香 港 大 學
THE UNIVERSITY OF HONG KONG

COMP4801 Final Year Project

Project Plan

Project Title: Blockchain-Based Land Registration System

Website Link

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1. Project Background

The current land registration system in Hong Kong is a deeds registration system, which is regulated by the Land Registration Ordinance (Cap. 128) (LRO). However, the Land Registration Ordinance (LRO) does not bestow validity upon an instrument when it is registered. Therefore, registering a person as the owner of a property in the land register does not ensure their legal ownership. The title to the property may contain uncertainties or defects, or another individual may have a claim to the property that is not reflected in the records maintained by the Land Registry (LR). Deeds for real property are often extensive, dating back to the 19th century, and are typically held by the seller or the bank that extended the mortgage. This creates a situation of asymmetric information, where the seller possesses more knowledge about the property's title than the buyer. Furthermore, the lack of an online registration system hinders the ability of buyers to easily examine and verify property titles, unlike in cities such as Beijing, Guangzhou, and Singapore, where land and property titles are registered and accessible online. Buyers need to engage solicitors to liaise with the seller and/or bank to inspect the title deed, adding to the cost and complexity of buying a home. This process often occurs after the buyer and seller have entered into the final sales agreement. Additionally, the legacy system of paper deeds no longer serves its purpose efficiently, posing challenges for secure storage, with some banks increasing fees or discontinuing the service altogether. These issues contribute to legal uncertainty and hinder the efficiency and transparency of the land registration system in Hong Kong. The Hong Kong government has not digitized the land registration system, which would reduce disputes, costs, and uncertainty, providing property buyers and sellers with peace of mind.

Numerous platforms are currently employed to establish dependable, decentralized, transparent, unchangeable, and safeguarded land registration and management systems using blockchain technology. Among these systems, smart contracts on the Ethereum blockchain have gained popularity. As a public blockchain platform, Ethereum enables broad participation in the blockchain ecosystem.

Efforts have been made to integrate land records with the emerging blockchain technology, aiming to enhance the security and maintenance of land data. In this context, the United Arab Emirates (UAE) took proactive steps and

devised a strategy to integrate blockchain into their projects. The Dubai Land Record Authority stands out as one of the initial government agencies to migrate its land titles onto the blockchain.

2. Project Objective

The objective of this project is to digitize and enhance the land registration system in Hong Kong by leveraging blockchain technology. The aim is to create a secure, transparent, and efficient platform that ensures reliable property ownership information, reduces legal uncertainties, and improves the overall buying and selling process.

The project will focus on achieving the following goals:

1. **Establish a Blockchain-based Land Registry:** Implement a decentralized blockchain network to serve as a digital land registry, storing and verifying land registration transactions securely and immutably. This will provide a reliable and tamper-proof record of property ownership.
2. **Automate Property Transactions:** Develop smart contracts using Algorand's Layer-1 smart contract capabilities written in TEAL. These contracts will automate the transfer of property ownership, ensuring secure and trusted transactions with built-in verification of transaction authenticity, owner authorization, and new owner acceptance.
3. **Improve Accessibility and Transparency:** Create a user-friendly frontend interface using React, allowing property buyers and sellers to easily view property details, initiate ownership transfer transactions, and verify transaction status. The interface will be responsive, ensuring accessibility across devices and providing a seamless user experience.
4. **Enhance Efficiency and Reduce Costs:** By digitizing the land registration system and automating property transactions, the project aims to streamline the buying and selling process. This will reduce the reliance on intermediaries, eliminate the need for physical document inspections, and lower costs associated with engaging solicitors. The system will provide peace of mind for property buyers and sellers, reducing legal uncertainties.

5. **Ensure Data Security and Privacy:** Implement robust encryption and cryptographic techniques to secure sensitive data stored on the blockchain. The decentralized nature of the blockchain network will enhance data security and privacy, reducing the risk of unauthorized access or manipulation.

3. Project Methodology

3.1 Equipment/Platform Setup

"This phase is synonymous with laying the foundation for a building."

The initial phase of the project involves the setup of our development environment. It involves the installation of indispensable software development tools and libraries, which act as the building blocks for our project. **React** is chosen for crafting the frontend due to its efficiency and flexibility, while **Node.js** or **Flask** will be used for backend development, based on the specific project needs. **Firebase** or **MySQL** will be adopted for database management, based on the scalability and performance requirements. For blockchain and smart contract development, we will use the **Algorand SDK** and **PyTEAL**, respectively, considering their robustness and wide adoption in the blockchain space. **Algorand Sandbox**, a Docker-based product, will also be set up to manage a local Algorand node, providing us with a controlled environment for development and testing.

3.2 System Architecture Design

The architecture of the system will be comprised of several key components:

- **Frontend:** The frontend will be developed using the React library, creating a user-friendly interface that communicates with the backend services.
- **Backend:** The backend, developed using Flask or Node.js, will handle user requests, execute transactions on the Algorand blockchain, and perform database operations.

- **Blockchain:** The Algorand blockchain network will be employed to store and verify land registration transactions. We will design smart contracts to automate the transfer of ownership.

3.3 User Interface Design

It focuses on creating an intuitive, user-friendly, and visually appealing interface developed using React. It will enable users to effortlessly view property details, initiate transactions for transferring ownership, and verify the status of these transactions. Clear instructions and feedback will be provided to users, making the interface easy to navigate. The design will be responsive, catering to users across various devices and screen sizes, thereby ensuring accessibility and a seamless user experience.

3.4 Smart Contract Design

- **Algorand Smart Contracts (ASC)** are a key feature of our project, they automate the process of property transactions, ensuring they are conducted in a secure, trusted and efficient manner.
- **Algorand's Layer-1** smart contracts, written in **TEAL** (Transaction Execution Approval Language), run atomically, preventing partial state changes. These contracts encode property transfer rules, verifying transaction authenticity, owner authorization, and new owner acceptance.
- **PyTEAL**, a Python language binding for TEAL, will be employed in this project to create a more developer-friendly smart contract writing experience. This phase is essential for automating blockchain property transactions, reducing errors, enhancing efficiency, and boosting the overall system's security and trust.

4. Project Schedule and Milestones

4.1 Tentative Project Timeline

We initiated the project in July, and our current focus is on research, a phase we've been actively engaged in since the project's inception. Over the month, we will continue our comprehensive research efforts, and try to narrow down the problems which we will actually be solving and the implementation of our project. Once this research phase concludes in October, we will transition into the implementation and innovation stage, where we'll define our project's scope and try to identify different strategies/approaches to solve our underlining problem. By December, we will be executing tasks according to our meticulously crafted project plan and closely monitoring progress. Testing and quality assurance activities will take place between January and February, ensuring the highest standards are met. In February, we'll shift our focus to finalization, documentation, and obtaining the necessary results. Finally, we plan to conclude the project in April, conducting a thorough review while wrapping up any remaining tasks and responsibilities.

4.2 Milestones and Deliverables

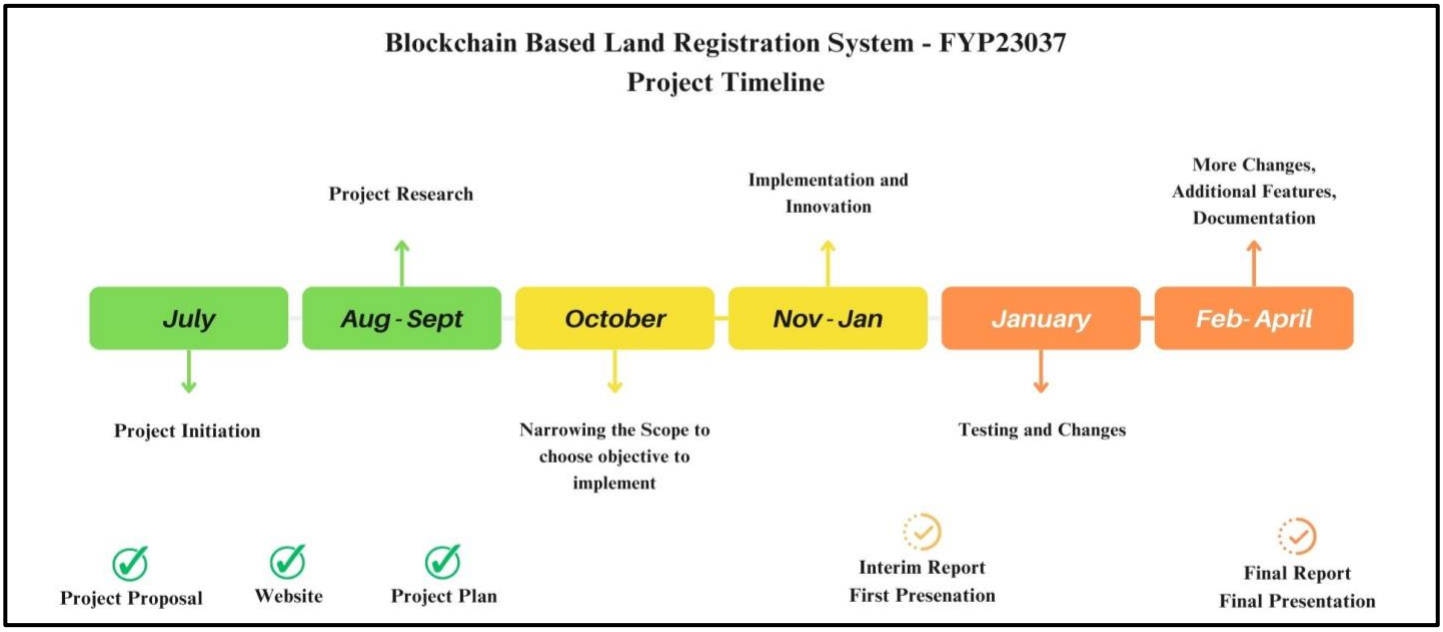

Figure 1 (above), shows the timeline for the implementation of the final year project. It also highlights the deliverables which need to be fulfilled by the given deadline.

5. Conclusion

5.1 Good Software Engineering Practices

1. **Requirements Analysis and Documentation**: In our project, we'll begin by conducting a comprehensive analysis of the requirements. We'll take the time to understand the project's needs thoroughly. This means gathering and documenting detailed requirements, including functional and non-functional aspects, user stories, and use cases.

2. **Version Control and Collaboration:** We understand the importance of effective collaboration and version control. To manage our project's source code, we'll implement a robust version control system like Git. We'll encourage disciplined version control practices, such as branching, merging, and code reviews.

3. **Testing and Quality Assurance:** Quality assurance will be a priority throughout our development process. We plan to follow testing best practices, including test-driven development (TDD) or behavior-driven development (BDD). Before writing code, we'll write tests to ensure that our software functions correctly. We'll establish a comprehensive suite of unit tests, integration tests, and end-to-end tests to validate the software's correctness.

By adhering to these practices, we believe that we can not only enhance the overall quality of our software but also streamline our development process, mitigate risks, and improve collaboration within our software engineering team.

5.2 Expected Outcomes and Benefits

1. Establish a Blockchain-based Land Registry

2. Automate Property Transactions and Improve Accessibility and Transparency

3. Enhance Efficiency and Reduce Costs

4. Ensure Data Security and Privacy

5.3 Future Scope and Recommendations

A blockchain based registration is the first step towards achieving tokenization in real estate assets. Whether real estate is commercial or residential, tokenization has several advantages such as smooth transfer, partial ownership and profit sharing. Real asset tokenization is a transformative financial innovation that leverages blockchain technology to represent ownership of physical assets, such as real estate, art, or commodities, as digital tokens. By converting these tangible assets into tokenized form, they become easily divisible, tradable, and accessible to a global audience of investors, thereby democratizing investment opportunities, and increasing liquidity in traditionally illiquid markets. Tokenization also offers benefits like reduced transaction costs, enhanced transparency through immutable blockchain ledgers, and the ability to automate various aspects of asset management, including dividend distribution and compliance. This evolution in the financial landscape holds the potential to unlock new avenues for asset ownership, investment diversification, and capital formation, ultimately reshaping the way we perceive and interact with real-world assets in the digital age. The challenge with tokenisation of real estate is the government and legal control over land. In our project, we are laying the founding stone of tokenization by working with the government to ensure real estate transactions and registration can be done on blockchain.

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