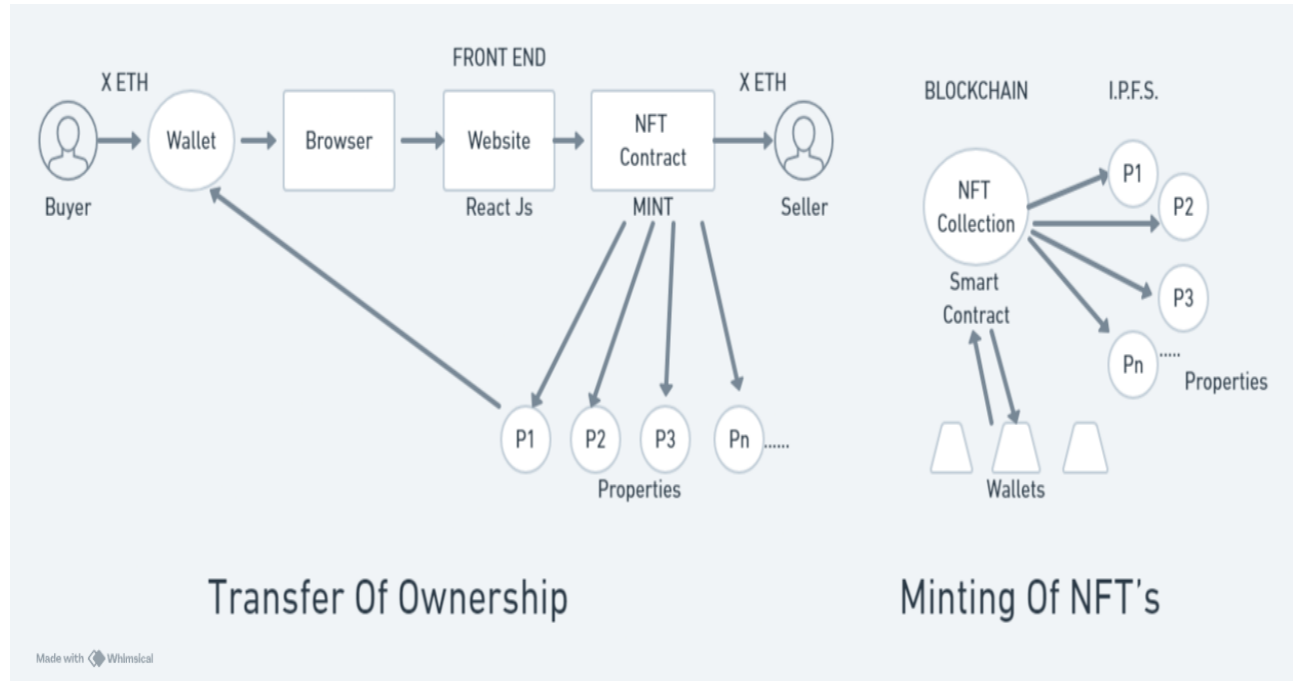


Figure 2.3: Comparison of vulnerability to data tampering in traditional vs decentralised database

- **Ownership Transfer using NFTs:** Ownership transfer using NFTs enables secure property transactions on a blockchain. When a property's NFT is transferred, smart contracts automatically update ownership details, ensuring efficient and transparent transactions without intermediaries. This process enhances traceability and security, reducing fraud in property transactions.
- **Property Minting as NFT:** Property minting as NFT involves creating a unique digital token on a blockchain to represent a specific property. This token captures property details like ownership, location, and identifiers, providing a secure digital representation of real-world assets.

## Chapter 3

# Implementation Of Proposed System

An outline of the implementation and algorithms is provided below. Key steps and processes are outlined to give a clear understanding of the approach.

### 3.1 Tools and technologies Used

In land registry management system using blockchain involves the use various tools and technologies. Here is the concise overview -

- React Js - React is particularly popular for creating single-page applications. It is basically a javascript library used to design frontend of a webapp[9].
- Metamask - MetaMask is a cryptocurrency wallet and browser extension that allows users to interact with decentralized applications (DApps) on the Ethereum blockchain[10].
- Ethereum - Ethereum is an open-source blockchain platform that enables the creation and deployment of decentralised applications[11].
- Hardhat - Hardhat is an open-source development environment and task runner tool for Ethereum smart contract development. It facilitates the creation, testing, and deployment of smart contracts on the Ethereum blockchain[12].
- IPFS - InterPlanetary File System is a decentralized protocol and network designed to create a peer-to-peer method of storing and sharing data in a distributed file system[13].

### 3.2 Functions Used

- transferFrom - The "transferFrom" function is often associated with the transfer of ownership rights from one party to another.
- updateInspectionStatus - The "updateInspectionStatus" function involves providing status updates on the inspection of the property. In the Land Registry Management System (LRMS), land inspectors or relevant authorities may use this function to update the inspection status of a property, indicating whether it meets the required standards or if further action is needed.

- approveSale - The "approveSale" function involves granting approval for the sale of a property. This action could be performed by relevant authorities, such as government agencies, after ensuring that all necessary conditions, verifications, and inspections have been successfully completed.
- finalizeSale - "finalizeSale" refers to completing the sale transaction. In the LRMS, this function may involve updating the ownership records on the blockchain, transferring funds, and finalizing legal aspects to conclude the property sale.

### 3.3 Algorithms

The algorithms of the key functions with their explanation are given below:

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#### Algorithm 1 Function For Finalizing Sale

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**Require:** NFT ID (`_nftID`)

**Ensure:** Success or failure message

```

1: Initialization:
2: Declare a function named finalizeSale to complete the sale transaction.
3:   Require Inspection Passed:
4: if inspectionPassed[_nftID]
5:   Require Buyer Approval:
6: if approval[_nftID][buyer[_nftID]]
7:   Require Seller Approval:
8: if approval[_nftID][seller]
9:   Check Sufficient Balance:
10: if address(this).balance  $\geq$  purchasePrice[_nftID]
11:   Update Listing Status:
12: Set isListed[_nftID] to false
13:   Transfer Payment to Seller:
14: (bool success, ) = payable(seller).call{value: address(this).balance}("")
15: if (success)
16:   Transfer NFT Ownership:
17: IERC721(nftAddress).transferFrom(address(this), buyer[_nftID], _nftID)

```

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**Explanation -** The Algorithm 1 takes the input as NFT\_Id of the property and checks whether the buyer has given their approval for the purchase, the seller has approved the sale, the contract has a sufficient balance to cover the purchase price of the NFT. If all these conditions will meet then it updates the listing status of the NFT to indicate that it is no longer available for sale and transfers the payment (in Ether) from the buyer to the seller and also transfers ownership of the NFT from the contract to the buyer .

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#### Algorithm 2 Function for minting a NFT

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**Require:** Token URI (`tokenURI`)

**Ensure:** ID of the minted NFT (`newItemId`)

1: **Function mint:**

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```

2: Input: tokenURI
3:   Increase the token ID counter
4: Get the current token ID (newItemId)
5:   Mint a new token with the current ID and assign ownership to the caller
6: Set the token URI for the newly minted token
7:   Return the ID of the newly minted token (newItemId)

```

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**Explanation** -The Algorithm 2 generates new Non-Fungible Token (NFT) by incrementing a token ID counter and assigning the current ID. It then allocates ownership to the caller, associates the token with a given URI, and returns the ID of the minted NFT, enabling the caller to access the unique identifier for the created token.

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### Algorithm 3 Function For Listing Property

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**Require:** NFT ID (*\_nftID*), Buyer Address (*\_buyer*), Purchase Price (*\_purchasePrice*), Escrow Amount (*\_escrowAmount*)

**Ensure:** Success or failure message

```

1: Function list:
2: Input: _nftID, _buyer, _purchasePrice, _escrowAmount
3: if onlySeller
4:   Transfer NFT from seller to this contract
5:   IERC721(nftAddress).transferFrom(msg.sender, address(this), _nftID)
6: Set isListed[_nftID] to true
7:   Set purchasePrice[_nftID] to _purchasePrice
8: Set escrowAmount[_nftID] to _escrowAmount
9:   Set buyer[_nftID] to _buyer

```

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**Explanation** -The "list" function facilitates the listing of a non-fungible token (NFT) for sale, identified by its unique NFT ID (*nftID*). The function then transfers the NFT from the seller to the smart contract, updates the listing status to true, sets the purchase price and escrow amount for the NFT. This process ensures transparency and clarity in the listing and sale of NFTs, enhancing the user experience and facilitating secure transactions.

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### Algorithm 4 Function For Update Inspection Status

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**Require:** NFT ID (*\_nftID*), Inspection Result (*\_passed*)

**Ensure:** Success or failure message

```

1: Function updateInspectionStatus:
2: Input: _nftID, _passed
3: if onlyInspector
4:   Set inspectionPassed[_nftID] to _passed

```

---

**Explanation** - The *updateInspectionStatus* function permits inspectors to update the inspection status of a given Non-Fungible Token (NFT). It verifies the caller's identity as an inspector, then updates the status of the specified NFT based on the inspection result. This mechanism ensures accurate and reliable tracking of inspection outcomes within the system.

## Chapter 4

# Observation

The land registry management system plays a pivotal role in establishing and maintaining property ownership rights. It also facilitates property transactions, and ensuring legal certainty in land- related matters. The paper has attempted to compare the existing land registry system with a blockchain-based land registry system, as shown in the table below :

Table 4.1: Comparison between traditional and Blockchain based land registry management system.

Basis	Traditional	Proposed system
Data Manag- ment	prone to manual errors (due to human actions during manual processes) and frauds	Blockchain based system(uses decentralized technology to securely record and verify asset ownership, improving transparency and reducing fraud.)
Data In- tegrity	Not Tamper Proof (Illustration of this observation shown in Figure 4.1)	Tamper Proof
Security	Centralised (Control and decision-making are concentrated in a single central authority)[14].	Decentralised (Control and decision-making are distributed across multiple nodes)
Data Verification	Not Fully Achieved (Paper-based records, limited oversight, contribute to the difficulty in achieving effective data verification)[15].	Achieved (By leveraging immutability, decentralization, transparency to enhance the reliability of land registry data)
Charges[16]	(7%-8%) approx. (Charges imposed by the government for property registration)	only some charges taken as a gas fees

The Figure 4.1 compares traditional databases and decentralized databases, focusing on their vulnerability to data tampering. The chances of data tampering in traditional database will be greater than 50% [17] as all the access and controls are in the hands of the administrator. But in decentralised database, the chances get reduced to 0% due to its immutable nature.

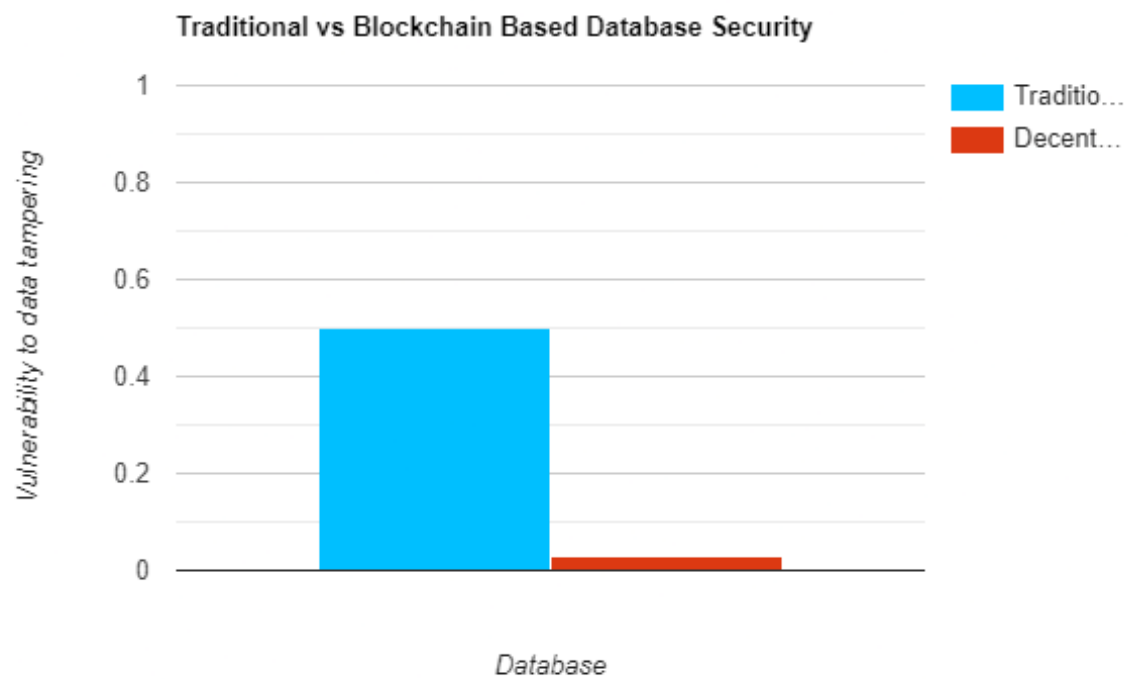


Figure 4.1: Comparison of vulnerability to data tampering in traditional vs decentralised database



## Chapter 5

# Conclusion

The paper has implemented a blockchain-based land registry system. It provides a strong substitute that leverages the properties of blockchain technology, such as decentralization, transparency, and immutability. The decentralization is being achieved by using a decentralized database, i.e., the Interplanetary File System. The digital representation of properties in the form of NFTs is enhancing security and facilitating seamless property transactions. Also resolving trust issues and settling the problem of double spending (the fraudulent act of selling or transferring the same piece of land to multiple buyers). It also guarantees accuracy, transparency, and reduces time delays simultaneously.

## Chapter 6

# Future Work

The proposed system may encounter scalability issues which can be handled using off-chaining. It refers to the use of separate blockchain networks that interact with the main chain to enhance scalability and functionality. It reduces congestion on the primary blockchain. Additionally, implementing features for tracking loans on different properties can also be a significant step towards enhancing financial transparency and should be a focus for future work. Another important area for future work is the development of an ownership transfer feature that allows for fractional ownership of a property, enabling multiple owners to hold shares in the same property.

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