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Land Registration and Ownership Verification application using Blockchain

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Summary

Declaration of Authorship

This is to certify that the work presented in this project is the outcome of the analysis and experiments carried out by Nafis Ahmed, Md Masuk Al Hussain, Nowshadul Islam Nishad under the supervision of Assistant Professor MD. Moniruzzaman and Lecturer Faisal Hussein, Department of Computer Science and Engineering (CSE), Islamic University of Technology (IUT), Dhaka, Bangladesh. It is also declared that neither of this project nor any part of this project has been submitted anywhere else for any degree or diploma. Information derived from the published and unpublished work of others has been acknowledged in the text and a list of references is given.

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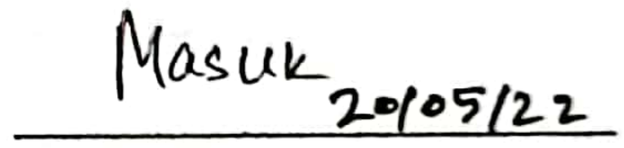

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The project titled **Land Registration and Ownership Verification using Blockchain** submitted by Nafis Ahmed, Md Masuk Al Hussain, Nowshadul Islam Nishad has been found as satisfactory and accepted.

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Abstract

Our project aims to explore the practicality of using Blockchain in the Land Registration Process and targets to prevent different fraudulent actions by verifying the Identity and Related Documents of the involved parties. In this report, we talk about the existing and proposed architecture of different research publications and analyze their usability on tackling the issues that we face in Bangladesh's process. But in our version of our project, we tend to make the whole procedure of registration and verification transparent and retain the integrity of the attested documents and information to prevent any sort of tampering.

Keywords: Blockchain, Land Registration, Fraudulent, Transparency

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Lastly to say that this project wouldn't have come to a fruition without the collective effort of the whole team, supervisors and other peers related to the development process.

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Chapter 1

Introduction

The term Blockchain has gained popularity due to the introduction of a decentralized currency system called Bitcoin. After gaining the spotlight, people have further studied the application of it in other domains. Blockchain is a chain of blocks that are linked cryptographically. These blocks are a growing list of records storing information like the block number, nonce (Number used only Once), timestamp, data, previous block hash and the hash of itself. For a block to be added in the chain certain conditions are to be met and these conditions are defined in the consensus algorithm. This algorithm is simply a protocol that creates or validates a new block or changes the data stored within the block after adhering to them. The blockchain is stored inside of a peer-to-peer network as a distributed ledger or records. The consensus protocol ensures that the ledger in every node of the network is not tampered with and recovers the ledger to the correct state if any node is attacked or has been tampered with. For having these mechanisms in the architecture, the blockchain technology has ensured security, transparency and fidelity in terms of storing data.

1.1 Motivation

Implementing Land or Property Registration Process using blockchain has been proposed in many countries aspect and in some countries it has been implemented too. Nations like Sweden [1], Honduras [2], Dubai [3] have planned to shift the land registration system to blockchain. While Sweden's project was taken up by Chromaway [4] in 2016 and successfully

implemented later. Even though Bangladesh has restrictions regarding using e-contract in land mutation, the government plans to move the registration process to blockchain by 2023; According to the National Blockchain Strategy of Bangladesh.

For moving Land Registration to Blockchain, processes like registration, mutation, verification of documents need to be integrated. Implementing Blockchain in the process would :

- Prevent Counterfeit of Records/Documents
- Prevent unauthorized Manipulation of Documents
- Prevent Socially Engineered Frauds
- Efficient and Faster Process
- Preservation of Records

1.2 Definitions and terminologies

Before moving on to further elaboration, here are some preliminary definitions necessary to understand the work.

1.2.1 Blockchain

Blockchain is a system of recording information in a way that makes it difficult or impossible to modify or hack the system. A blockchain is essentially a digital ledger of transactions that is duplicated and distributed across the entire network of computer systems on the blockchain. [5]

1.2.2 Distributed Ledger

A distributed ledger is a database that is consensually shared and synchronized across multiple sites, institutions, or geographies, accessible by multiple people [6]. The ledger itself is replicated and shared across the participant nodes of the network. Any updates will be reflected

on the copies shared over the network within a matter of seconds or minutes depending on the network. The transactions stored on these ledgers is publicly viewable to the participants.

1.2.3 Consensus Algorithm

A consensus algorithm is a process in computer science used to achieve agreement on a single data value among distributed processes or systems [7]. Consensus algorithms are designed to automate the validation and verification process of any changes on data in distributed/multi-agent systems or databases.

To accommodate this reality, consensus algorithms necessarily assume that some processes and systems will be unavailable and that some communications will be lost. As a result, consensus algorithms must be fault-tolerant. [8] On typical assumption, for example, that only a portion of nodes will respond but require a response from that portion, such as 51 percent, at a minimum.

There are numerous variations of consensus algorithms based on the practical usage in individual domains or systems, such as,

- Practical Byzantine Fault Tolerance (PBFT)
- Proof of Work (PoW)
- Proof of Stake (PoS)
- Proof of Burn (PoB)
- Proof of Elapsed Time (PoET)

Proof of Work

The intuition behind this algorithm is that the node which can solve a complex mathematical puzzle which requires a considerable amount of computational power; solve it before other competing nodes and then be verified by them has the privilege to append or mine the next block. It is computationally expensive and rewards the miner of the block with digital currency. Bitcoin uses this as their consensus algorithm

Proof of Stake

Adapted by the Ethereum blockchain it uses the miners or owners digital currency to use as collateral to validate the newly appended block. Here no expensive computational power is required, validation is done by the owner who has a larger stake and wallet balance on the network.

1.2.4 Public Key Infrastructure

A public key infrastructure (PKI) is a set of roles, policies, hardware, software and procedures needed to create, manage, distribute, use, store and revoke digital certificates and manage public-key encryption [9]. Ethereum blockchain network uses its own PKI to set a user's address, his private key and verification of incoming transactions through the public key of the transaction initiator.

1.2.5 Smart Contract

A smart contract is a computer program or a transaction protocol which is intended to automatically execute, control or document legally relevant events and actions according to the terms of a contract or an agreement [10]. Smart contracts are simply programs stored on a blockchain that run when predetermined conditions are met. [11] They typically are used to automate the execution of an agreement so that all participants can be immediately certain of the outcome, without any intermediary's involvement or time loss.

1.2.6 Transactions

Transaction in a blockchain can be described as transfer of currency affiliated with the network, while information is stored or modified in a newly appended block of the blockchain.

1.2.7 Token

[12] The term crypto token refers to a special virtual currency token or how cryptocurrencies are denominated. These tokens represent fungible and tradable assets or utilities that reside

on their own blockchains. Crypto tokens are often used to fundraise for crowd sales, but they can also serve as a substitute for other things. These tokens are usually created, distributed, sold, and circulated through the standard initial coin offering (ICO) process, which involves a crowdfunding exercise to fund project development.

1.2.8 Wallet

A cryptocurrency wallet is a device, physical medium, program or a service which stores the public and/or private keys for cryptocurrency transactions [13]

1.3 Framework and Tech Stacks

1.3.1 Frontend

Flutter

Flutter is Google's open source cross-platform UI development kit.

Web3

web3.js is a collection of libraries that allow you to interact with a local or remote ethereum node using HTTP, IPC or WebSocket.

Metamask

MetaMask is the trailblazing tool enabling user interactions and experience on Web3. It is currently available as a browser extension and as a mobile app on both Android and iOS devices. It makes it easier to build a dapp - decentralized app and test its transactions and functionalities.

1.3.2 Backend

Ethereum Blockchain

Ethereum is a decentralized open-source blockchain network that uses Proof of Stake consensus algorithm and adopts smart contract for the development of decentralized applications.

Solidity

Solidity is an object-oriented, high-level language for implementing smart contracts. Smart contracts are programs which govern the behaviour of accounts within the Ethereum state. Solidity is a curly-bracket language designed to target the Ethereum Virtual Machine (EVM). It is influenced by C++, Python and JavaScript. You can find more details about which languages Solidity has been inspired by in the language influences section. Solidity is statically typed, supports inheritance, libraries and complex user-defined types among other features.

Ganache

A part and a transaction testing tool of the truffle suite, Ganache is a personal blockchain for rapid Ethereum and Corda distributed application development. You can use Ganache across the entire development cycle; enabling you to develop, deploy, and test your dApps in a safe and deterministic environment. Ganache comes in two flavors: a UI and CLI. Ganache UI is a desktop application sup- porting both Ethereum and Corda technology. The command-line tool, ganache-cli (formerly known as the TestRPC), is available for Ethereum development.

Truffle

A development environment, testing framework and asset pipeline for blockchains using the Ethereum Virtual Machine (EVM), aiming to make life as a developer easier. With Truffle, you get:

- Built-in smart contract compilation, linking, deployment and binary management. Automated contract testing for rapid development.
- Scriptable, extensible deployment migrations framework.

- Network management for deploying to any number of public private networks.
- Package management with EthPM NPM, using the ERC190 standard.
- Interactive console for direct contract communication.
- Configurable build pipeline with support for tight integration.
- External script runner that executes scripts within a Truffle environment

IPFS

IPFS is a distributed system for storing and accessing files, websites, applications, and data. Making it possible to download a file from many locations that aren't managed by one organization: Supports a resilient internet. If someone attacks Wikipedia's web servers or an engineer at Wikipedia makes a big mistake that causes their servers to catch fire, you can still get the same webpages from somewhere else. Makes it harder to censor content. Because files on IPFS can come from many places, it's harder for anyone (whether they're states, corporations, or someone else) to block things. We hope IPFS can help provide ways to circumvent actions like these when they happen. Can speed up the web when you're far away or disconnected. If you can retrieve a file from someone nearby instead of hundreds or thousands of miles away, you can often get it faster. This is especially valuable if your community is networked locally but doesn't have a good connection to the wider internet. (Well-funded organizations with technical expertise do this today by using multiple data centers or CDNs — content distribution networks

1.4 Project Specifications

Based on our findings we assumed a basic requirements for the project specification. They are :

1. Secure SSH authentication
2. In-app crypto payment method

3. Multiple file or image upload for document verification

4. Mapping physical plot via 3rd party map services

5. Connection with other systems for document verification

6. Rerouting the documents to the corresponding officers or authority for formal verification

7. Creating an online video conference platform for virtual attendance of related party's before ownership transfer

8. Hashing the sensitive documents before storing on file system storage

1.5 Organization of the Documentation

This documentation is broken down into following chapters. Chapter 2 provides a literature review which covers various framework/architecture proposed by different authors. Chapter 3 describes the problem statement and Chapter 4 describes the proposed architecture of the project in detail. Chapter 5 presents the overview of the implementation process and the functionalities of the project. The final segment, chapter 6, which contains the conclusion of the project documentation with the summary and possible future improvements of our proposed approach.

Chapter 2

Literature Review

2.1 Reducing Forgery in Land Registry System using Blockchain

2.1.1 Overview

Forgery in the registration process is a very common sight in any government office and it's hard to prevent because there is no proper system and time-stamping in the normal database system.

Continuous time stamping and limited user access make the system more effective to prevent any kind of forgery. In this paper, the authors tried to establish a more secure system in this land registry system using private blockchain.

2.1.2 Procedure

In [14], along with a buyer and a seller there is also a third party included in this process who does the job of Proof of Work. When a seller wants to sell a land he/she has to submit a soft copy of his property to the registrar which should also be present in Digilocker. Seller also should have a hard copy of his properties. After getting a soft copy, the registrar has to convert this soft copy into a hash value to verify with the hash value of this document which is already present in blockchain. Buyer witnesses the verification process and if he/she does not become convinced he buys the land and the transaction process ends. But if the buyer becomes convinced the registrar transfers ownership from seller to buyer. Then the registrar

prepares a hard copy of this document and converts it into a soft copy then uploads into the database of the government. Lastly the registrar makes another hash value of this soft copy then uploads into the blockchain.

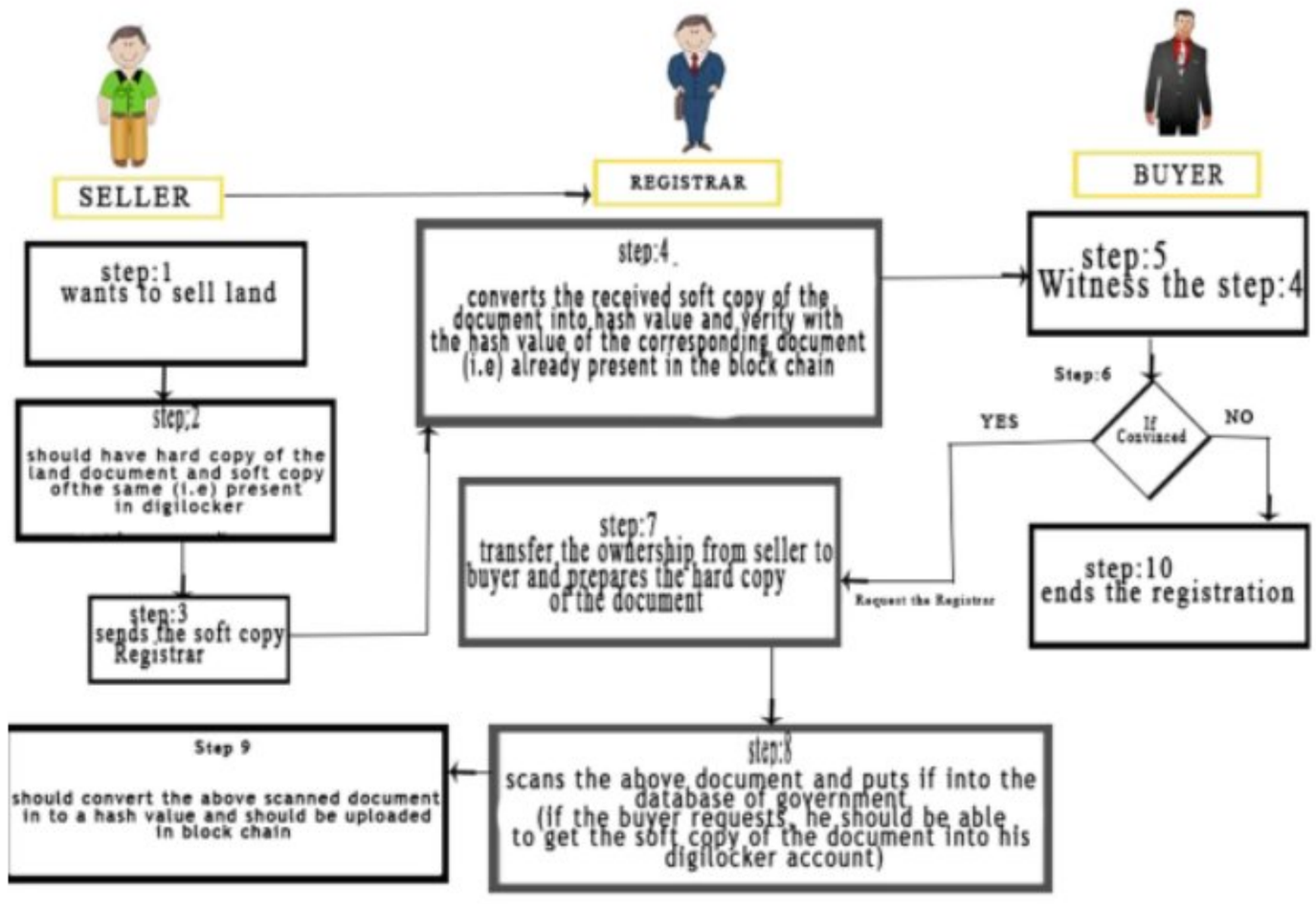

Figure 2.1: Proposed Architecture : Reducing Forgery in Land Registry System using Blockchain

2.1.3 Limitations

- Information concealment: Seller can hide information about land, he/she also can provide false information in that case buyers won't be able to understand anything.
- Corruption: Seller can bribe government officials which can cause corruption
- Lack of Authenticity: Only a soft copy of a property doesn't verify authenticity of this process.
- Time Consuming: Registrar work as third parties here. He/she does the job of creating hash value and uploading soft data into a digilocker manually. That's why the proposed process is time consuming.

2.2 A secured Land Registration Framework in Blockchain

2.2.1 Overview

In [15], they built a framework eliminating the involvement of a middleman during the registration and mutation process. The registration process depends on external national citizenship database there the user is authenticated by their personal identification. The buyer and seller can initiate a token by dual consensus. Thus, beginning a transaction. The mutation process is executed withing the application but the financial application happens with bank transaction.

2.2.2 Procedure

Here, a new user can acquire membership after registering and getting verified by the external system for personal identity verification. Interested buyer can initiate a smart contract with the plot owner to initiate a transaction. After the both parties comes to a consensus the transaction is validated and the blocks data is upgraded. The Government entity is a special class entity in the system that can revoke any transaction if any case of litigation is associated with the land or property. The whole system is distributed in the nodes of end user and government officials.

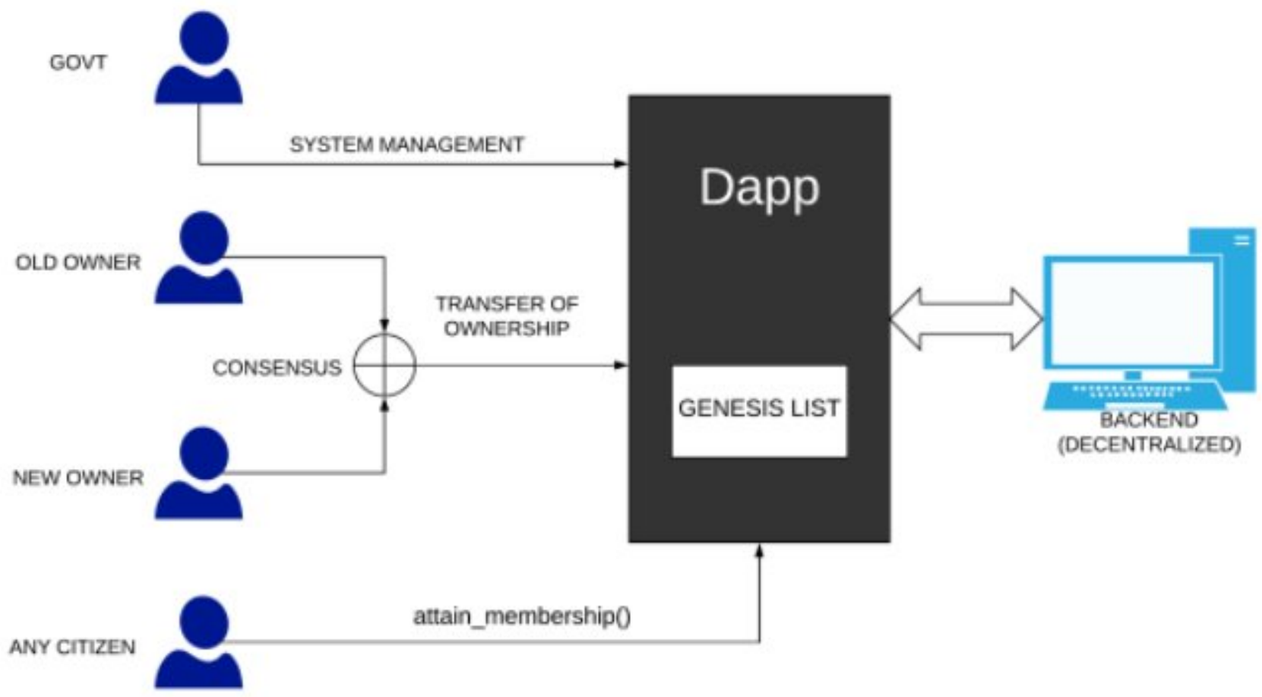

Figure 2.2: Proposed Architecture : A secured Land Registration Framework in Blockchain

2.2.3 Limitations

The limitation of the system is that it depends on many external system for verifying identity and documents. The system is not fully transparent as the user can't see any documents related to the land.

2.3 A Novel Framework for Implementation of Land Registration Ownership Management via Blockchain in Bangladesh

2.3.1 Overview

By building this framework authors tried to develop a digitized land registry system for a proper verification process and a decentralized system to prevent the process from forgery. A transparent system was also offered for ownership verification and a fraudulent free registration process.

2.3.2 Procedure

After the agreement between the buyer and seller, the transaction between the buyer and seller occurs through the system. After that, all the related data gets verified and stored in a block. In this process, a third party(Land Registrar) is involved who witnesses all the transactions and pieces of information.

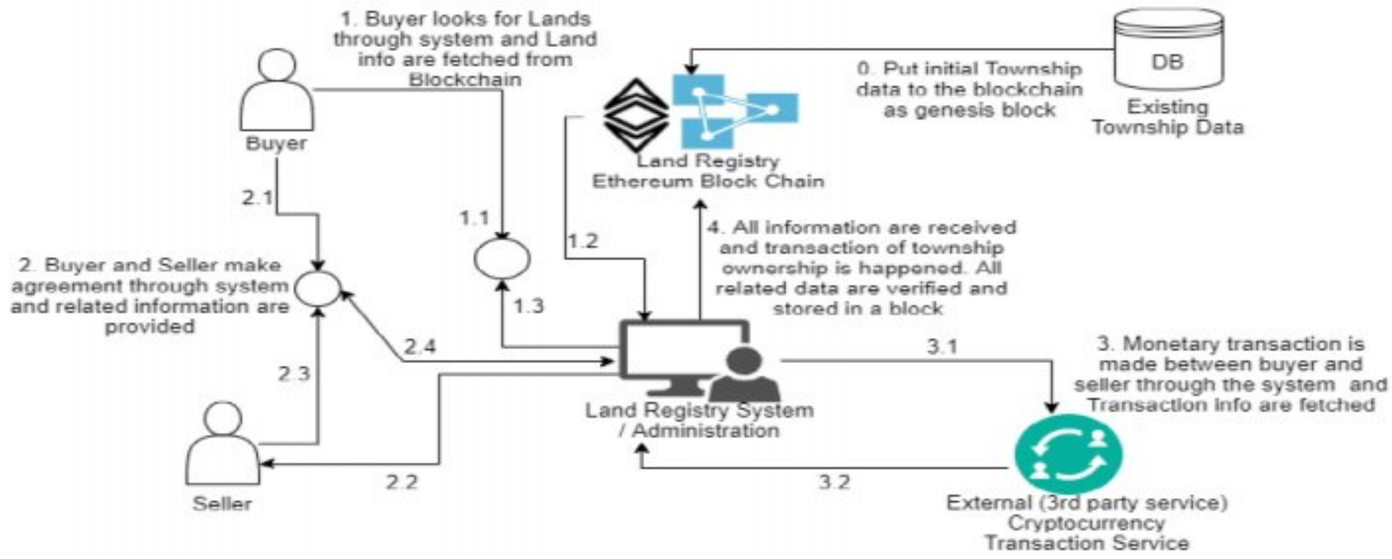

Figure 2.3: Proposed Architecture : Flow diagram of proposed system

2.3.3 Limitations

Some of the limitations in this architecture are-

- Difficulty in the maintenance process
- Third-party is involved which will require more manpower and will increase the cost

Chapter 3

Problem Statement

3.1 Common Problems in Traditional Method

Land is a tangible, immovable property and a non-liquid asset. The process of registration and keeping track of ownership/transfer records of a land/property is a taxing process with little to no transparency in the whole process. The owner of the property can't know if any changes are made in the registration office and whether during the mutation process any of the document has been tampered with or not. These scenarios are very common in Bangladesh. Besides bribing corrupt government officials, denying involvement in the transfer or manipulation of the deed, socially engineering fraud documents for non-existent trades are also some cases that can lead to dragging litigation and disputes. The land registration process can be automated partially and soft copy of documents can be stored in databases. But given our country's context it will create a scope for document(transaction, registration form, deed) preservation but it will make the system more accessible to fraudulent actions. Even though the digitization of property deed is not permissible according to our country's ICT Act 2006.

Demand for all types of land is increasing in Bangladesh due to extreme population pressure. Although land has been found to solve the housing crisis, its price is much higher, especially in urban areas. In this case, the broker or fraudster comes and informs the interested buyer about the "good land at a cheap price" then the buyer goes to take possession of

the land by paying the deposit and registering quickly so that he doesn't miss the opportunity.

At the time of buying land, the buyer often finds that:

- The seller was not the real owner of the land.
- Land disputes with other partners have been going on for a long time.
- The seller already sold the land and he had no right to sell it again.
- It is a vested property.
- The order has been seized by the government.
- According to the inheritance, the seller claims ownership that has not been established by the appropriate court.

Buyers usually can't do anything about these issues. Brokers or fraudsters cover up everything and keep themselves hidden before even buyers know about it. Though the buyer resorts to the civil court to recover the land, everybody blames the tired and devastated buyer for being stupid before the case is finalized, allowing him to appear in the case for a long time.

3.2 General Awareness

Buyers can be cautious about a few things before the registration to prevent this kind of situation. Before purchasing the land, the buyer must verify the following pieces of information which are given below:

- Whether the seller has actual ownership of the land.
- Whether the seller has the latest survey BS record, SA record, or RS record as proof of ownership and is sure to look at the original copy or attested copy of the record/ledger.
- If the seller is the owner of the land at the time of purchase, then whether he has done mutation or naming in his name.
- Verification of possession of land proposed for sale.

- Verification of rent receipts.

- The land ownership should be ascertained by verifying the record number of the land proposed for sale and the ledger number, the records of the district record room, and the records of the sub-assistant land office.

- In the case of the purchase of agricultural land, the partners in the record owner can exercise preference. So partners need to be sure about consent.

- Buying land from unoccupied landowners is a risky business. Because there is a possibility of going after unwanted conflicts or lawsuits to take possession of the land.

- Buyers/sellers may be penalized under Section 64 of the Stamp Act for registering a deed at a price lower than the market value of the land to evade stamp fees.

- It should be ascertained that there is a dispute over ownership as there is a possibility of litigation if such land is purchased.

- If the land is offered for sale at a much lower price than the market price, it is more likely to have problems. (Price of land and registry information can be obtained from the office of the concerned Sub-Registrar)

- It is important to check with the concerned office whether the land proposed for sale in the city and suburbs has already been acquired by the government or is under offer for acquisition.

- If it is necessary to check and verify the relevant documents to confirm the ownership and possession of the seller, the advice of an experienced, honest, and a dedicated lawyer should be sought.

- If the land has been transferred more than once before naming after the first sale, then it is necessary to check all the fake documents and check the name of the mouza, buyer/seller ledger, and dag number to confirm the ownership of the last seller. (From the concerned AC Land Office or Deputy Commissioner's Office, it will be possible to

know whether the real owner of the land is Dag Suchi, Khatian, Mouza Map, JL No., Record, Rent, Namjari, Survey, and Land)

- It is very important to check whether the land has been auctioned due to non-payment of rent/land tax.

- Whether the owner has been revoked due to land acquisition or any other reason needs to be thoroughly verified.

- It is very important to check whether the land buyer wants to buy is mortgaged due to borrowing from the government or any other organization. Because by doing this you can get into unwanted problems.

- Whether there are any disputes or lawsuits in the land proposed for sale can be ascertained by inquiring from the surrounding owners.

- Before purchasing a jointly owned property, the consent of all concerned (heirs) or the power of attorney must be ascertained.

- The number of times the land proposed for sale has been transferred in the last 30 years must be verified by a searcher in the office of the Sub-Registrar. Apart from this, information related to land ownership can also be found on the website of the Ministry of Land.

- In the area where the survey is going on, the field leaflets kept by the seller have to be verified. If something is written in the comment column of the ledger, for example: If it is written in the comment column (AD) in this way, then it should be understood that there is an objection against this ledger. Before buying such land, one has to go to the survey office/camp to know the latest condition of the land.

- Verify that the property of the seller has been divided with the partners of the seller of the inherited land.

- Documents collected from the seller such as ledgers/worksheets etc. should be checked at the concerned union land office along with the summons/title register.

- The latest registration forms D, C, R, and tax deposit (receipt) need to be verified. If the land tax is in arrears and the land is purchased while the tax is in arrears, the buyer has to pay the arrears.

3.3 Traditional Registration Process

Some information is required to register. To register the land, full details of the land sold should be mentioned. The document should include the name, full address and recent photograph of the donor-recipient parent. The name of the person who will sell the land must have a name (mutation) (without inheritance). Must have a brief description of the last 25 years of ownership and a continuous history of the acquisition of the property. The actual value of the property, the boundaries around the property, must be in the design document. There must be an affidavit stating that the property sold by the donor has not been sold to anyone else. There should be continuity of ownership in land deeds (CS, SA, RS). Must have baya documents (if required).

After gathering all the pieces of information and bits of knowledge we can proceed with our registration process. There are eight steps in the registration process. These steps are showed in the following

Figure 3.1: Registration Process

Chapter 4

Proposed Method and Implementation

4.1 The Architecture

After considering the limitations and the country's context, we are proposing an architecture that can tackle the problems. We are planning to build a hybrid blockchain containing the properties of both Consortium Blockchain and Public Blockchain.

Consortium Blockchain is a type of blockchain that is maintained by multiple central authorities. For verifying involved parties identification, proof of income, land taxes we have to check the proper documents from the respective government authorities. By including these government offices or ministries in the blockchain network we can verify those documents.

By implementing the properties of public blockchain mainly the distribution of ledger or records in every node in the network we can prevent any sort of tampering of data by a group of third party intruders that can bribe a few of the officials of the government organization to get majority of consensus.

Also we intend to map the plot or properties to additional documents like registration papers and khajna or land tax papers.

4.2 Progressed Works

Up until now we have done the following:

- Study Existing Literature and Solution Architectures
- Feasibility Study of The existing Architectures
- Study Existing Implementations
- Partial Implementation
- Analyse the findings

4.3 Existing Implementations

There are a handful of existing implementations available online that we have studied and analysed for our own implementation. The existing ones usually are file systems stored in traditional blockchain architecture. We couldn't find source code or practical implementation for any of the academic literature that was provided, as they were partially implemented or wasn't a full software with a usable UI.

4.4 Analysis of existing Solutions

The solutions that are currently available have the following characteristics:

- Mostly theoritical.
- Hybrid blockchain architecture.
- Emphasises on the procedure of the registration and transfership process.
- Reliability of the third party verifier isn't questioned.

4.5 Our Implementation

Since we couldn't find any of the source codes for the hybrid blockchain architecture, we had to rely on the pre-built frameworks and ehtereum-based blockchain system to build our system. Due to time constraint we couldn't conduct a feasibility study to gather requirement specification from real users and the usability study whether to see it tackles the aforementioned problems in Chapter 3. So, our implementation were mostly build on the assumptions of our understanding of the previous literature studies and the problems on our current process of land registration

4.5.1 Process Overview

From the homepage the users can log in based on their roles with their private keys. Anyone can register in the system as users (mainly buyer/seller). Their registration request is the approved by the land officer/inspector and their account is verified. The owner of the contract operated over the blockchain assigns the land officer. The contract owner may be the Managing Director/Chief/Secretary or Commissioner of the Ministry of Land or similar organization. This role can be transferred to the immediate successor.

As for the users, they have to include documents related to their identification to register. They can register their land on the application with related documents for verification and an online plotting of the land. Selling of land can be initiated after the ownership is verified by the land officer. The buyer can request from the seller to show interest buying the property. After verifying the buyers identity they can initiate transaction for payment using cryptocurrency. Then the ownership of transfer is verified by the land officer which happens after an online video conference which has to be attended by both parties and the officer himself. Finally, a document is generated containing the buyer and seller identification document, mutation and registration document, transaction info and information about the officers related to the verification procedures. The whole process is summerized through a flowchart in 4.1

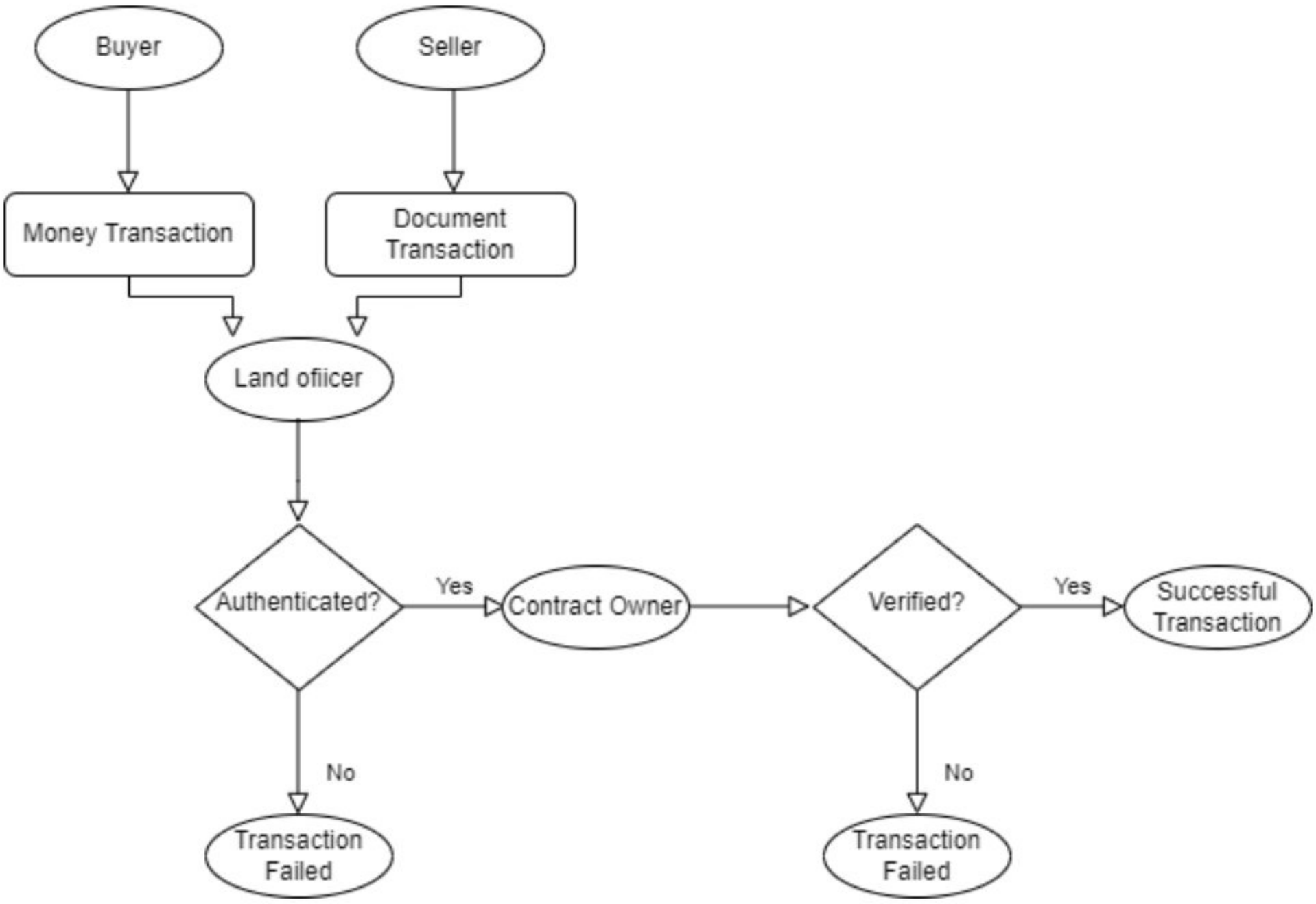

Figure 4.1: Flowchart of the process workflow

4.5.2 UML Diagrams

Class Diagram

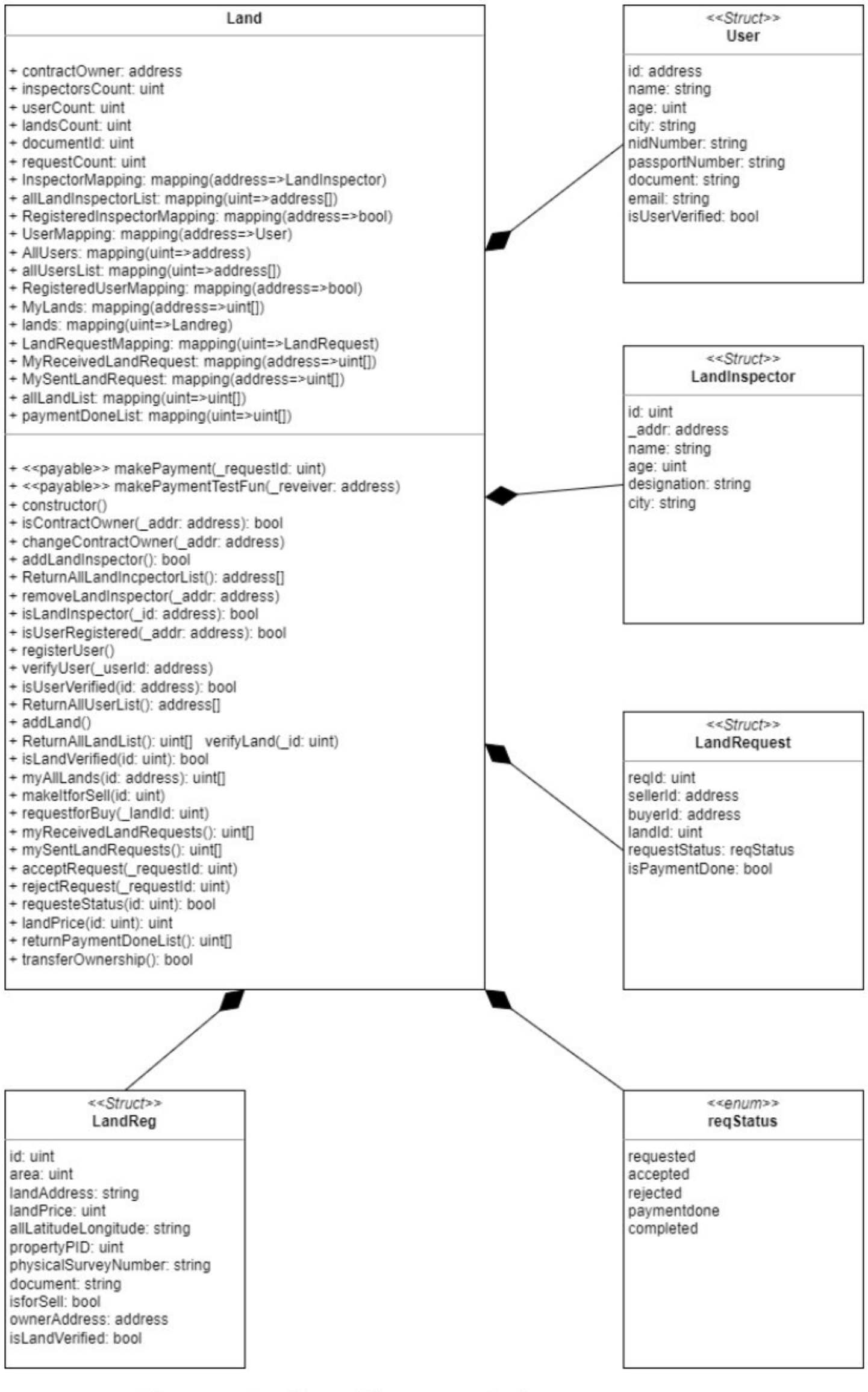

Figure 4.2: Class Diagram of the smart contract

The class diagram represents the variables and their datatypes along with each functions or methods it executes. In the project there is a whole smart contract class which has a set

of defined record structures (i.e. LandReg, User, LandInspector and LandReq). In solidity a record list is defined and structured by the keyword *struct*. In figure 4.2, we can see the record types that the contract generated as well as all the variables, datatypes and functions which are executed in the dapp. As the Contract executes a set of methods for a specific request and all the variables need to be read during execution the read type of them is set to public.

Use Case Diagram

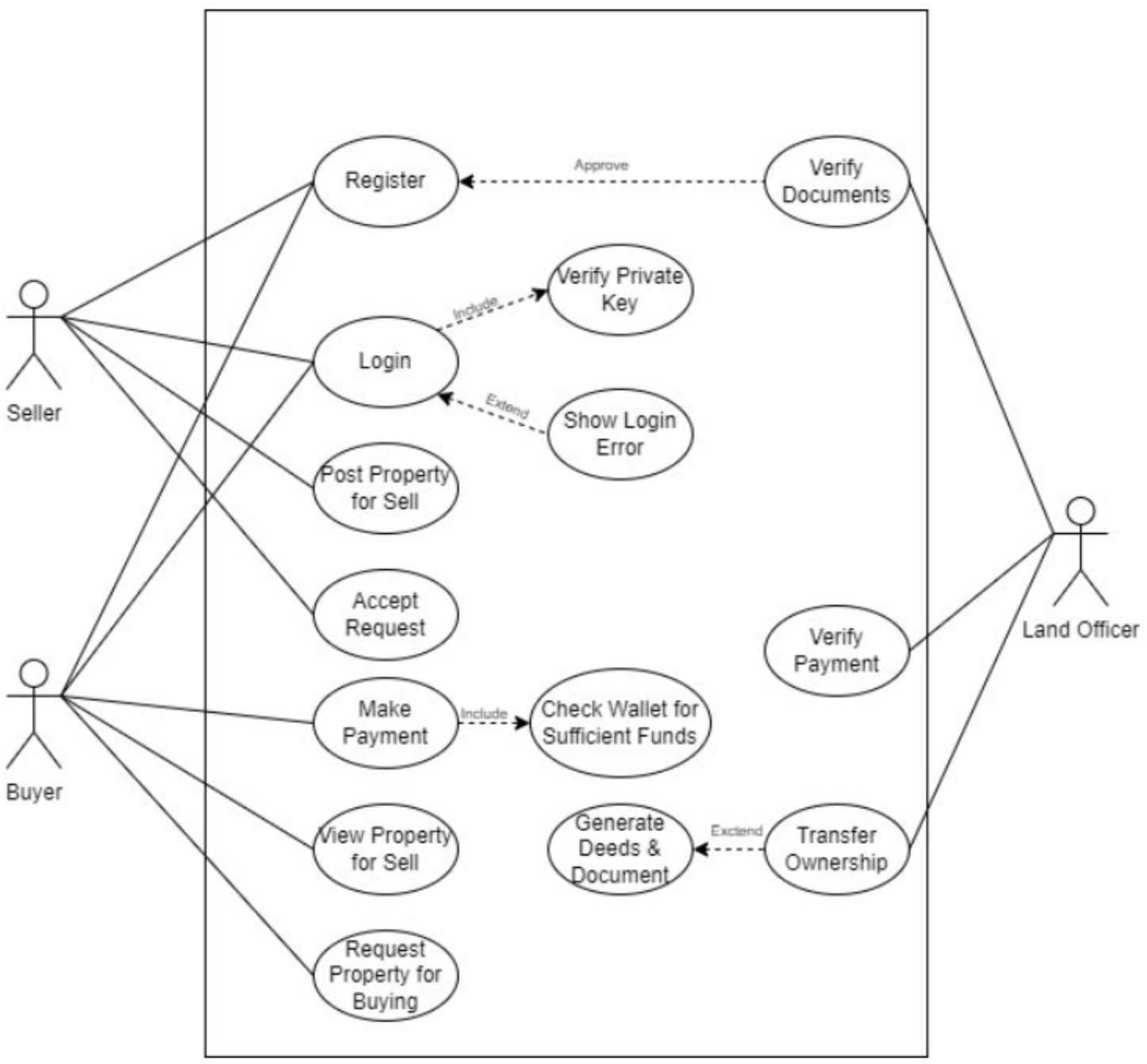

Figure 4.3: Use case Diagram of the Land Registration Dapp

From the figure 4.3, we can get a general idea of the core functionalities of the application. Each type of user is constrained by a few set of actions in the application. The role of the Land Inspector or Officer is to verify the user by checking their attached documents related to their identification. He can also verify payment and the transaction before going on to the final step which is transferring the ownership and finalizing the generated documents of the transaction by signing it off. On the other hand, normal user, which in this case, are people who are interested in buying and selling properties can register in the application, login, view

available properties, post their own with corresponding documents, show interest in buying a property and make payment through cryptocurrency.

4.5.3 User Interfaces

Here are a few images of the user interface of the application including the frameworks used (i.e. Metamask, Ganache).

In figure 4.4, we can see that ganache has hosted a dummy ethereum network for testing purpose with pre-populated testing accounts. Here we can see how much transaction each account has initiated and the balance, address of the account and also the private key which is shown after the key icon is clicked

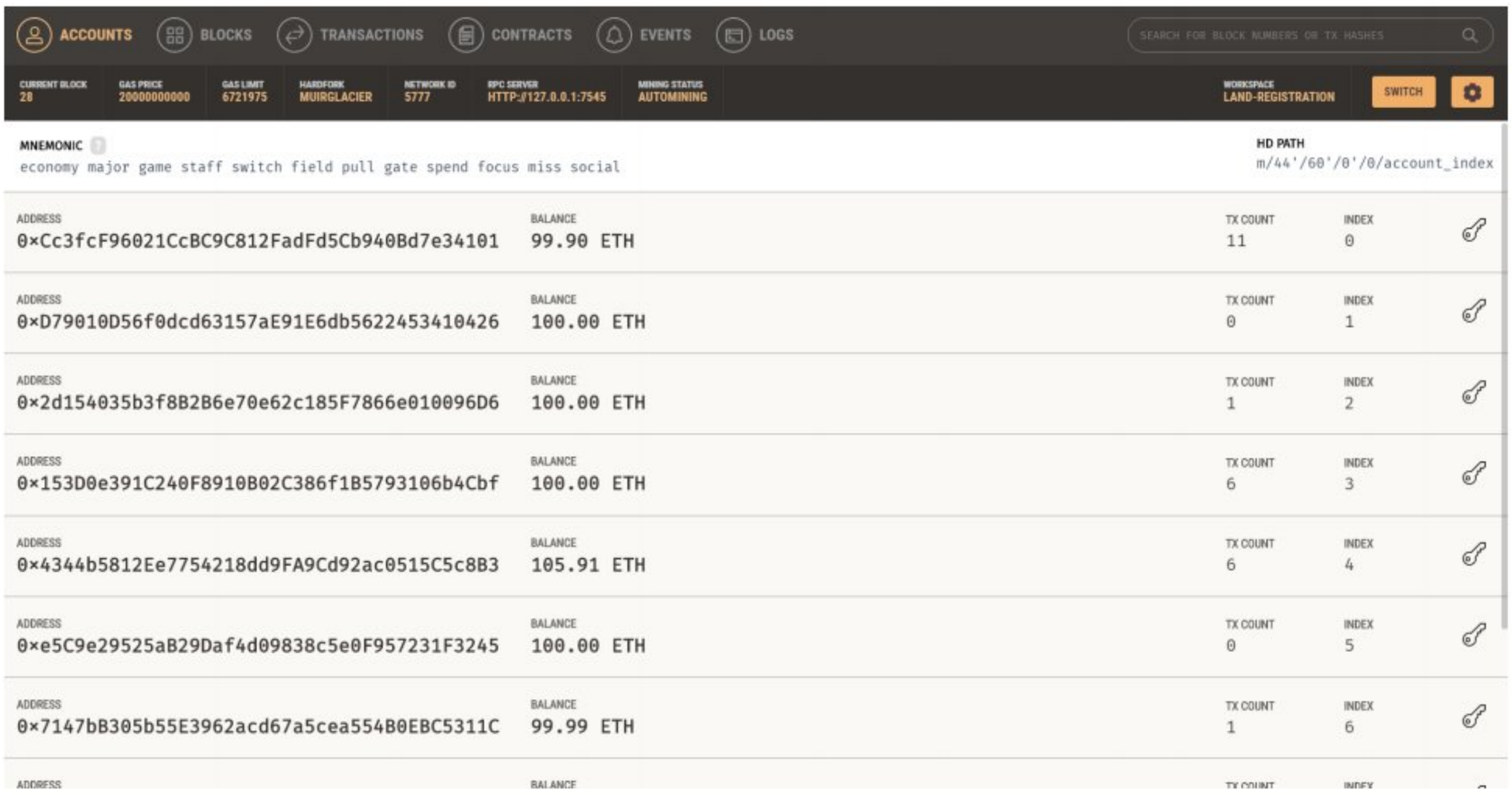

Figure 4.4: Snapshot of Ganache running proxy accounts

In figure 4.5, we can see the dashboard of the metamask wallet application. Metamask wallet can switch between ethereum test network or a customized network for private blockchain hosts.

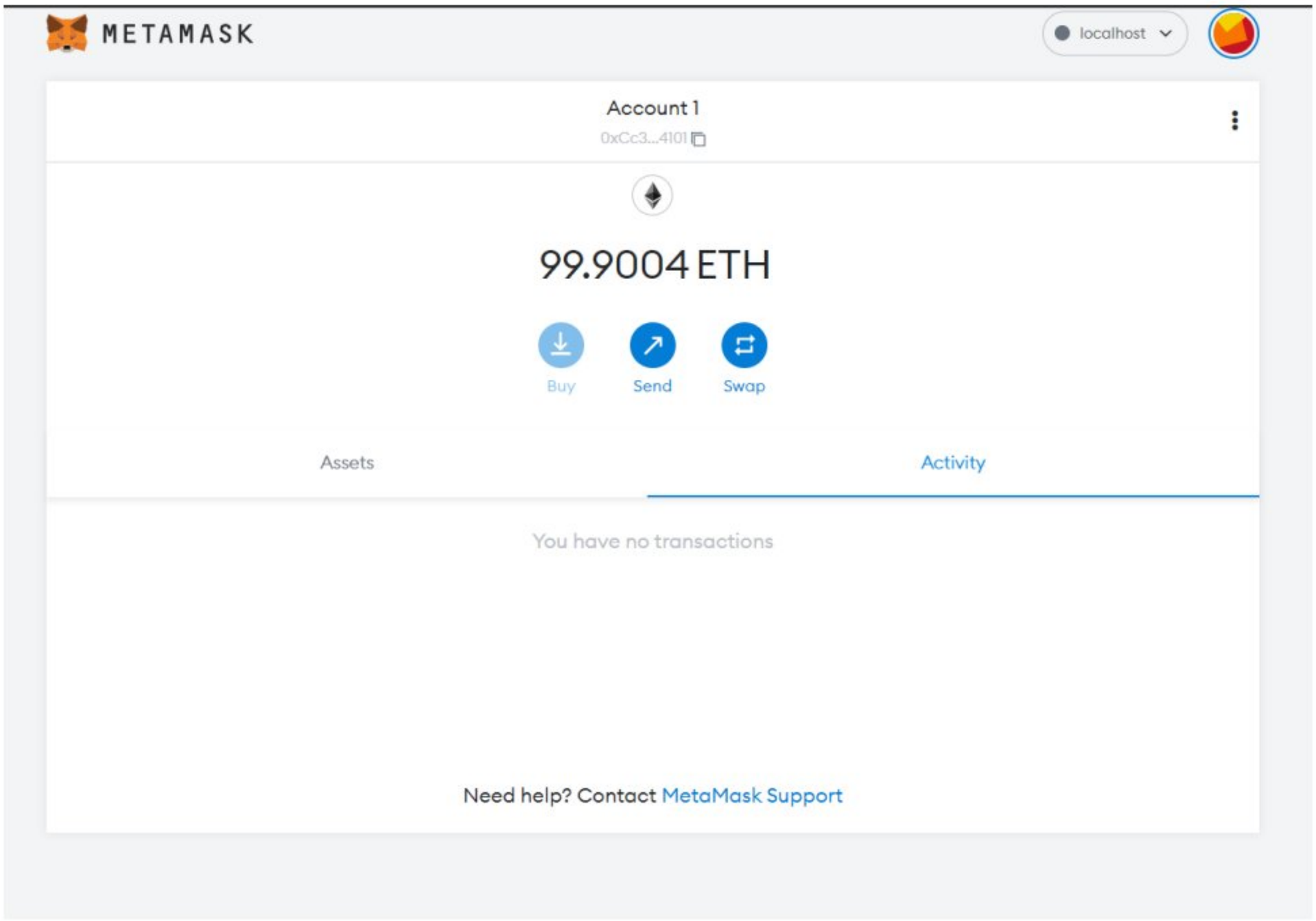

Figure 4.5: Snapshot of metamask wallet manager

Figure 4.6, gives an overview of what the homepage looks like.

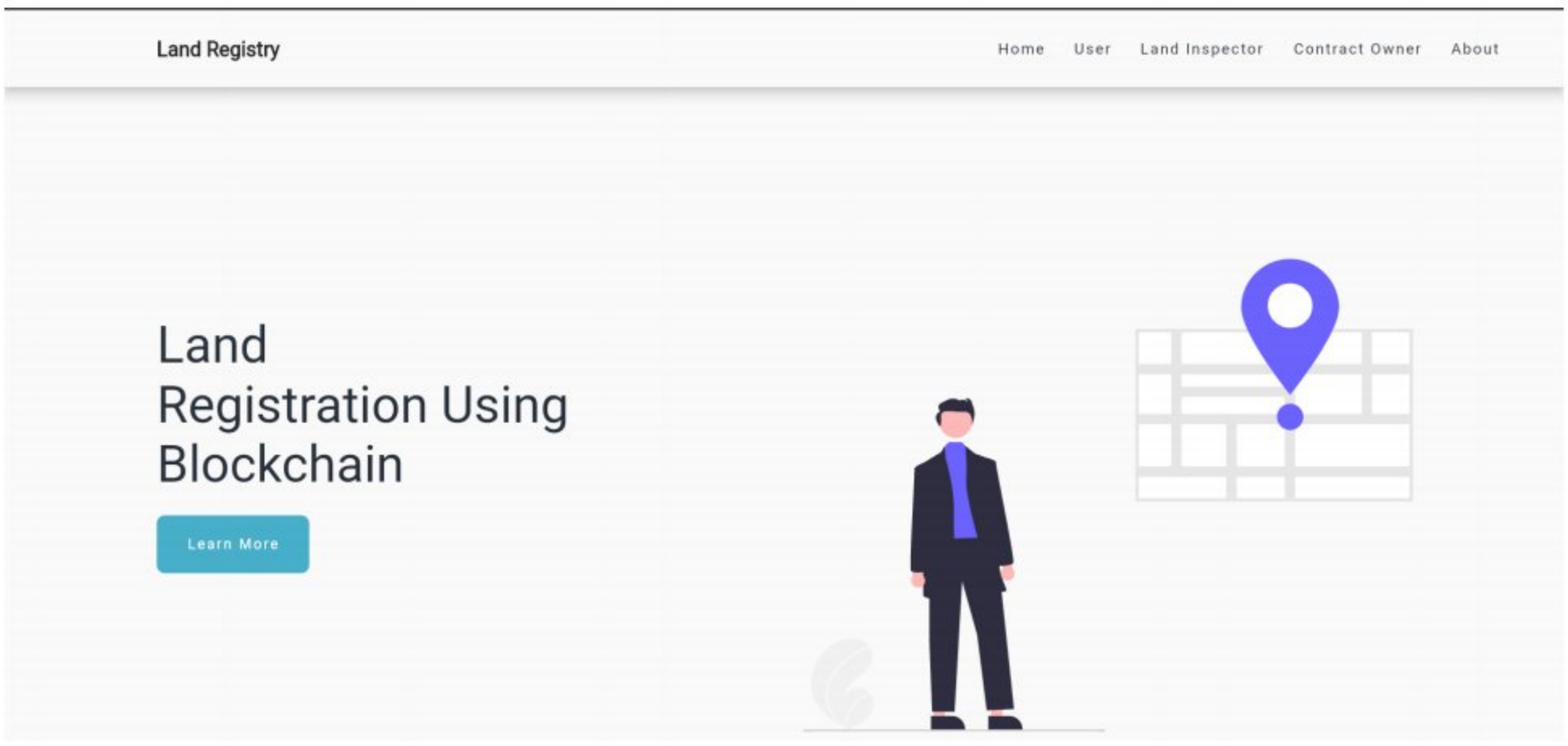

Figure 4.6: Snapshot of the homepage of the application

The login page of all roles redirect to page shown in figure 4.7. Based on the private key inserted the application redirects to the corresponding dashboard of the roles.

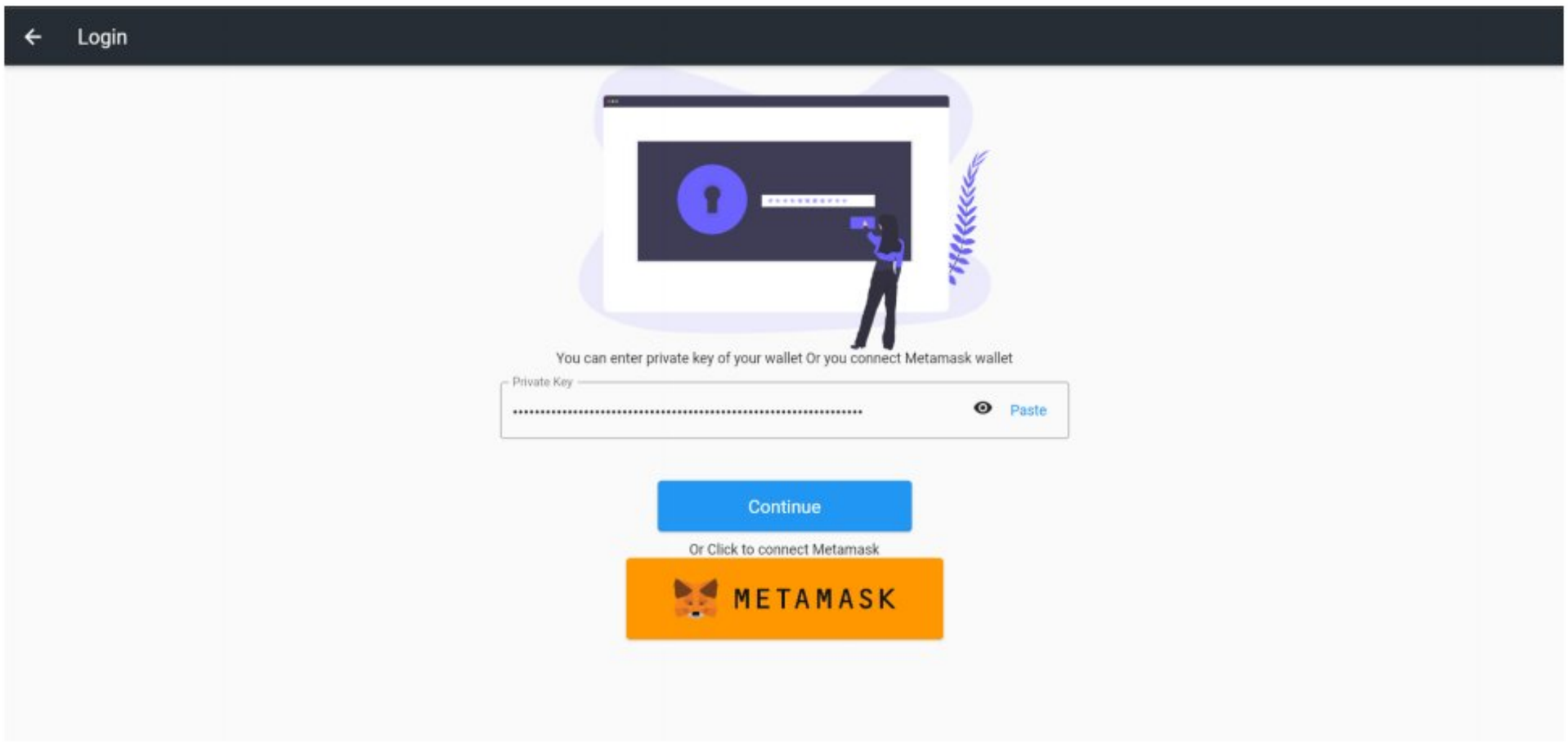

Figure 4.7: Snapshot of the login page of the application

In figure 4.8, we can see the dashboard of the contract owner who initiates and migrates the contract in the application. He can add land inspector or officers and change his ownership to other registered land officer. Figure 4.9, we can see the registered land officers along with their information and the option to remove them.

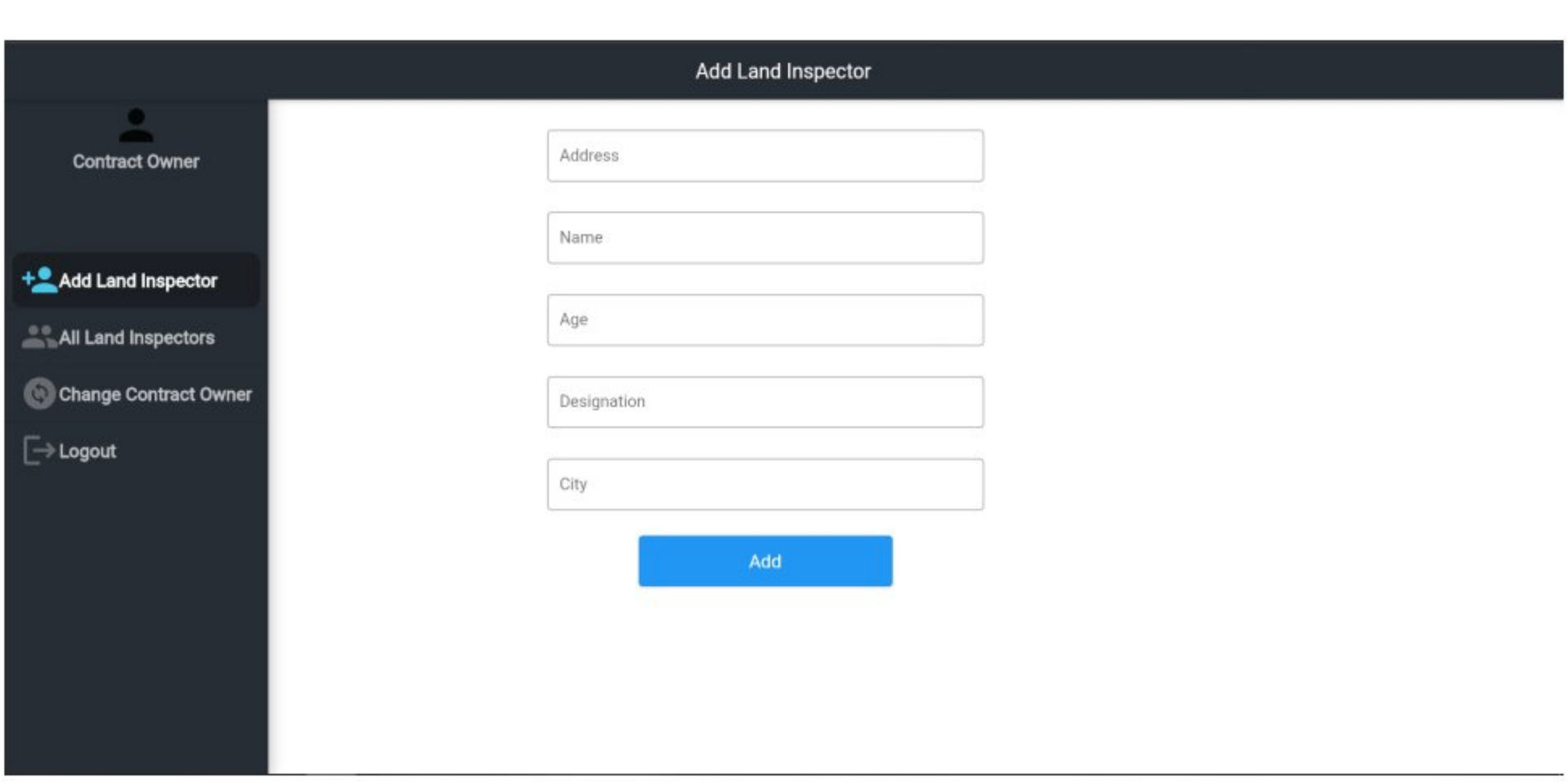

Figure 4.8: Snapshot of the dashboard (adding land officer) of the contract owner

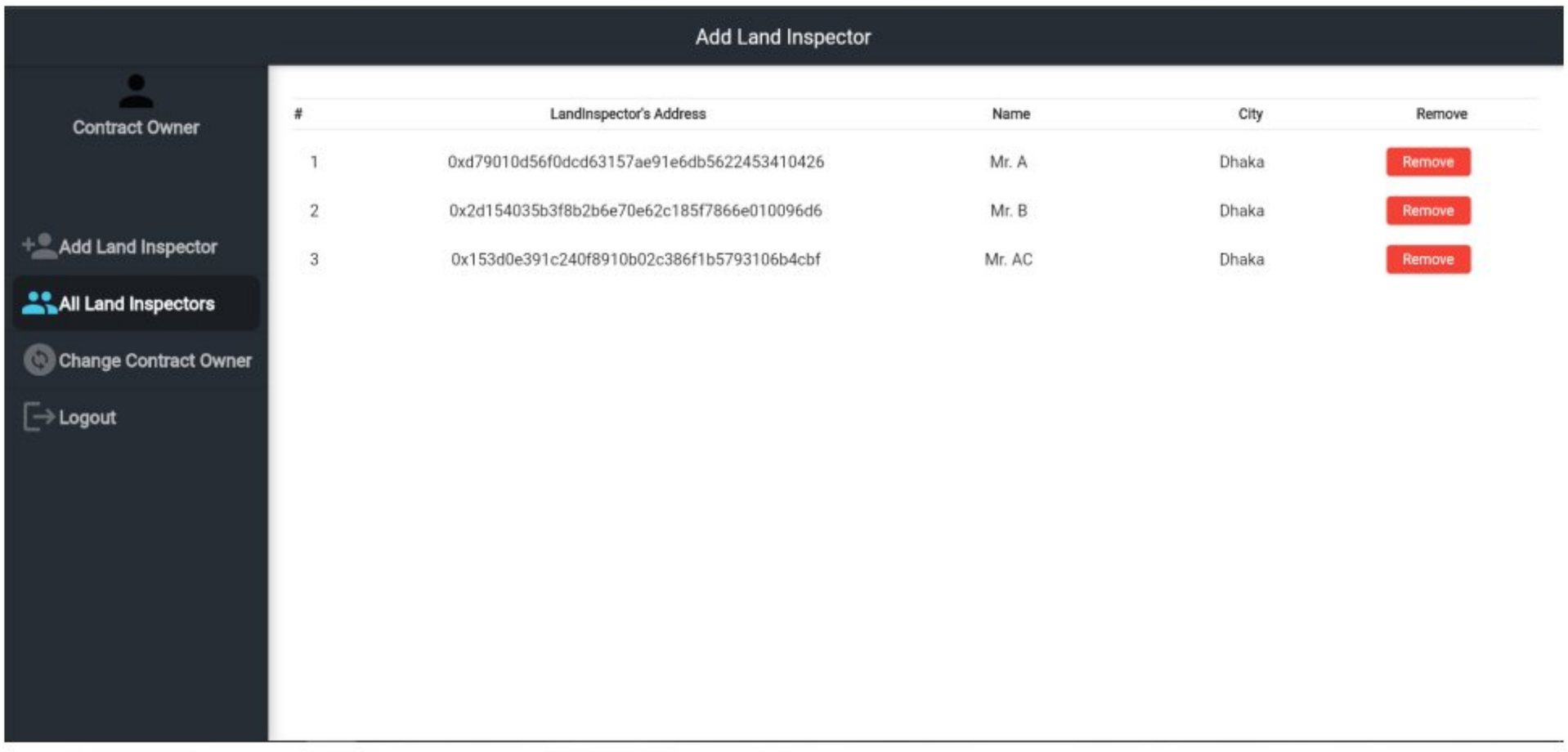

Figure 4.9: Snapshot of the dashboard (removing land officer) of the contract owner

Figure 4.10, we can see the dashboard of the land officer. His responsibilities are to verify the users by checking the validity of their documents (figure 4.11), verify lands and transfer ownership after the whole payment and verification procedure is done (figure 4.12).

Figure 4.10: Snapshot of the dashboard of the land officer

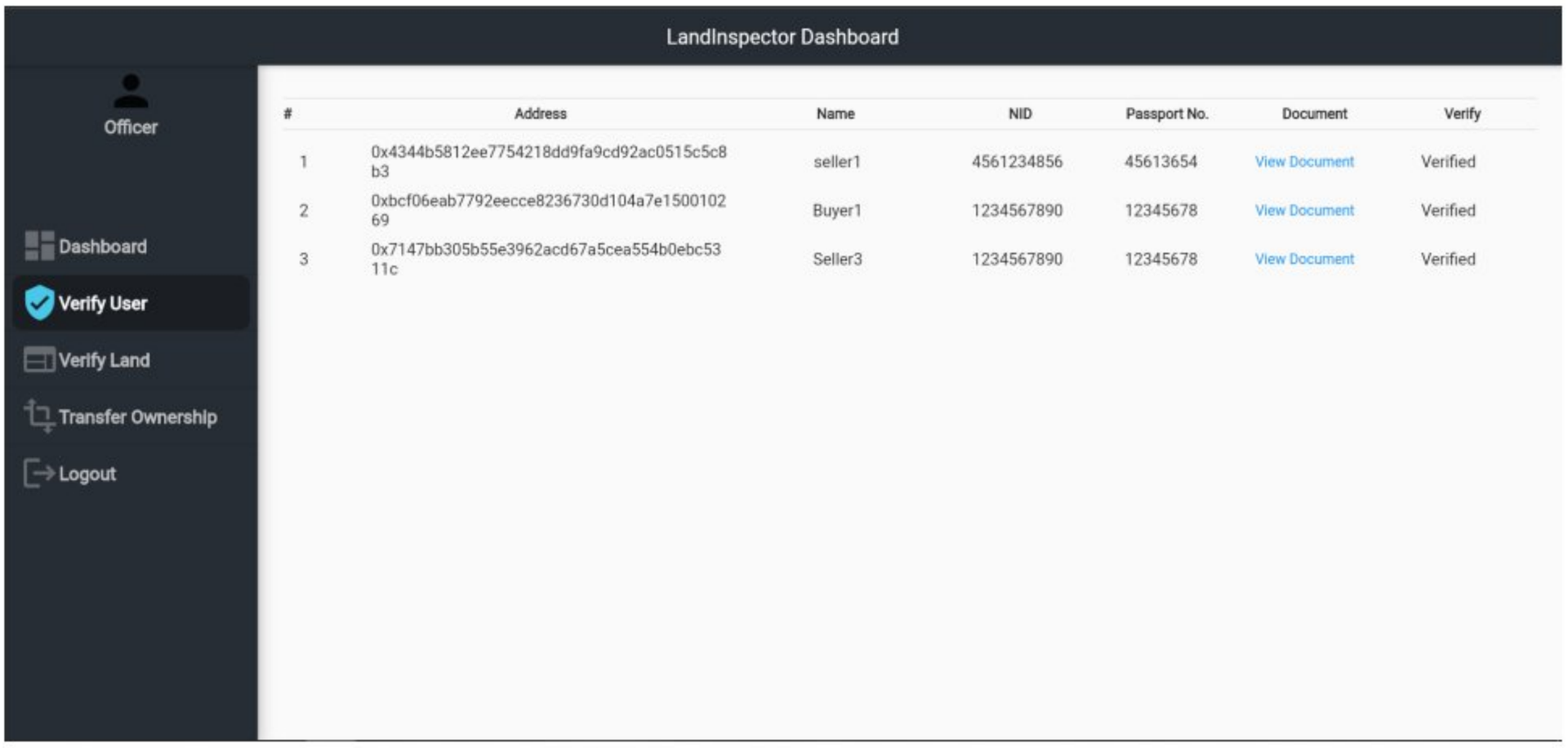

Figure 4.11: Snapshot of the dashboard (user verification) of the land officer

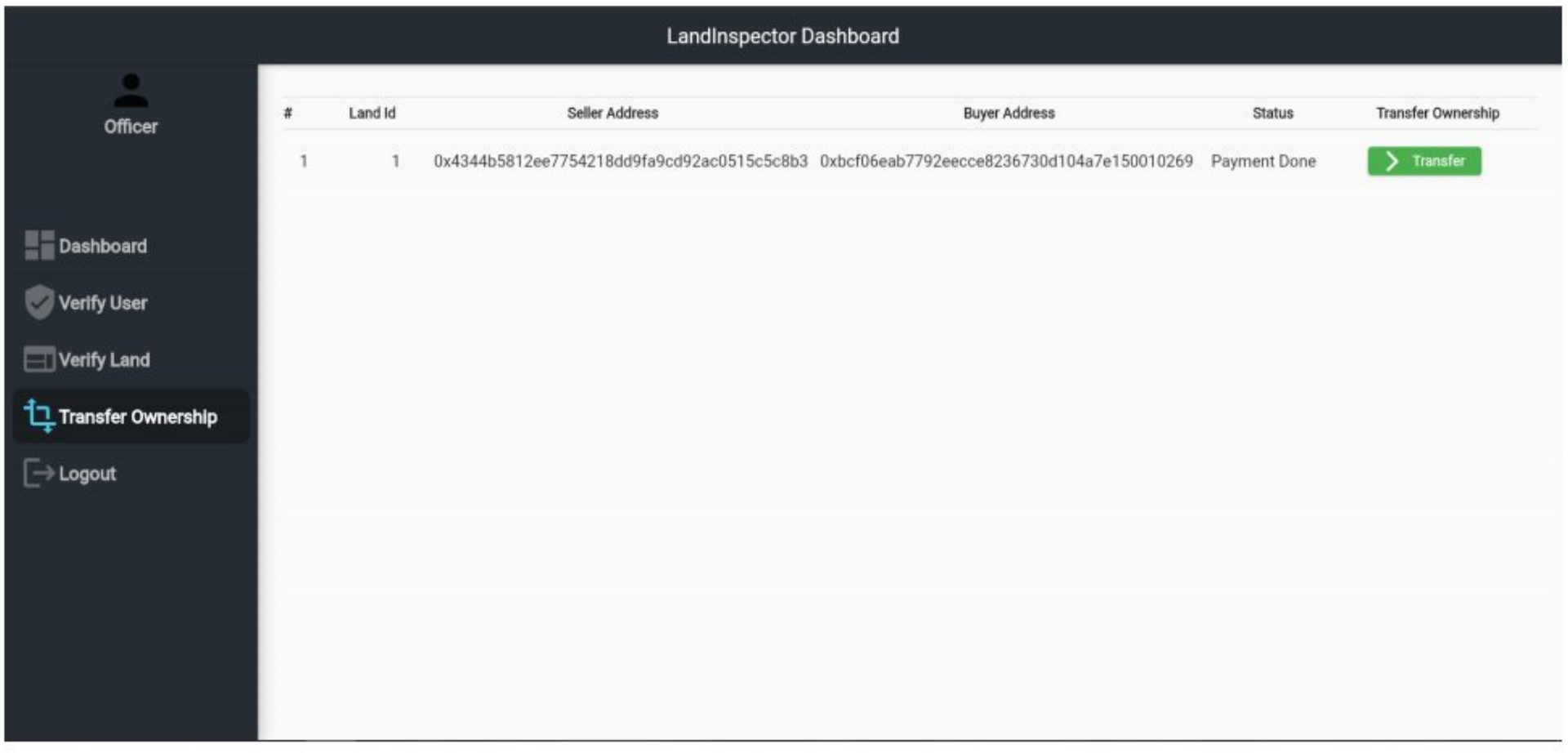

Figure 4.12: Snapshot of the dashboard (ownership Transfer) of the land officer

Now for the seller, we can see the seller information from their dashboard, in figure 4.13. We can navigate to *Add Lands* to add information about the land he's willing to sell. From figure 4.14, we can see that the seller has to fill up a form and upload documents and also plot the coordinates of the property to post a land for sell. In figure 4.15, we can see the property enlisted by individual seller and from received request in 4.17 we can see the buyers who are interested to buy property from the seller.

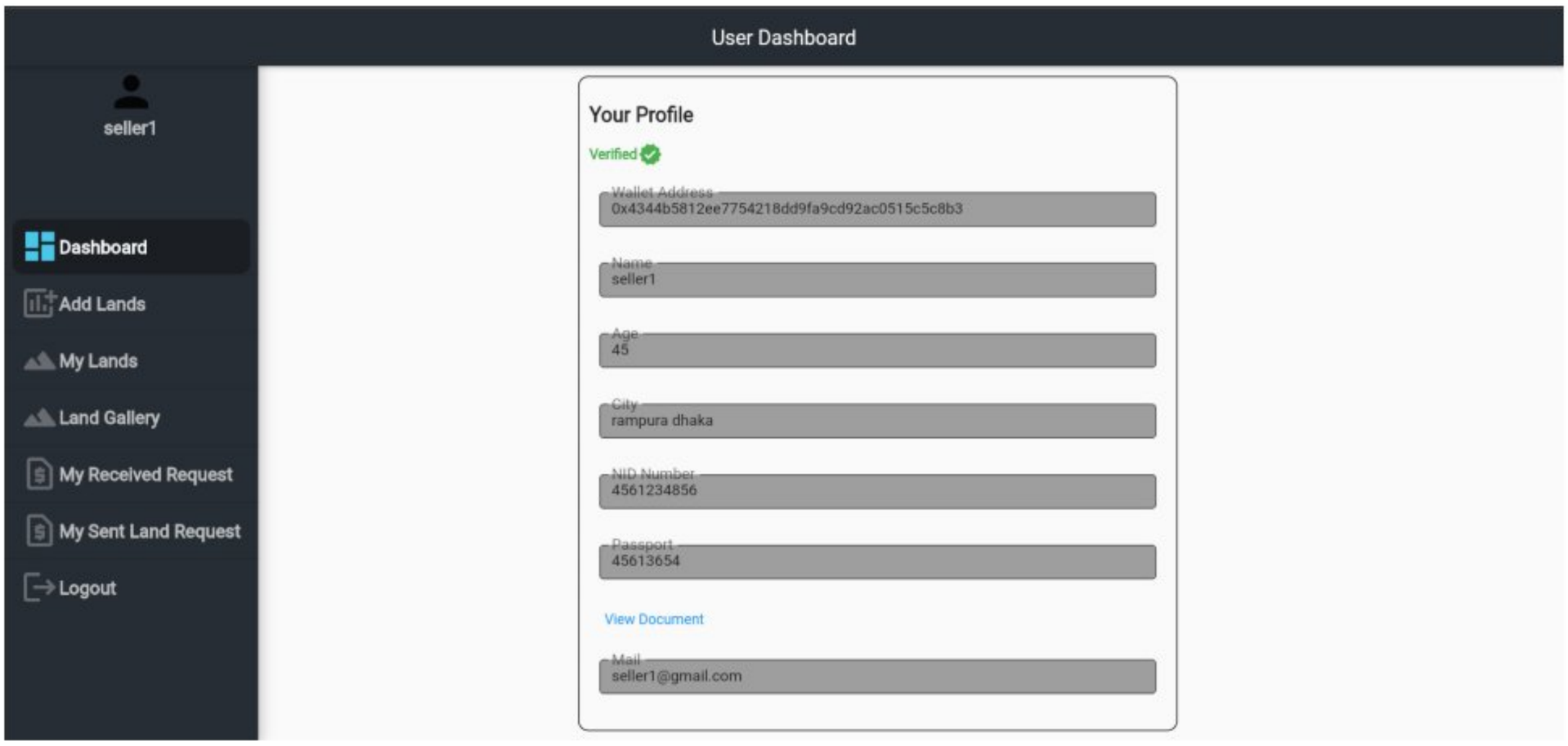

Figure 4.13: Snapshot of the dashboard (user info) of seller

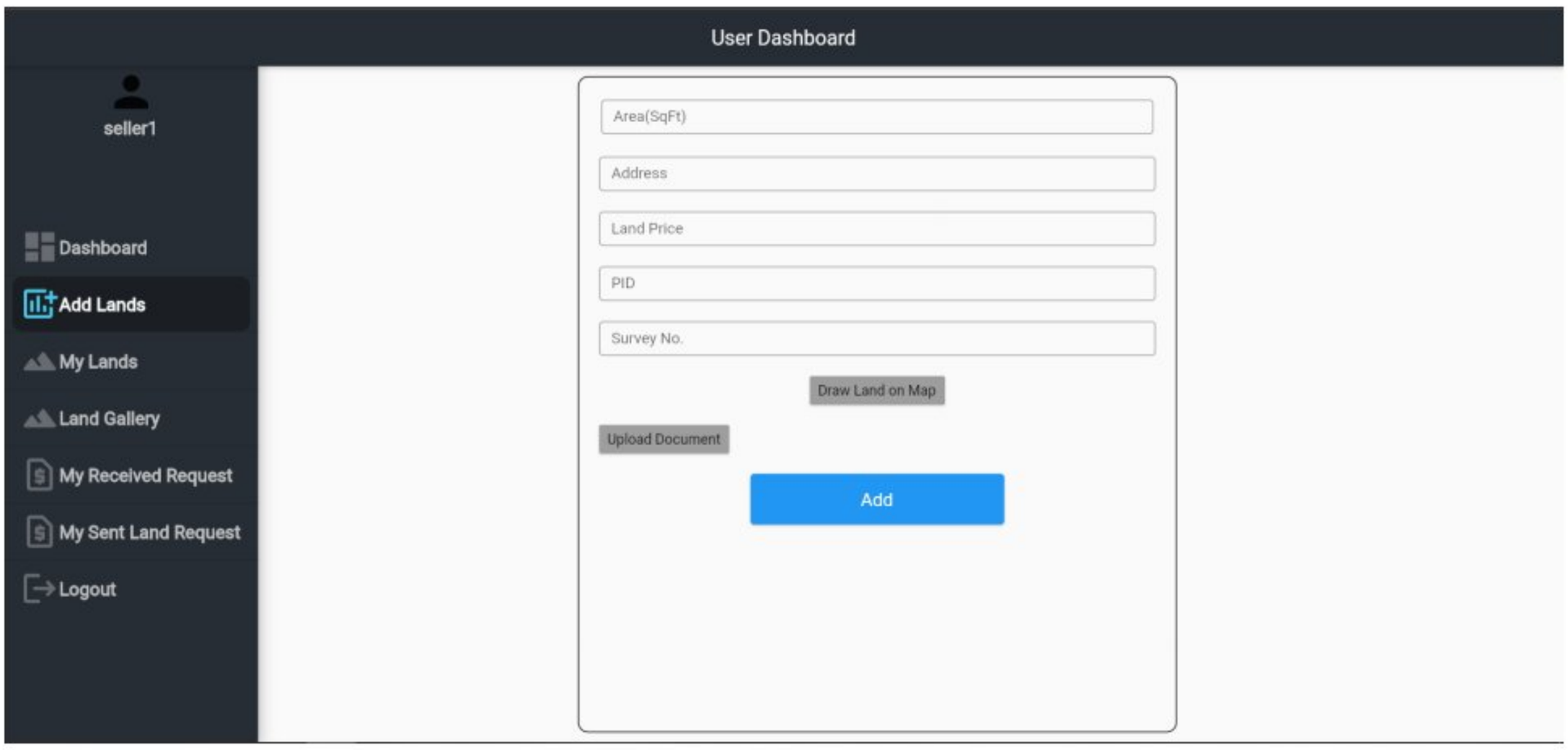

Figure 4.14: Snapshot of the adding land page by the seller

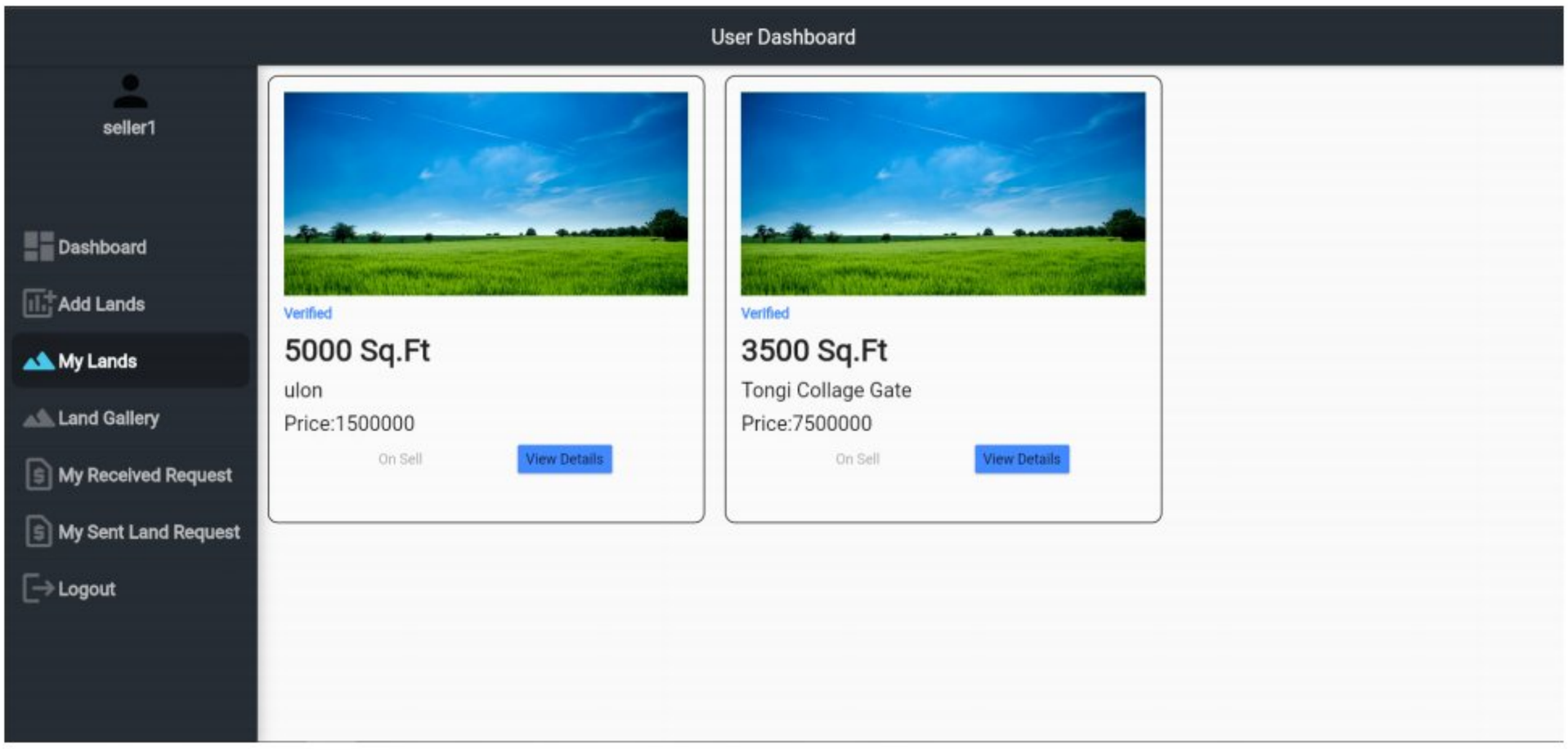

Figure 4.15: Snapshot of the posted land page by the seller

Figure 4.16: Snapshot of the buy request page of the seller

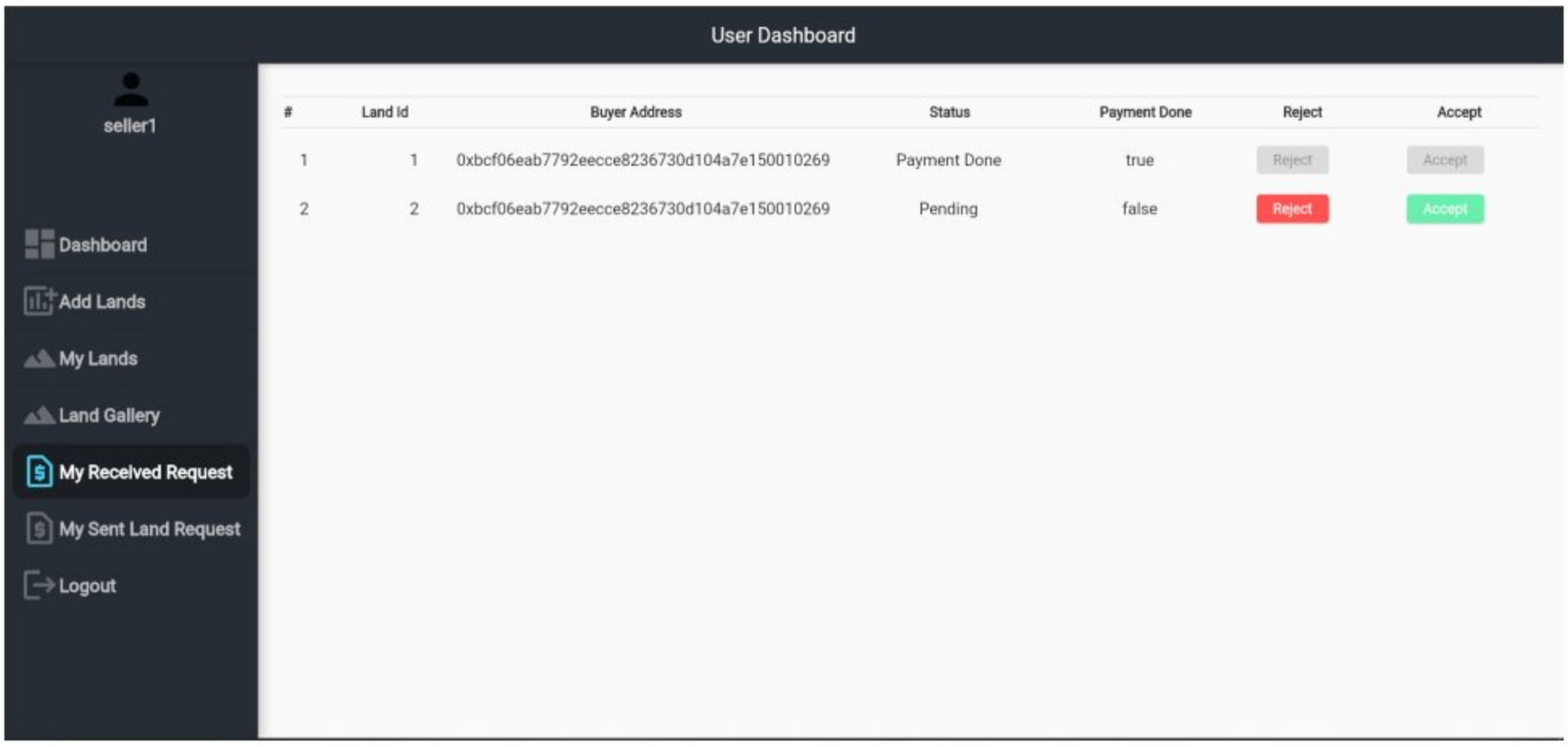

Figure 4.17: Snapshot of the buy request page of the seller

Here is a detailed version of what the buyer can see of the land in figure 4.19. A buyer can view the physical location of the land, its info and view the documents. A third party API (mapbox) was used to achieve the service of mapping the property through satellite map view.

Figure 4.18: Snapshot of the land information page

Lastly in figure 4.19, we can see the available land list from the buyers dashboard. A buyer can send a request to buy from this page. In 4.20, the prompt of a paytab is shown where the local currency is converted to ETH cryptocurrency before confirmation of payment.

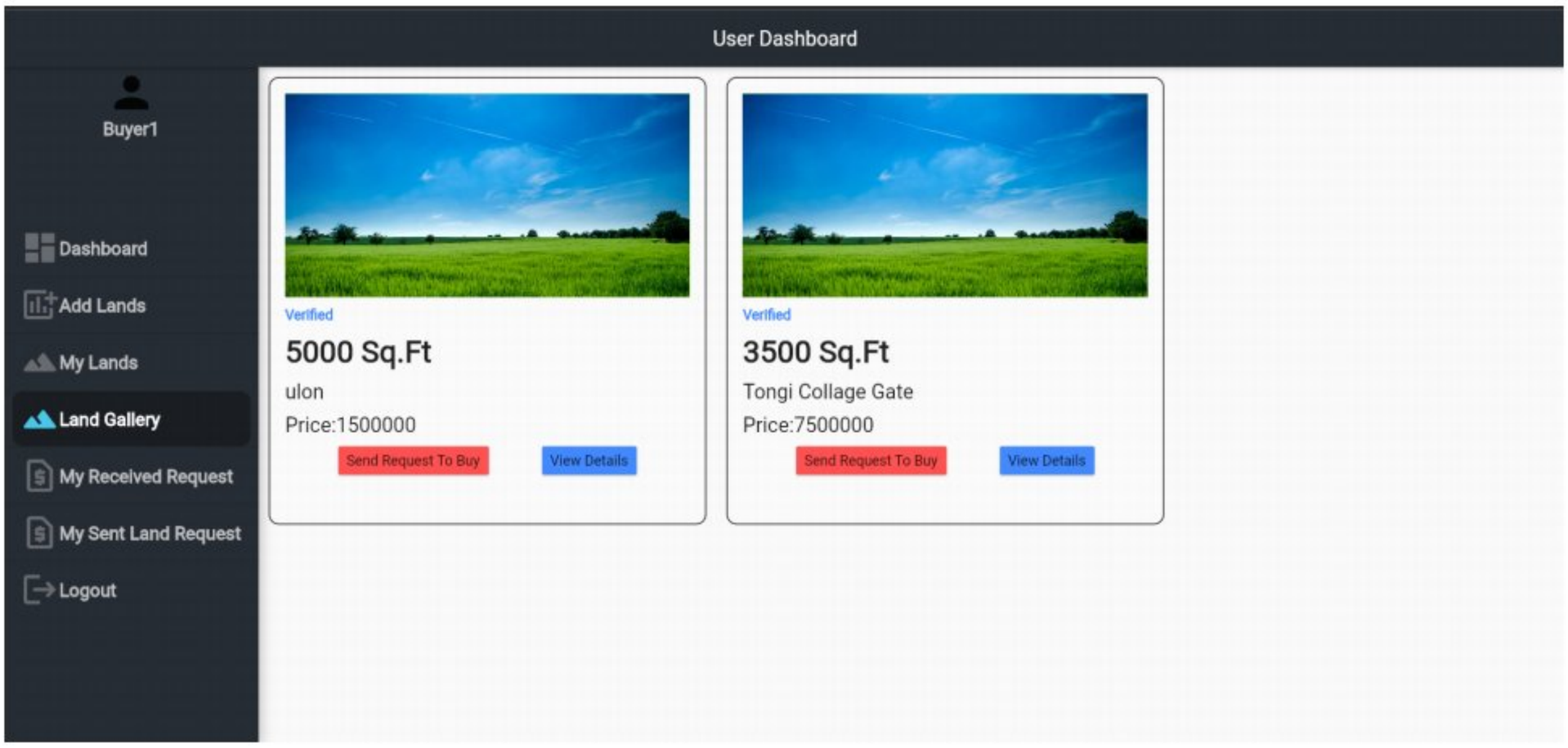

Figure 4.19: Snapshot of the available land list page (Buyer's dashboard)

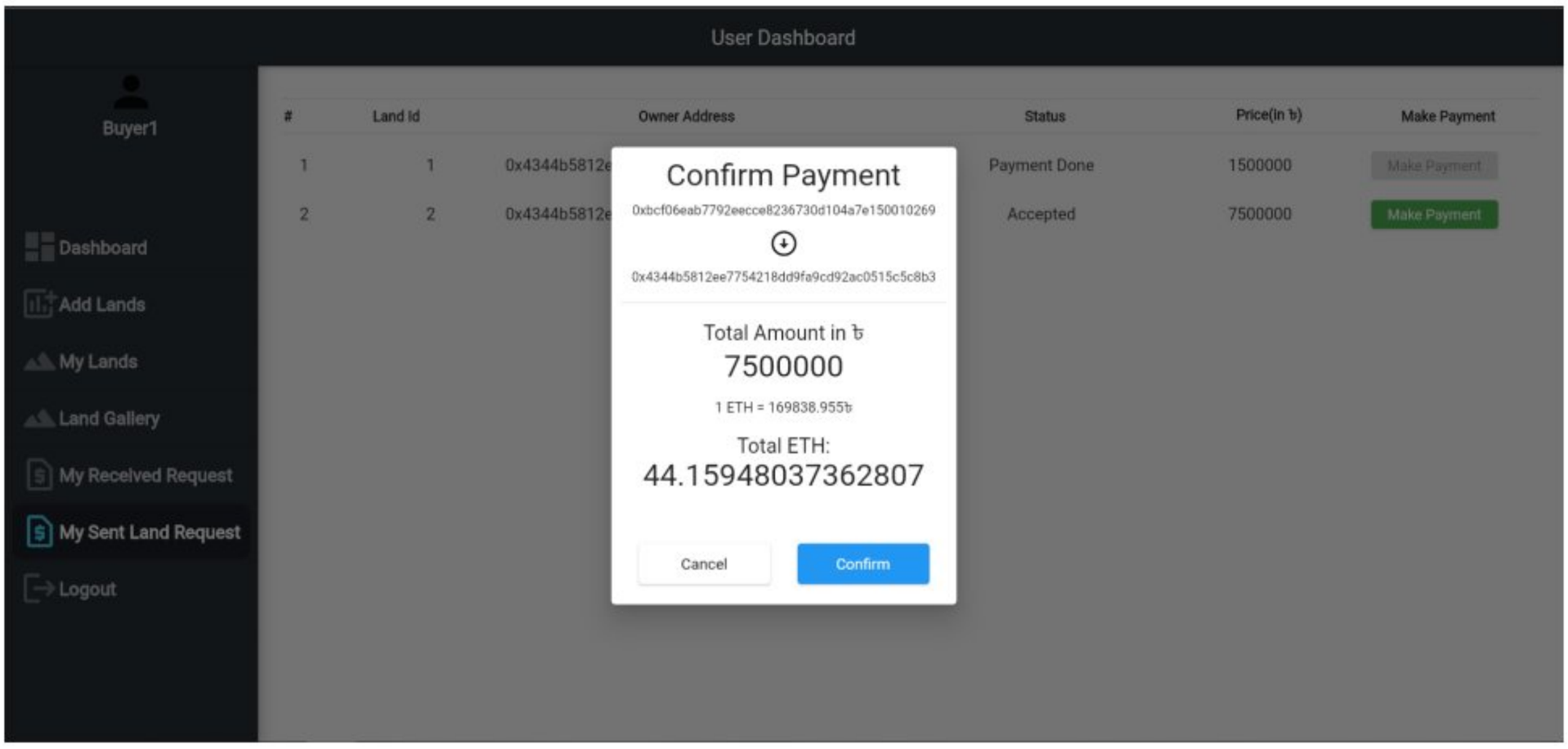

Figure 4.20: Snapshot of the payment tab

Chapter 5

Conclusions and Future Work

5.1 Conclusions

By the end, we intend to design our proposed system, taking in mind of the flaws and loopholes in our country's land registration process. Blockchain is a comparatively new technology in terms of its age but has the potential to bring a significant turnover to the technology world. The recent usage of blockchain in different application domain is still comparatively immature and further usage may introduce new vulnerability in the systems developed by attackers or schemers. So,the methodology proposed by us may not fully cover all sort of fraudulent actions but may reinforce the security of existing architectures in this domain of land registration process

5.2 Future Work

There are still some incomplete features of the application but we intend to complete them in near future. We also intend to polish the existing application and make the UI more clean and easy to use. For our future endeavours we would:

- Integrate the application with national identification and tax/duty databases to make the verification process easier for the land officers.
- Analyze and strengthen all the security aspects related to the system.

- Conduct a survey among official personnel for the possibility of putting it to official governmental usage.
- Optimize the performance of the system
- Data collection, survey and feasibility study for Bangladesh

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