Affiliated to Pokhara University

UNITED TECHNICAL COLLEGE

A Major Project Proposal

on

DECENTRALIZED LAND OWNERSHIP SYSTEM USING BLOCKCHAIN

[Code No: CMP 490]

(For partial fulfillment of 8th Semester in Computer Engineering)

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Submitted to

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January 24, 2025

Abstract

The Decentralized Land Ownership System Using Blockchain (DLOSUB) outlines the development of a decentralized land ownership management system utilizing blockchain technology to address the significant challenges faced by traditional land registration systems. Current systems are often plagued by issues such as fraud, inefficiencies, lack of transparency, and high transaction costs, which undermine trust and accessibility for individuals, particularly marginalized communities. By leveraging blockchain's inherent characteristics security, transparency, and immutability this project aims to create a tamper-proof digital ledger for land ownership records, streamline transaction processes through smart contracts, and enhance user accessibility without the need for intermediaries. The proposed system will integrate existing land records, ensuring secure ownership verification and reducing fraudulent claims. Through pilot testing and stakeholder engagement, the project seeks to evaluate its effectiveness in improving land management practices. Ultimately, this initiative aspires to empower individuals with secure proof of ownership, foster trust among stakeholders, and promote equitable access to land resources, contributing to social stability and economic growth. The successful implementation of this decentralized framework will serve as a model for future innovations in land management, addressing the growing global demand for secure land tenure.

Keywords: *Decentralized Land Ownership System, Blockchain, Transparency, Smart Contracts, Ownership Verification.*

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Acronyms and Abbreviation

ACL	Access Control List
CSS	Cascading Style Sheet
DApp	Decentralized Application
DLOSUB	Decentralized Land Ownership System Using Blockchain
EVM	Ethereum Virtual Machine
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
IPFS	InterPlanetary File System
JS	JavaScript
MySQL	My Structured Query Language
NPM	Node Package Manager
OECD	Organisation for Economic Co-operation and Development
QR Code	Quick Response Code
RDBMS	Relational Database Management System
RFID	Radio-Frequency Identification
SaaS	Software as a Service
VS Code	Visual Studio Code

Chapter 1: Introduction

1.1 Background

Land ownership is a critical asset for individuals and communities, serving as a foundation for economic stability and social development. However, traditional land registry systems, often paper-based or centralized, face numerous challenges, including fraud, incomplete records, and inefficiencies in ownership transfers. These shortcomings lead to disputes, lengthy litigation, and significant economic loss [1].

The field of land ownership management is undergoing a significant transformation, driven by advancements in technology, particularly blockchain. Recent developments have highlighted the potential of decentralized systems to enhance the security, transparency, and efficiency of land registration processes. Countries such as Sweden, Georgia, and India have initiated pilot projects that leverage blockchain technology to create tamper-proof land registries. These projects aim to eliminate the inefficiencies associated with traditional paper-based systems, which are often plagued by issues such as fraud, bureaucratic delays, and lack of accessibility. By utilizing blockchain, these initiatives provide a secure digital ledger that records all transactions related to land ownership, ensuring that each transfer is verifiable and traceable [2].

Despite the promising advancements, existing land registration systems still face significant drawbacks. Many traditional systems are centralized, making them vulnerable to corruption and manipulation. The reliance on intermediaries, such as notaries and brokers, not only increases transaction costs but also introduces opportunities for fraud. Furthermore, the lack of interoperability between different land registries can lead to discrepancies and disputes over ownership, particularly in regions where land is frequently bought and sold. These challenges underscore the need for a more robust and integrated approach to land management that can address the limitations of existing systems [3].

The significance of developing a decentralized land ownership system using blockchain technology cannot be overstated. Such a system has the potential to empower individuals by providing them with secure and verifiable proof of ownership, thereby enhancing their access to credit and economic opportunities. Additionally, by reducing the need for intermediaries, the system can lower transaction costs and streamline the registration process, making it more efficient for all parties involved. As the global demand for secure land tenure continues to grow, the implementation of blockchain-based solutions represents a critical step towards creating a more equitable and transparent land management framework that can benefit communities and economies alike [4].

1.2 Problem Statement

The management of land ownership faces significant challenges that undermine the effectiveness of traditional land registration systems. These systems, primarily reliant on paper-based documentation, are time-consuming and highly susceptible to fraud and manipulation. The lack of transparency often leads to disputes over land titles, resulting in lengthy legal battles that consume valuable time and resources. Fraudulent activities, such as document forgery and unauthorized alterations of ownership records, create an environment of mistrust among stakeholders, complicating the verification of ownership and the transfer of land titles [5].

Moreover, the involvement of intermediaries, such as brokers and notaries, increases transaction costs and complicates the process, making it less accessible for individuals, particularly those from marginalized communities. These intermediaries often act as gatekeepers, deterring potential buyers and sellers due to high costs and bureaucratic hurdles. Additionally, existing land registries frequently lack transparency, making it difficult for individuals to verify ownership and access land records. This lack of accessibility can lead to disputes and further erode trust in the system, underscoring the need for a more efficient and reliable approach to land ownership management [6]. The major problems in land ownership today's world are:

1. **Fraud and Manipulation:** Traditional land registration systems are vulnerable to fraudulent activities, including document forgery and unauthorized alterations of ownership records.

2. **Inefficiencies in Registration Processes:** The bureaucratic nature of current land registration systems often results in delays and inefficiencies, making the process cumbersome and time-consuming.

3. **Lack of Transparency and Accessibility:** Existing land registries frequently lack transparency, making it difficult for individuals to verify ownership and access land records, which can lead to disputes and mistrust among stakeholders.
4. **High Transaction Costs:** The involvement of intermediaries, such as brokers and notaries, increases transaction costs and complicates the land transfer process, making it less accessible for individuals, especially those from marginalized communities.

1.3 Objectives

This project aims to address the challenges of traditional land management systems by focusing on these key objectives, ultimately leading to a more efficient and reliable approach to land ownership. The following are the specific objectives of our project:

1. To provide tamper-proof and publicly verifiable land ownership records using blockchain.
2. To eliminate duplicate claims and ensure secure ownership with cryptographic authentication.
3. To streamline and automate land transactions with cost-effective smart contracts.

1.4 Motivation and Significance

This project addresses inefficiencies and fraud in traditional land ownership by leveraging blockchain's decentralized, secure, and transparent framework. It aims to provide a user-friendly platform using technologies like smart contracts, and decentralized identity (DID) to resolve key challenges. The motivation for developing a decentralized land ownership system using blockchain technology stems from the need to address the inefficiencies and vulnerabilities of traditional land registration systems. As populations grow and urbanization increases, secure and transparent land management is essential. This project aims to empower individuals with secure proof of ownership, enhancing access to economic opportunities and promoting social equity.

The significance of this project lies in its potential to transform communities and economies. A reliable land ownership system can stimulate investment, encourage responsible land use, and attract both local and foreign investments, contributing to economic growth. By fostering trust among stakeholders, the project can also help mitigate conflicts over land ownership, ultimately advancing social stability and equity in land tenure.

1.5 Scope and Limitations of the Work

The scope of this project encompasses the development and implementation of a decentralized land ownership management system utilizing blockchain technology. Key components include:

1. **System Design and Development**: Creating a user-friendly blockchain platform for secure land registration and transaction processing, including smart contracts.
2. **Data Integration**: Collaborating with existing land registries to integrate current land records into the blockchain system.
3. **User Accessibility**: Ensuring the platform is accessible to landowners, buyers, sellers, and government officials for easy verification of ownership.
4. **Security Measures**: Implementing robust security protocols to protect land records from unauthorized access and fraud.
5. **Stakeholder Engagement**: Involving local communities, government agencies, and legal experts to ensure the system meets user needs.
6. **Pilot Testing and Evaluation**: Conducting pilot tests in selected regions to evaluate functionality and gather feedback.
7. **Training and Support**: Providing training for users to facilitate adoption of the new system.

Boundaries and Limitations

1. **Geographic Scope**: Initial implementation will focus on specific regions, limiting applicability in areas with different legal frameworks.
2. **Regulatory Compliance**: The project must navigate varying legal requirements, which may impact design and functionality.
3. **Data Availability**: Success relies on the accuracy of existing land records; incomplete data may pose challenges.

4. **Technology Adoption**: Resistance to change or lack of digital literacy may limit user engagement.
5. **Funding and Resources**: Budget constraints may affect the scale and speed of implementation.

Chapter 2: Related Works

2.1 Overview of Existing System

The management of land ownership records has traditionally relied on centralized systems, which are often paper-based or utilize non-transparent digital databases. These conventional systems face challenges such as fraudulent ownership claims, inefficiencies in record verification, and disputes over land titles. Recent advancements have explored the use of blockchain technology to address these issues, offering a decentralized, secure, and transparent framework for land registry systems. Below are examples of existing systems that have been developed or proposed:

1. **Republic of Georgia Blockchain Land Registry**

   The Republic of Georgia partnered with Bitfury to develop a blockchain based land registry system. This system timestamps property transactions and stores them on a public blockchain, ensuring the authenticity and immutability of records. This system provides with transparent record keeping, reduced transaction costs, and verifiable ownership records. However, it initially relies on existing centralized data for the genesis blocks and faced limited scalability during implementation [7].

2. **Sweden Land Registry (Lantmäteriet)**

   Sweden's Lantmäteriet collaborated with ChromaWay to test blockchain for land title transfers. The system integrates digital signatures and smart contracts to streamline transactions. Smart contracts for automated processes, reduced time for property transactions, and enhanced data integrity. However, the initiative faced challenges, including high implementation costs and reliance on stakeholder collaboration for successful data migration [8].

3. **India's Telangana Blockchain Pilot**

   The Indian state of Telangana initiated a blockchain pilot for land record management, leveraging Ethereum for decentralized record storage. The system features decentralized storage, tamper-proof records, and integration with government services, ensuring greater transparency and security. However, the pilot faces challenges in scaling due to the state's large population and existing bureaucratic hurdles, which complicate the widespread adoption and implementation of the system [9].

4. **Ghana's Bitland Project**

Bitland uses blockchain to create a digital ledger for land transactions, targeting areas with weak property rights infrastructure. The system offers accessible records for underprivileged communities, helps reduce corruption, and simplifies dispute resolution. However, Bitland faces drawbacks such as limited funding and significant infrastructural challenges, which hinder its full implementation and expansion[10].

2.2 Comparison of Features

Table 1: Comparison of existing systems

System	Features	Drawbacks
Republic of Georgia	-Public blockchain, timestamps, verifiable records -Transparency, cost efficiency	-Initial Reliance on centralized data
Sweden's Lantmäteriet	-Utilization of smart contracts and digital signatures -Reduction of transaction time -Integrity of data	-High implementation cost -Dependence on stakeholder for data migration
India's Telangana Pilot	-Secured, tamper-resistant records	-Difficult to scale due to large population
Ghana's Bitland	-Blockchain ledger for underprivileged communities - Transparency resulting in reduction of corruption	- Infrastructural challenges and limited funding

2.3 Gaps in Existing System

Despite the advancements in blockchain based land registry systems, several gaps remain:

- **Integration Challenges**: Transitioning from legacy systems to blockchain requires significant effort, especially in digitizing and verifying historical records.

- **Scalability**: Many existing systems struggle to handle a large volume of transactions, particularly in populous regions.
- **Accessibility**: While blockchain increases transparency, its implementation often requires internet access and digital literacy, which may not be feasible in remote areas.
- **Fraud Prevention**: Although blockchain is tamper-proof, initial data entry errors or fraud during genesis block creation can propagate through the system.
- **Cost**: High setup costs and the need for specialized expertise deter widespread adoption.

2.4 Significance of Proposed Work

The proposed decentralized land ownership system aims to address the limitations identified in existing systems:

- **Improved Scalability**: Leveraging advanced consensus mechanisms to ensure efficient handling of high transaction volumes.
- **Enhanced Accessibility**: Integrating mobile and offline verification methods to include users in remote or underdeveloped areas.
- **Data Integrity**: Incorporating multi-layer verification for initial data entry to ensure the authenticity of records.
- **Cost Efficiency**: Utilizing open source blockchain platforms and optimized protocols to reduce implementation costs.
- **Interoperability**: Ensuring compatibility with existing government systems to streamline data migration and future updates.

By addressing these gaps, the proposed system aims to create a reliable, secure, and user-friendly framework for land ownership management, drawing inspiration from advancements in blockchain based systems such as those implemented in Georgia and Sweden. These systems demonstrate the potential for increased transparency and efficiency but also reveal gaps in scalability and integration that this project seeks to improve upon., ensuring transparency and trust among all stakeholders.

Chapter 3: Methodology

Methodology refers to the comprehensive structure of principles, methodologies, and protocols employed in a specific field of study or research. It encompasses the organized approach used to gather, analyze, and interpret data, as well as the methods and instruments employed to address research inquiries or resolve issues within a particular discipline [11].

3.1 Requirements Gathering

The objective of this phase is to identify and document the technical and functional requirements for the decentralized land ownership system using blockchain. To achieve this, a literature review will be conducted on case studies of blockchain based land ownership systems. This review will help analyse the technical specifications of existing decentralized systems, identifying gaps and opportunities for improvement. A requirement analysis will also be performed to define the core system functionalities based on the project objectives, mapping out user needs and system constraints through theoretical analysis. The requirements will be documented using collaboration tools such as Microsoft Word, while findings will be systematically organized in spreadsheets for easy reference.

3.2 System Design

The decentralized land ownership system is designed with a robust framework leveraging blockchain technology to ensure transparency, security, and immutability of land ownership records. Key components include a user authentication module for secure registration of landowners using multi-factor authentication, and a permissioned blockchain network to securely store and manage ownership data, allowing only authorized entities to access or modify records. Smart contracts automate processes such as transferring ownership, verifying titles, and executing transactions, ensuring tamper-proof operations. A user-friendly web application serves as the primary interface for landowners, authorities, and stakeholders to interact with the system, check ownership status, initiate transfers, and view transaction history. To support development, system architecture diagrams are created using draw.io, and user interface prototypes are designed using Figma to visualize and refine the platform's design. This comprehensive approach ensures a streamlined and secure land registration and ownership management process.

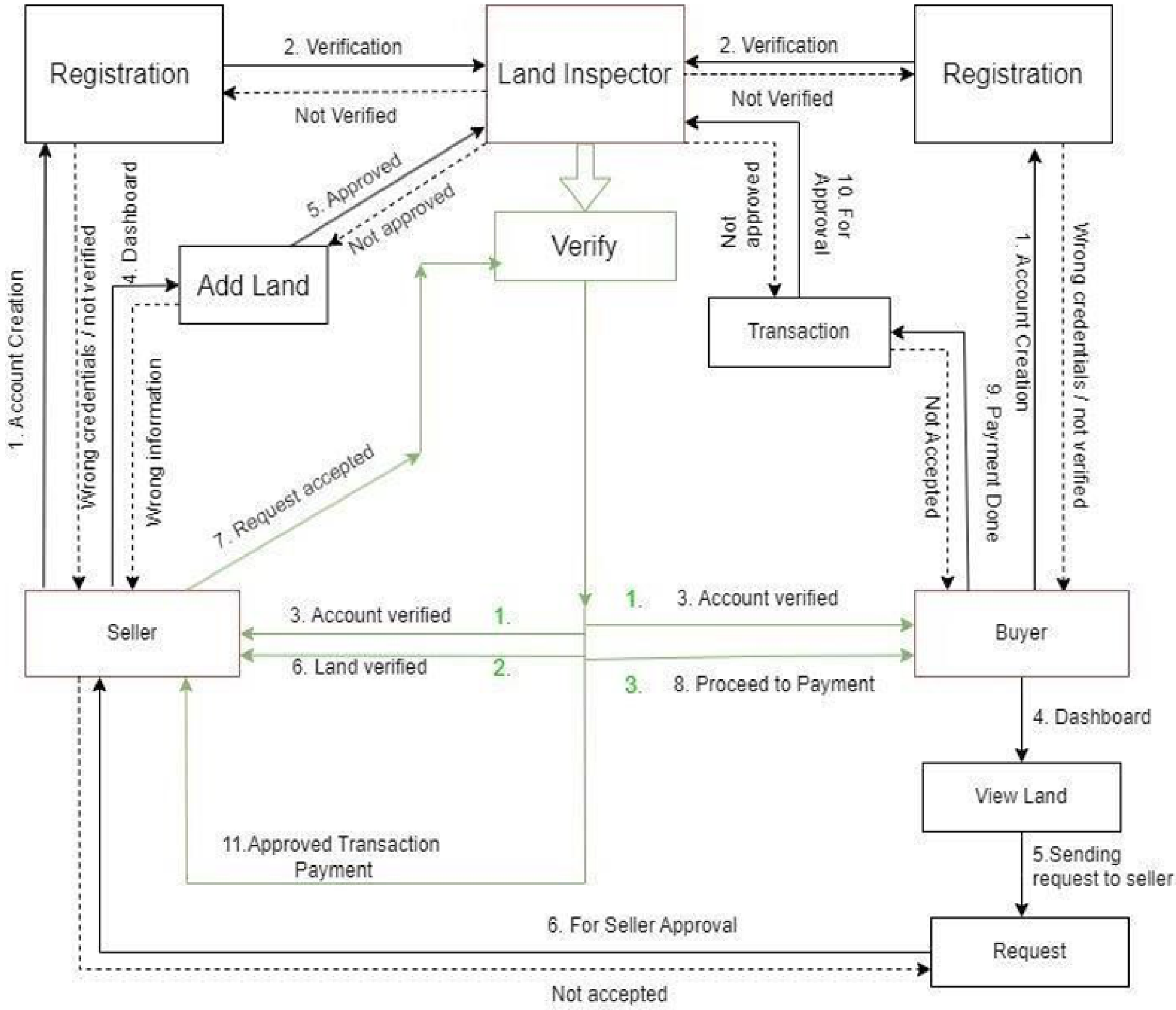

Figure3.1 System Flow Diagram of DLOSUB (Group Study, 2025)

3.3 Technology Stack

- **Backend:**

  Python (Flask/Django) for handling API logic and communication with the blockchain.

- **Frontend:**

  HTML, CSS, JavaScript (with optional frameworks like React.js for better UI/UX). Tailwind CSS for streamlined and utility first styling.

- **Blockchain:**

  Ethereum (or other blockchain platforms like Polygon, Binance Smart Chain) with smart contracts written in Solidity.

- **Database:**
  IPFS (InterPlanetary File System) for decentralized storage and MySQL or PostgreSQL for auxiliary data storage.
- **Wallet Integration:**
  MetaMask for connecting users to the blockchain, enabling secure authentication and transaction execution directly within the system.
- **Smart Contact Security**
  MythX for security analysis of smart contracts, utilizing symbolic execution and fuzzing techniques to detect vulnerabilities.

- **Development Tools:**

  - **Node.js** for building scalable and high performance server side applications.
  - **Express.js** for creating robust APIs and web applications.
  - **VS Code** as a lightweight and customizable source code editor.

3.4 Development Process

Approach: This project will adopt the Agile methodology for iterative development, enabling flexibility and continuous delivery of valuable features. Agile focuses on

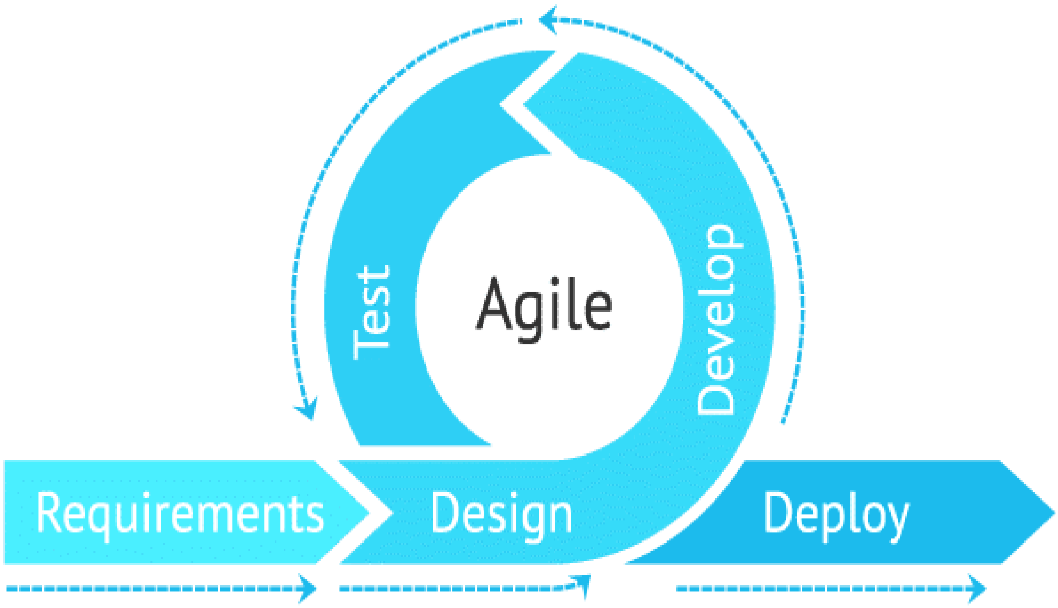

Figure 3.2 Agile Development Approach (Group Study, 2025)

breaking the project into smaller, manageable tasks, called sprints, typically lasting 2-

4 weeks. This allows the team to prioritize and complete high value features such as secure landowner registration, blockchain integration, and smart contract automation in each sprint. After each sprint, the team will review the progress with stakeholders and gather feedback, which will be incorporated into the next sprint. This iterative approach ensures that the project evolves in line with user needs and adapts to any emerging requirements or issues. Regular testing will be integrated within each sprint to ensure high quality standards, and adjustments will be made based on feedback, minimizing risks and optimizing the development process throughout the project lifecycle.

Version Control: **Git** will be used for version control to manage code changes efficiently. GitHub will serve as the central repository, ensuring easy collaboration, version tracking, and branching for different features or bug fixes. This will also provide a history of changes and allow rollbacks if necessary.

Collaboration and Task Management: **GitHub Projects** will be used to organize and monitor tasks. These tools help in visualizing the project timeline, assigning tasks, setting priorities, and tracking progress. They allow the team to maintain focus on high priority features, manage sprints, and ensure clear communication between developers, testers, and stakeholders.

Chapter 4: Expected Outcome

The Decentralized Land Ownership System Utilizing Blockchain (DLOSUB) technology aims to achieve the following specific, measurable, achievable, relevant, and time-bound (SMART) outcomes:

1. **Tamper-Proof Land Records**: The system will provide a secure, tamper-proof digital ledger for land ownership records.
2. **Reduction in Fraudulent Claims**: The project aims to reduce fraudulent ownership claims assessed by monitoring reported disputes before and after implementation.
3. **Streamlined Transaction Processes**: Smart contracts are expected to decrease transaction time.
4. **Increased Accessibility**: Users, including marginalized communities, will be able to access and verify land ownership records without intermediaries, evaluated through user surveys during pilot testing.

By achieving these outcomes, the project will enhance the efficiency, security, and transparency of land ownership management, addressing critical challenges in traditional systems and promoting equitable access to land resources.

Chapter 5: Conclusion

In conclusion, the proposed decentralized land ownership management system utilizing blockchain technology represents a transformative approach to addressing the longstanding challenges faced by traditional land registration systems. By leveraging the inherent advantages of blockchain such as security, transparency, and immutability this project aims to create a more efficient and reliable framework for managing land ownership. The expected outcomes, including tamper-proof records, reduced fraudulent claims, streamlined transactions, and increased accessibility, highlight the potential for significant improvements in the land management landscape.

This initiative not only seeks to empower individuals with secure proof of ownership but also aims to foster trust among stakeholders, reduce transaction costs, and enhance overall economic opportunities. By addressing the critical issues of inefficiency, fraud, and lack of transparency, the project aligns with the growing global demand for secure land tenure and equitable access to land resources.

As we move forward with the implementation of this system, we anticipate that it will serve as a model for future innovations in land management, ultimately contributing to social stability, economic growth, and the promotion of equitable land rights for all. The successful execution of this project will pave the way for a more transparent and trustworthy land ownership framework, benefiting communities and economies alike.

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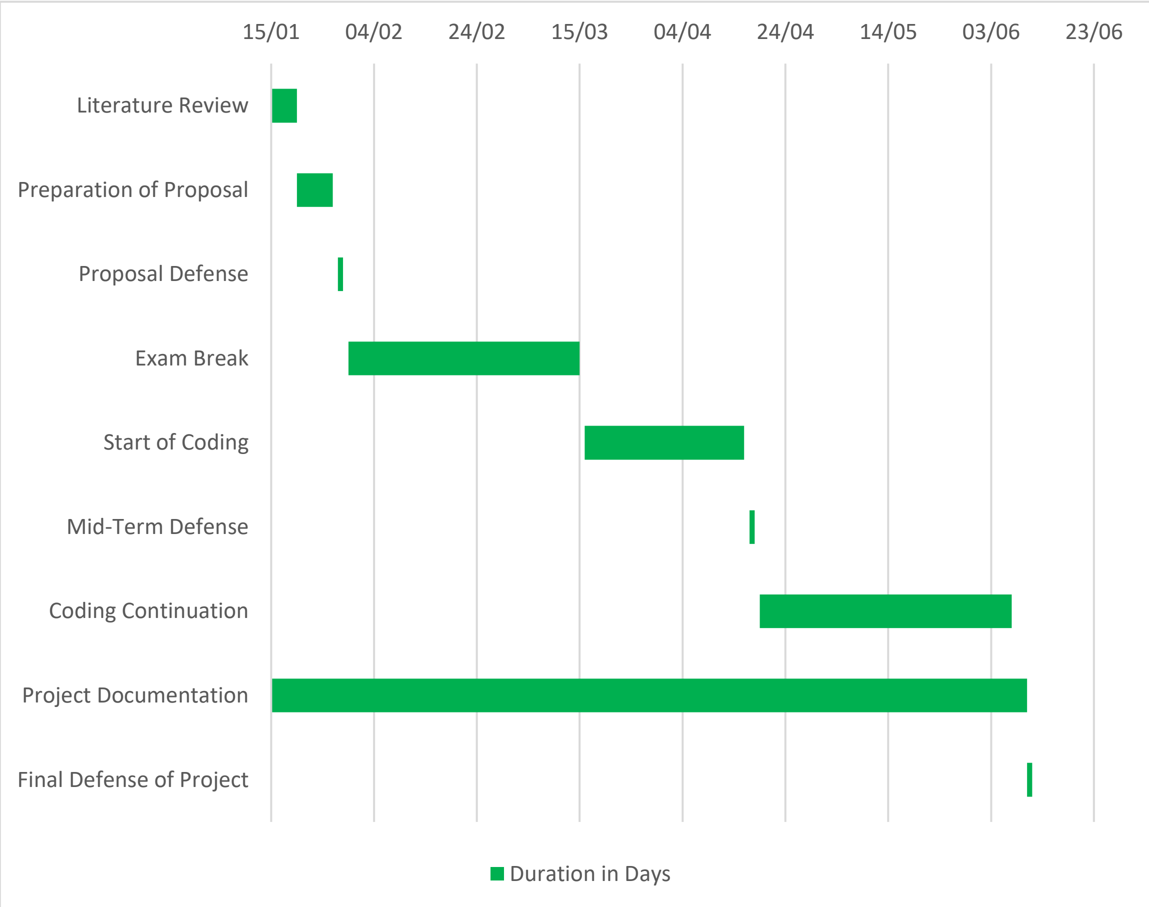
Appendices

Appendix A: Gantt Chart

Before getting started with any project, we must prepare a working schedule consisting of several topics that we would be working on throughout the project development phase. For the same reason,the following is the Gantt chart representing our work schedule in a total span of 8 months, i.e., 32 weeks ranging from the phase after proposal defense to final report submission and defense:

Table 2: Gantt Chart of the project



Appendix B: Cost Estimation

The budget estimation of our Decentralized Land Ownership System Using Blockchain (DLOSUB) is considered by various factors such as the scope of the project, the desired features and functionalities, the complexity of implementation, and any specific customization or integration requirements. Here's the table with the estimated cost range for our Decentralized Land Ownership System Using Blockchain (DLOSUB) project:

Table 3: Cost Estimation

Cost Element	Estimated Cost Range (NPR)
Infrastructure and Hosting	NPR 5,000 – NPR 10,000
Testing and Quality Assurance	NPR 5,000 – NPR 10,000
Training and Documentation	NPR 5,000 – NPR 10,000
Maintenance and Support	NPR 10,000 – NPR 25,000