



## Blockchain-based Land Certificate Management in Indonesia

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### Abstract

*Indonesia is a densely populated country with a population of 260 million, making Indonesia the fourth most populous country in the world. The continued rapid development of the economy in Indonesia has made land an asset that provides benefits. In Indonesia, land ownership that has the highest legal power is proven by a Certificate of Ownership or in Indonesian is called as Sertifikat Hak Milik (SHM). Meanwhile, the land titling process is often complex and lengthy, and because of the processing carried out by government agencies in handling a variety of different documents, some structured people commit fraud. The impact is that the model currently used does not have good governance. This research offers a Blockchain-based solution in providing data harmony and openness, lightening in data access, permanent records management, and most importantly it is a solution that is cheaper and faster. This research offers a step-by-step model of Blockchain selection beginning from the public Blockchain ledger which will continuously incorporate two degrees of Hybrid Blockchain. The smart contract design of the Public Blockchain is provided in detail as well as the use of Ethereum in implementing its prototype system. In the experimental test using the local Ethereum test network directly to show the effectiveness of the system. The results of the analysis show that the model offered can reduce the costs required for processing information, the number of trips required, and result in easy access to important information. With the implementation of Blockchain, efforts to digitize land rights in Indonesia can increase.*

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*Keywords : Blockchain; Land Certificate Management; Smart Contract; Ethereum.*

## I. INTRODUCTION

The Indonesian economy, which is currently booming, has made Indonesia a country with high economic potential in Southeast Asia[1][2]. This rapidly developing economic development has spurred the conversion of Indonesian agricultural land to non-agricultural land to increase profits[3]. Currently, the land is a valuable asset in investing. As a result, many people are fighting over ownership of the land. Currently, ownership of land is guaranteed in the form of various documents such as deeds, certificates, transfers, etc. which are maintained by the government[4][5]. This has led to acts of fraud by irresponsible parties in bribing the government in falsifying land ownership documents which led to land rights disputes. Many of the land rights disputes cases take a long time to resolve from court to court which takes a lot of time and money in the process. Currently, it is important to have a sophisticated integrated mechanism[6] for entering digital[7] land transaction documents (such as proof of transfer, sale, purchase, inheritance, deed, etc.) with a high level of data authenticity and security[8][9].

The current system has a major problem, namely fragmented information in various places of government that is not implemented properly and irresponsible people who can commit fraud in falsifying documents. For this situation, fraud related to land ownership cannot be resolved through a centralized system[10]. Blockchain as an example of Distributed Ledger Technology (DLT) can be used as a solution to this issue. DLT is an information base model that interfaces node where every node has a total duplicate of the record and is connected in a shared network. In the process of changing the ledger must be approved by a majority such as Proof-of-Work and Proof-of-Stake of each node.

The intrinsic idea of land ownership rights is identified with the historical backdrop of proprietorship that changes over the long run. The authenticity of land ownership documents will be maintained by the main building blocks of the Blockchain[11]. On the blockchain, the new block that is inserted confirms the previous blockchain and can be searched back to the original node. This property of the blockchain can be implemented in land ownership issues. When new blocks that are submitted to the blockchain in a peer-to-peer[12] manner are accepted, the previous blocks are difficult to change and even irreversible. This is why the implementation of the blockchain can be used in the handling of document forgery by the authorities.

Another example of the application of Distributed Ledger Technology (DLT) is tangle and hash-graph but it is still not effective in dealing with this problem. The use of blockchain in similar cases has been applied to the management[13] of land ownership rights. And this is what underlies the importance of implementing blockchain technology[14] regarding the issue of land ownership rights in Indonesia.

Since being discovered by Satoshi Nakamoto in 2008, blockchain has changed the development of technology[15]. The early versions of blockchain that only concerned cryptocurrencies like Bitcoin, were upgraded again on blockchain versions 2.0, 3.0, to 4.0 which resulted in extraordinary findings of the last decade. Smart contracts have an important role as small scripts that define rules regarding data to be confirmed before operations are performed on the blockchain ledger[16].

In implementing public blockchain the use of smart contracts has been widely used, therefore vulnerabilities in smart contract security[17] should be the main focus[18][19]. The current advancement of 5G technology, also provides opportunities for collaboration from IoT and AI on the Blockchain[20]. Problems related to land ownership in Indonesia can be overcome with the use of IoT and AI combined with smart contracts[21].

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Land management[22] policies in Indonesia are still traditional using paper, which can be easily faked. In making the agreement, it also takes a long time. Identification when registering a transfer of ownership to a bank lease is also difficult. In solving this problem, this research offers a Blockchain-based solution[23][24] in providing data harmony and openness, lightening in data access, permanent record management, and most importantly, a solution that is cheaper and faster. This research contains the main focus as follows:

- Provide an explanation of the system of land ownership certification which is currently a problem.
- Reviewing the current process of digitizing land registration, the general public's understanding, the required government training, the required regulations, and laws, this research offers a step-by-step implementation of blockchain in land certification management in Indonesia.
- In this research, the first stage is a public blockchain that can be regulated based on authority. The second stage is as a limited-scale Hybrid Blockchain where the private

ledger is handled by a confided openly or private foundation whose principal subtleties are shown in the public ledger. The last stage is the implementation of the Full Hybrid Blockchain when the government is willing to increase the scale of the system.

- This research offers the design and development of smart contracts on blockchain in land ownership certification systems.
- The prototype system offered utilizes the Ethereum Blockchain which states that this system can reduce the costs required in processing information, the number of trips required, and result in easy access to important information.

Furthermore, in this study, **Section 1** describes the management system of efforts to digitize land rights in Indonesia. **Section 2** describes the related studies that correlate with this study. **Section 3** describes the stages of the blockchain model being offered. **Section 4** describes the details of the smart contract model of the proposed public blockchain and rules of the experiment, its results. In **Section 5**, there are conclusions from this research that allow future research to be carried out. And last, in **section 6**, there is an acknowledgment for the support and assistance that led to the success of this research

### **The Existing Land Title Certification System In Indonesia**

The government has issued a program to address land certification issues following the Regulation of the Minister of Agrarian Affairs and Spatial Planning / Head of the National Land Agency of the Republic of Indonesia Number 35 of 2016, a Complete Systematic Land Registration or in Indonesian is called as *Pendaftaran Tanah Sistematis Lengkap* (PTSL) program was created. This program is an activity compiled by the government regarding land registration which is carried out simultaneously for objects of land registration in a village or sub-district in Indonesia which consists of a data collection process, determining[25] the correctness of physical and juridical information of the item to be registered. The parties involved in this program include the Ministry of Agrarian Affairs and Spatial Planning / Head of the National Land Agency, the Ministry of Environment and Forestry, and the Ministry of Public Works and Public Housing.

The complicated registration procedure for certification is not fully realized by the general public in Indonesia. This procedure involves multiple documents[26] being sent from one government office to another which takes a long time to complete. This has resulted in a flaw of fraud from irresponsible parties in making bribes for document falsification which resulted in land dispute problems[27]. Many cases have occurred in Indonesia regarding land disputes

that have not been resolved for years. In the Completion of PTSL program, several steps must be passed. Including Counseling, Data Collection, Measurement, Committee A Session, Announcement and Ratification, and Certificate Issuance[28] which can be seen in Figure 1.

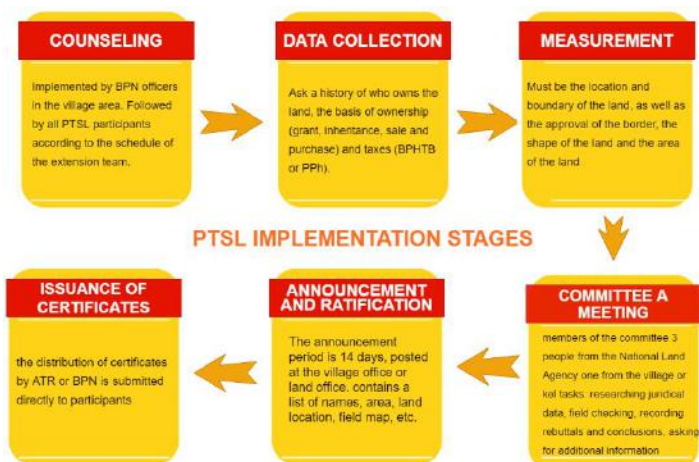


Figure 1. Existing Land Rights Management System In Indonesia.

- 1. Counseling**  
This stage is carried out by BPN officers in the village or sub-district area according to the counseling schedule.
- 2. Data Collection**  
After counseling is carried out, the next step is to collect data by the officers to the community after the extension is carried out, then the officers will collect data to the community including the history of land ownership, the basis of land ownership (whether the land is the result of inheritance, grants, or buying and selling) and also evidence of BPHTB tax and PPh that have been paid.
- 3. Measurement**  
If you have passed the administrative data collection process, then at the next stage the officer will take measurements on the registered land. Measurements taken include the length and width of the land, land boundaries, the shape of the land parcels, and the area of the land parcels.
- 4. Committee Meeting A**  
At this stage, 3 BPN members and one representative from the village or sub-district hold the trial. The trial which was conducted had the objective of examining juridical data, conducting field checks, recording rebuttals to conclude, and finally asking for additional information.
- 5. Announcements and Ratification**  
After the committee meeting stage has been passed, the results will be announced, which contains the name of the landowner, land area, land location, and plot of land. After that, the official will approve it within 14 days after the results of the announcement are posted at the village office or sub-district office or the local land office. If there is no objection or protest from other parties within 14 days after the announcement is circulated, then the

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registered land is declared safe from the dispute and can be followed up to the certificate issuance stage.

#### **6. Issuance of Certification**

After all the stages have been passed smoothly without hindrance, the final stage is the issuance of a certificate submitted by the ATR or ABN to the participant who registered the land.

### **Problems That Exist In The Running System**

The current land certification system includes a series of procedures that are lengthy and require a long time to complete. This procedure also involves many departments in managing important documents needed. This complex set of procedures generally goes unnoticed by the general public, resulting in fraud and bribery taking advantage of government officials' assistance. The following are some of the critical issues that can be described:

- Many irresponsible parties falsified documents through the help of government officials to take over land by force. As a result, it takes a long time for legal landowners to prove ownership of their land in court.
- Irresponsible parties can make false documents by bribing officers and selling land to uneducated parties using these fake documents. As a result, there are two landowners, namely the legal owner and the owner with fake documents which can lead to land dispute problems.
- When there are problems regarding land ownership rights, the settlement made by the judiciary takes a lot of money and takes a long time to resolve the problem.

## **II. LITERATURE REVIEW**

The progress of blockchain originated from the existence of cryptocurrency, and along with the times, the smart contract domain using blockchain emerged. Currently, there are many blockchain-based domains used in finance, health, IoT, media royalties, passports, voting, supply chains, and so on, but the combination of 5G, IoT, and blockchain-based AI is still at an early stage of implementation[29]. There is very little use of blockchain other than cryptocurrency[30] that is currently implemented in Indonesia. As a developing country, the Indonesian government is still working on the digitization process of securities[31], such as land ownership certification to create a transparent system[32].

The research conducted by[33] proposed a method using blockchain technology that is applied to land registration problems using an integrated conceptual framework. The Republic of Georgia implemented a land certification process using blockchain in stages to minimize the possibility of corruption in the registration of land ownership. The system implemented has succeeded in achieving success as seen from the 1.5 million blockchain-based land rights that were successfully issued [34][35][36]. This implemented system contains various features such as a land ownership registration feature, a land purchase feature, to a mortgage feature. With the implementation of this system, the time required for the land certification process is reduced. Research [37] offers an archiving model of blockchain-based electronic medical records in supporting the healthcare 4.0 movement[38]. This system has the main objective of maintaining the confidentiality of patient medical data and accessing the required data more easily. Blockchain-based land registration was tested in the country of Sweden with the main

objective of minimizing the number of physical documents, the overall cost, and the required stages. However, this experiment must pass through various negotiating institutions before it can be fully implemented even though the results of the experiment show good results[39][40]. The next use of blockchain is carried out by the Indian state of Andhra Pradesh, which has collaborated with several companies in realizing a blockchain-based land registration system. This system has secured 100,000 soils as an initial test of the system. This has made the state of Andhra Pradesh a popular destination for Blockchain-based FinTech[41]. The United Arab Emirates (UAE) and Dubai have implemented a project called "UAE Blockchain Strategy 2021" which makes them the leading countries in implementing blockchain. This ongoing project is applied to various sectors such as the transportation and logistics sector, the energy and water sector, the tourism sector, the economic development sector, the safety, and justice sector, the health sector[42], the city, and land sector, and the social services sector [43][44].

A comprehensive study was conducted by[45][46] regarding the land registration management[47][48] framework in India with the reception of blockchain innovation to build up the current framework. The blockchain-based land certification model for India is given in this research, but it does not explain the smart contract scenario, type of architecture, and Public Key Infrastructure (PKI) in its implementation[49]. As explained that it is not easy to replace the old model with the new model based on the blockchain without any policies that can be adopted in real life. As presented in regarding land tenure system for India utilizing Hyperledger Fabric as legal Block-chain and InterPlanetary File System (IPFS) used in document storage. The biggest challenge in this research is the transfer of existing land records in the proposed blockchain-based system. In the research conducted by[50], there is a digital asset exchange system utilizing Ethereum using the PKI model as a proof of delivery mechanism.

The land title certification process in Indonesia goes through several complex stages involving different departments in handling the important documents required. Cheating is also inevitable with the occurrence of various land disputes between the government or the private sector, as well as uneducated people who are victims of fraud by irresponsible parties, which can be processed by the judiciary for a long time. This research offers a land ownership certification system using hybrid blockchain technology as a solution to the problem and in realizing the transparency of existing data. This system uses the PKI model as a third party to ensure that the party registering the certification will be confronted by the arbitrator in making an agreement. The blocks on the blockchain are irreversible and permanent, this makes the block history honored together at every node utilizing a shared network in storing copies of the entire block so that transparency and availability of information can be realized. The limitations of the existing land cause the handover of land ownership rights to be less in number and there is not much important information as identifiers that can help in knowing the original owner of the land, therefore public nodes can be used as public storage places to earn profits. After that, the government will choose private or public institutions to cooperate in obtaining data from the private ledger on the system being offered. In introducing this Full Hybrid solution it will take a long time, therefore the running system will be divided into three stages. The definite plan of the public blockchain has been furnished alongside the smart contract unendingly the utilization of Ethereum in its framework usage. This research has shown significant progress in the manual land title certification process in Indonesia today.

### III. METHODE

One of the main obstacles in implementing blockchain in Indonesia is the lack of existing digital literacy, inadequate and inadequate government funding assistance, and lack of transparency regarding its expenditure budgets, weak bureaucracy, and the absence of a statutory policy issued by the government regarding this matter. Although the implementation of the blockchain has been tested for its application, the use of this blockchain takes a long time to be fully implemented in Indonesia. This study offers a gradual use of blockchain in overcoming the problem of land title certification in Indonesia in Figure 2. The first stage contains counseling from the public blockchain with a simple display that can be used on mobile devices. Later, it will also discuss its relationship with Hybrid Blockchain and Full Hybrid Blockchain as the next stage. The following will explain the procedure of the system offered in detail.

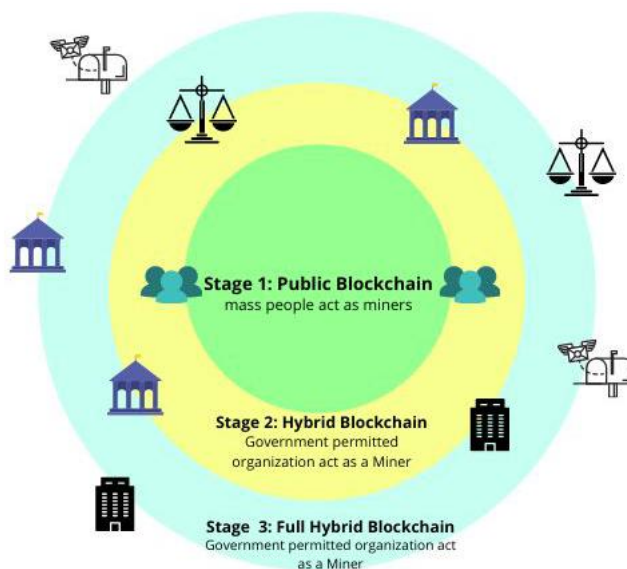


Figure 2. The Proposed Model of Blockchain Adoption of Land Rights Management in Indonesia.

### Stage 1: Public Blockchain Workflow

The initial problem that hindered the implementation of blockchain in Indonesia was that there were still many Indonesians who were illiterate or unable to read. Along with today's technological developments[51][52], we offer a simple UI interface that can create a stamp block on the general ledger when the certification process is submitted. Later, the process of introducing land buyers and sellers will be carried out by checking the Identity Number or in Indonesian, we call it as *Nomor Induk Kependudukan* (NIK). Later this data will be stored in a hash that is in the public ledger and will be processed by the government. This ledger acts as a stamp on the land certificate when the sale and purchase of land are carried out. Because currently there are still many land areas that are not registered through the proper system[53].

In the implementation of this ledger system, voluntary participation from several parties is required and will be regulated by local officials. Every time a new certification is registered, there must be a special identification[54] issued by the National Land Agency (BPN) office. Likewise, in the case of ongoing disputes or land that is being leased, the data must also be recorded in the public ledger of government agencies[55][56]. In the future, land that has not been registered is also expected to be collected into a general ledger, given the ease of use of the application offered. Data that is entered into the general ledger can only be done by government officials or notaries. This is done to prevent fraud or falsification of data. The problem that is obtained from the adaptation of this system is the inability[57] of everyone to use computing which can cause problems in the management of public ledgers. Due to the limited land area at this time and also the limited number of land sale and purchase transactions, the public ledger can be prepared by a gathering of individuals who volunteer. Volunteers who maintain general ledgers also benefit from successful deal deals or the search process. In this blockchain-based public ledger, prospective buyers will be able to see the history of the land they will buy and the status of the land without having to pay a lot of money. The land officer will inspect the land data in the public ledger before the land gets the new ownership handover. This is done so that both parties making transactions can find out about the data in the public ledger. because the process of digitizing takes a long time, it is necessary to collect data on public ledgers as a continuation of the previous stage. Meanwhile, other parties such as startups that have obtained permission from the government can participate in implementing this public blockchain.

### **Stage 2: Hybrid Blockchain Workflow**

In the previous stage, blockchain technology was introduced to the general public and the benefits it provides. This is the basis for the importance of the government implementing blockchain in the digitization process in Indonesia. However, due to the difficulty of making changes to more sophisticated technology, in the first stage preparations must be made by the government before the Hybrid Blockchain stage can be carried out. In this Hybrid Blockchain-based land ownership certification model, we offer a PKI-based communication that is applied to buyers, sellers, and land offices. Along with the digitization process of the land data collection system[58] carried out by the government, then at this stage public or private parties can take part in managing this blockchain system. At this stage, it will also introduce the Private Blockchain ledger which contains land history data on the public blockchain. Everyone who needs PKI must contact the certifier to get the key[59]. Because the benefits of blockchain can already be felt by the community, it is important that the use of PKI can also be felt by the community. At the point when the land deal and buy exchange was completed, the PKI acted as a reliable channel of communication between the seller, buyer, and the land office. The PKI will ensure the responsibility of the officer in charge of making transaction agreements.

Public or private parties who have received permission from the government can participate in the main management at this stage[60]. The few nodes of the allowed private ledger will have a high capacity in solving search problems. Other parties such as universities, courts, post offices, and banks will act as observers in providing important information on the public ledger simultaneously. The government will distribute funds to each trusted node participating in the private ledger and public search. There will be a lot of data confirmed by the private blockchain that can be synchronized digitally as a solution from the current government. Important documents that have been digitized can be viewed using an API provided by the government to any government or private office if digital evidence is required. At this stage, IPFS has not been used to store documents. Since the key information is in the public ledger, it is not

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difficult for people to view land records with a system that is reliable and costs little. this will minimize submissions for land data checks to the land office.

### **Stage 3: Full Hybrid Blockchain Workflow**

In the early stages, counseling was carried out about the advantages of blockchain implementation on the issue of land ownership certification. In the second stage, it has also been explained about the steps that the government can take in implementing the Hybrid Blockchain as the next stage. From the two stages that have been passed, it is hoped that in the future the general public and the government can face the third stage, namely Full Hybrid Blockchain. At this stage, there will be more and more parties involved, such as public or private institutions that will take part in the management process of the private ledger. Modifications of blocks can be done by nodes that have been permitted by the private blockchain when the process of digitizing existing documents in the government is complete. In this final stage, IPFS will be used as a distributed file system to store all existing digital documents. This IPFS system acts in peer-to-peer file sharing where each file gets a unique hash key and the distribution of data blocks is also carried out on this file system. The giving of this uni hash key is done by digital files that are in the immutable block. Later, the government will provide funding to public or private organizations that participate when users submit requests to access documents. The user who requests the document can be a prospective land buyer, the current landowner, or someone who wants to get an overview of the land. The search service for this document will be provided from day to night[61].

In the previous section, it has been explained how the first stage has the function of keeping track of the time of sale and purchase of land transactions, data collection of land owned, land disputes, or land funding issues. In the system we offer, an account must be created by the user before submitting or searching for data. These users can choose their status, whether as owners or people who will buy the land, officials sent to take care of land affairs, financial officials, judicial officials, and notaries. The NIK of the parties involved such as sellers, buyers, and arbiters will be saved at whatever point another block is added to the public blockchain. Detailed data from land or processes related to land can be seen by everyone without having to pay a lot of money. In the next section, we will explain the details of the system offered in detail as you can see in Figure 3:

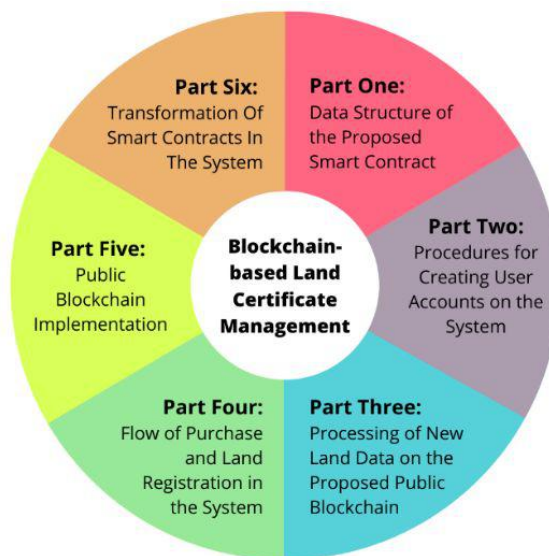


Figure 3. Details of The Proposed Model of Blockchain-based Land Certificate Management in Indonesia.

#### **Part One: Data Structure of the Proposed Smart Contract**

In this section, the smart counter stores detailed user data and the data of Freehold Title or in Indonesian, we call it as *Sertifikat Hak Milik* (SHM) that are entered into the data structure. All details of this user data include such as NIK, full name, date of birth, address, etc. Details of the SHM contain the land certificate number, province, district or city, etc. These details can make it easier when searching for certain data on this smart contract. To expand the space available on a smart contract, land requires a unique identifier taking advantage of the existing division of districts or cities and provinces. Later we will also provide a unique hash code as a combination of the SHM number with the hash plot information.

#### **Part Two: Procedures for Creating User Accounts on the System**

When a user wants to create an account on the system, the user must come to the land office with the documents required for data checking. If the check has been completed and is declared feasible, the user will get an account added to the blockchain. The information contained in this account includes all information from the user and allows editing. If needed, the user can also change his account password. Figure 4. Each account created can only be owned by one user because of the unique ID that each account has. When the first account is created, the user has an empty balance on the account, however, the client can purchase the blockchain money at the land office to do activities on the system.

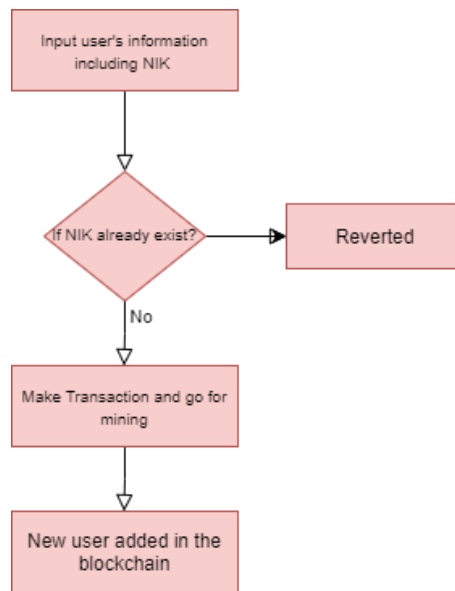


Figure 4. The procedure for creating a new user account

### Part Three: Processing of New Land Data on the Proposed Public Blockchain

If there is a legal owner of land who wants to register his land, the landowner can go to the land office to enter land data on behalf of the owner by providing the required documents. This given document will be checked by the authorized officer before being granted ownership rights to the account that has been created and can be edited if needed later. Data that is entered on the blockchain will also contain SHM and its legal ownership participating in the public blockchain. When entering new SHM data on the blockchain, the first thing that is done is to determine[62] the details of the SHM needed to calculate the required hash Figure 5. The transaction will be canceled if the hash has been registered on the system.

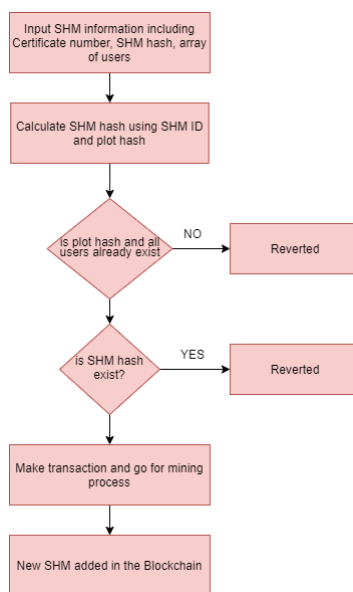


Figure 5. The procedure for adding new SHM to the Blockchain system.

#### Part Four: Flow of Purchase and Land Registration in the System

When making a land sale and purchase transaction, the purchaser and vendor should concur with the existing terms and agreements. The process will continue if the purchaser has paid the complete expense and enlistment charge given[63]. However, if the purchaser is unable to pay off, then they can agree to pay part of the cost and must be paid in full at a specified time. This agreement must also be submitted to the officers at the land office for later checking of the submitted documents. After the documents are checked and legal ownership is declared, the officer will make a fee settlement agreement two different times to allow the buyer to pay the fee. If the buyer declares that he can pay at one time, then the status of the land will change to "not available" and the seller will not be able to make other sales transactions on the land as long as this agreement is still running. Later the buyer must pay the money at the specified time at the land office using the blockchain currency[64]. the money will be deposited in the wallet in the seller's account. Money cannot be disbursed until the seller of land has paid the total price of the land. If the buyer is unable to pay the specified fee, the status of the land will change again to "available" and the agreement will be canceled. If the transaction is successful, the land title will be renewed through a new agreement.

#### Part Five: Public Blockchain Implementation

Ethereum is a distributed tool that provides the opportunity to compile a smart contract in application development [65][66]. In the development of a public blockchain prototype, we offer using Ethereum in implementing smart contracts for land title certification. Solidity is also used in this system as a programming language for executing ethereum code[9][67]. In addition, Ganachecli is also used to test the network, Remix to run solidity code, then use HTML and CSS on the website display[68]. web3.js is used as a library of javascript in interacting with Ethereum via HTTP or IPC and Metamask [69] network connections.

### Part Six: Transformation Of Smart Contracts In The System

The proposed smart contract contains several important objects such as user, SHM, and wallet applied to Ethereum. The first object, namely the user, will load the user's information such as NIK, name, address, etc. The second object contains details of the SHM such as the number of the certificate of ownership, city or district, province, etc. The details of this object will be recognized by an ID or hash[70]. This object wallet also utilizes blockchain technology which functions as a storage place for blockchain currency related to the certification process from land. Every object wallet with a user of the blockchain will be related to one another.

Structure-mapping is used in maintaining the relations of objects that exist in solidity. This mapping process acts as a key-value pair, on all the unique fields that each structure has as well as the values that other structures have in each mapping process. Whenever a unique field with compound value is required, the hash computation process for each compound field is performed using a Keccak256 hash key. The data type of string or text can be used in controlling the storage space. The data type used will be converted into a bytes32 data type which is obtained from the blockchain and converted again to a string data type so that the user can read it. In the heavy data collection process on the blockchain, a lot of gas is needed as a unit to know how much work the computer is doing. Errors can occur such as error gas limits and result in processing failure. In this system, we make use of some sufficient data with reasonable limits in land certification issues.

### Functions Of The Proposed System

The system we are proposing is still in prototype form and has three main objectives focused on creating users, creating freeholdings, and applying for land registration. At the initial stage, the admin officer will enter the user and certificate number utilizing the model of the framework. The admin officer will make a new SHM using the ID of the SHM, and the ID of the user, and later on, the percentage of their SHM property will be explained. Information regarding land and ownership is stored in the freehold block[71]. To make it easier to use Solidity, a hash calculator is utilized to calculate hashes and input details. This hash is used by admin officers in determining the SHM hash which will be used to find details of the designated land on the implementation of the public blockchain. In the previous discussion, we have explained the use of 32 byte-based text in minimizing storage and gas. As can be seen in Figure 6. The initial display did not previously store information from SHM, therefore we have to add data from users and SHM on the website provided.

The screenshot shows a web interface titled "SHM Management". On the left side, there is a vertical navigation menu with the following items: "Add User", "Add SHM", "Calculate Hash", "Search", and "Search". The main content area is titled "ADD SHM" and contains the following form fields:

- Certificate Type:
- Certificate No:
- SHM Hash:
- Percentage of Owned:
- Owner NIK:  Owner Percentage:
- Owner NIK:  Owner Percentage:
- Owner NIK:  Owner Percentage:

At the bottom of the form, there is a button labeled "Add SHM".

Figure 6. The initial view of SHM storage for landowners.

Figure 7. User Interface Display of SHM Mutation

This display will show the initial SHM data along with the percentage of ownership of the SHM. If there are other operations, such as buying or selling land, the system will create a new SHM in the entry system. This new entry will load data from the new owner as shown in Figure 7. In our proposed system we have implemented a hash calculator using the javascript equivalent of Solidity's Keccak256. This hash calculator can be used by users when they want to search for data on the blockchain through SHM hash calculations. Users can also perform SHM data searches by entering the SHM hash in the search box Figure 8.

Certificate No	SHM Hash	Percentage of Owned	Owner NIK	Previous SHM Hash	Sell to SHM Hash
00724	<a href="#">0xaca07f460920f44f5b9d6dc959e1627d18e35e888b</a>	50	<a href="#">33-06-12-44-03-98-0354</a>	None	<a href="#">0x2952f28386a85977bf6bad405</a>

Figure 8 User Display in SHM Search

#### IV. RESULT AND DISCUSSION

This research provides various stages of the blockchain adoption model in overcoming land ownership problems in Indonesia. Current land management policies in Indonesia are still paper-based, traditional, and complex, with various departments working hard to coordinate their work which leads to fraud. Fraud is the main reason for current civil cases in Indonesia and can take a long time to resolve. In solving these problems of transparency, accessibility, and synchronicity, in this study, we have described the stages of implementing a system based on a

hybrid blockchain. Ethereum was used in the implementation of the first stage of the public blockchain prototype model. We actualized a model of the first stage of public blockchain utilizing Ethereum. We have done various network tests, we take advantage of two networks in implementing smart contracts. In testing using the local test network and the live test network ropsten taken from Ethereum

In this study, we offer an answer to tackle the issue of land ownership. The data entry section activity is an exchange in a blockchain-based smart contract. Transactions made will be summarized into one block on the blockchain. The data that is carried out will be maintained safely using Ethereum-based nodes on the blockchain. This system uses Ganache CLI in local network testing[72] to serve 10 dummy accounts with 100 ether on Ethereum each. In testing the local network to implement smart contracts, we use the help of Metamask. The gas limit on the use of the CLI Ganache set on this system reaches 1000000000.

Ten records, ten private keys, and one tuning in port can be generated while the Ganache CLI initialization process is running. The result of this process is that the port status changes from default to 8545 and the use of truffles in port logging to run correctly on Ganache. The history of the smart contract implementation or any existing transactions can be monitored[73] in the Ganache terminal window that has been provided. Testing of Ethereum was carried out using the Ropsten test network which was operated by a voluntary party. Robsten's Remix code is utilized through the use of Matemask. Blockchain[74] operation requires costs, as well as computing power in implementing smart contracts. The results of this application can be seen in Table 1.

Data Type	Network Testing	The Average Expense per Network (Gas)	Final Average Expense	Average Expense
Contract Deployment	Local Test Network	373643	302736	124.67
	Ropsten Test Network	382648		
Adding new client activity	Local Test Network	252738	287657	8.26
	Ropsten Test Network	282684		
Adding new plot activity	Local Test Network	153589	178976	5.35
	Ropsten Test Network	167389		
Starting SHM passage activity	Local Test Network	496436	476890	17.29
	Ropsten Test Network	473928		
SHM transformation activity	Local Test Network	476464	439892	18.94
	Ropsten Test Network	597578		

Table I. Financing From Transactions on Proposed Smart Contracts.

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In implementing blockchain in the issue of land title certification, it has major advantages, namely that the data contained in it is not easily manipulated, and the history of land sale and purchase transactions can be traced back. As a result, the act of manipulating the history of the sale and purchase of land cannot be done because of the immutable nature of the data from the blockchain. The next advantage is that users can easily use the application through a simple GUI display. With these advantages, the time needed to make land certificates can be faster and easier, and the costs are not too much. In the first stage, we have described a demonstration of the advantages of using the blockchain model.

The research we do is purely for academic purposes and we have no relationship with any government agencies. Therefore the government has full control of whether or not this proposed model is applied. In this research, the Ethereum Blockchain will fill about 1.5 GB of storage space and will continue to increase along with the use of blockchain in the real world. Therefore, not

everyone can operate a public blockchain. The private ledger on the hybrid blockchain will later manage larger blocks of data. The result of implementing this public blockchain is the progress of the digitization process that the current government is working on. In this blockchain implementation, the government should make laws and regulations regarding blockchain currencies related to land. In the future, the community must also be given knowledge and training in digitally collecting their land. Besides, the government must also have a process that is superior in the management and data collection of PKI that is safe.

#### V. CONCLUSION & SUGGESTIONS

In Indonesia, the management of land rights is a complex and lengthy process, and there is a lack of synchronization between various government departments. This opportunity was utilized by reckless people and degenerate authorities to make bogus records in carrying out different land wrongdoings. Most civil cases burden the national justice system. We offer a solution using Blockchain Hybrid to provide continuity of interested people, data that is ensured to be transparent, access to data that is made easy, and transaction data that cannot be changed or is permanent. Considering that the technical level of the government and the public is still unfinished, this research offers the implementation of blockchain in 3 stages starting with the public blockchain, which continues to the hybrid blockchain, to the implementation of the full hybrid blockchain. This research offers a detailed smart contract design on a public blockchain and a model framework implemented through utilizing a test network of Ethereum blockchain. From this research, it can be seen that the solutions offered are cheaper, faster, and friendlier for use by general users or the land administration department.

It should be underlined that this research is only limited to academic work and we do not collaborate and have nothing to do with government agencies. This research shows that statutory policies must begin to be issued by the government, and the government must also begin to form the main public infrastructure management agency of Blockchain, improve capabilities, conduct training for officials, and provide lessons to the general public so that the implementation of Blockchain technology can be successful. In the future, the implementation of this research can continue through the application of Hybrid Blockchain or by introducing currency to land issues. Future countermeasures can be taken through security simulations. Also, in the future, it is necessary to prioritize the importance of smart contract security along with an analysis of its vulnerabilities, as well as the correct use of PKI management.

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