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Blockchain-Based Authentication System Using IPFS for Land Certification in West Nusa Tenggara

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ABSTRACT

Land certification is an important process in natural resource management, especially in land and soil management. However, this process often faces security and validity issues, such as duplication, manipulation, and the use of counterfeit documents. Therefore, this research develops a blockchain-based authentication system that uses InterPlanetary File System (IPFS) technology to enhance the security and validity of land certification in West Nusa Tenggara. A web application prototype was developed to demonstrate the practical implementation of this framework. Rigorous testing of the prototype validated the correct functionality of the proposed solution. The research findings indicate that the blockchain-based authentication system using IPFS technology can improve the security and validity of land certification, as well as facilitate the land and soil management process.

Keywords:

Blockchain;
Authentication;
IPFS;
West Nusa Tenggara;
Land certification;

1. Introduction

Land certification is a crucial process in managing natural resources, particularly in land and soil management. This process involves the formal recognition and documentation of land ownership or usage rights, which is essential for ensuring the security of property rights, facilitating land transactions, and enabling effective land-use planning and resource allocation. Land certification helps to establish clear boundaries, minimize disputes, and promote sustainable land use practices (Krishnapriya & Sarath, 2020; Yadav et al., 2021).

In the region of West Nusa Tenggara, Indonesia, land certification process involves the National Land Agency (BPN) and local government authorities, who are responsible for conducting surveys, mapping, and issuing land certificates to property owners. However, the current system is vulnerable to various issues, such as document duplication, manipulation, and forgery, which undermine the security and legitimacy of land ownership claims. Consequently, the region faces challenges, including land tenure conflicts, unlawful land transactions, and the absence of a centralized and secure land registry system.

To address these challenges, blockchain technology offers a promising solution. Blockchain is a decentralized, distributed, and transparent ledger that records transactions across a network of nodes, making it ideal for ensuring the security and integrity of land ownership data (Chang et al., 2022; Keresztes et al., 2022). Additionally, the InterPlanetary File System (IPFS) can be used to store and manage large amounts of data efficiently, which is crucial for the data-intensive requirements of land registration. IPFS is a decentralized storage system that allows users to store and share files in a peer-to-peer network. By combining blockchain and IPFS, the land certification process can become more efficient and scalable, enabling the secure and transparent management of large amounts of data (Li et al., 2023).

According to Bouafia & Gulalov (2024) explored the utilization of blockchain technology in enhancing authentication and authorization processes across various industries. Traditional

methods of authentication and authorization often involve time-consuming and cumbersome processes that require physical interaction with businesses or institutions. By leveraging blockchain technology, users can securely authenticate their identities and authorize transactions using private keys.

Another research on implementing blockchain for authentication, Yang et al. (2020) highlighted the vulnerabilities of traditional methods like passwords, which are susceptible to hacking, and centralized authentication systems, prone to breaches. Particularly in cloud computing, centralized access control exposes sensitive data to tampering or leakage by external hackers and internal managers alike. Blockchain technology presents a more secure alternative by linking user identities to blockchain addresses and encrypting access permissions directly on the blockchain. This decentralized approach eliminates single points of failure that attackers could exploit.

To explore the advantages of IPFS, Sun et al. (2020) focused on addressing the security and privacy concerns associated with storing and sharing sensitive electronic data, such as medical records. The researchers propose utilizing the decentralized InterPlanetary File System (IPFS) to store encrypted electronic data. The decentralized IPFS architecture enhances security by eliminating the single point of failure vulnerability present in centralized storage systems, thereby ensuring improved security and privacy of sensitive data.

The literature review provides evidence that blockchain and IPFS can be used to enhance authentication. The contribution of this research is developed a prototype of blockchain and IPFS implementation in website that ensures the integrity and authenticity of land certification documents and purpose new schema to store land certification data that is tamper-proof and secure.

The paper is organized as follows: Section 1 encompasses the introduction and literature review. Section 2 details the methods employed, including a thorough description of the architectural system and tools used. Section 3 presents the results and discussion. Finally, Section 4 concludes the paper with a conclusion.

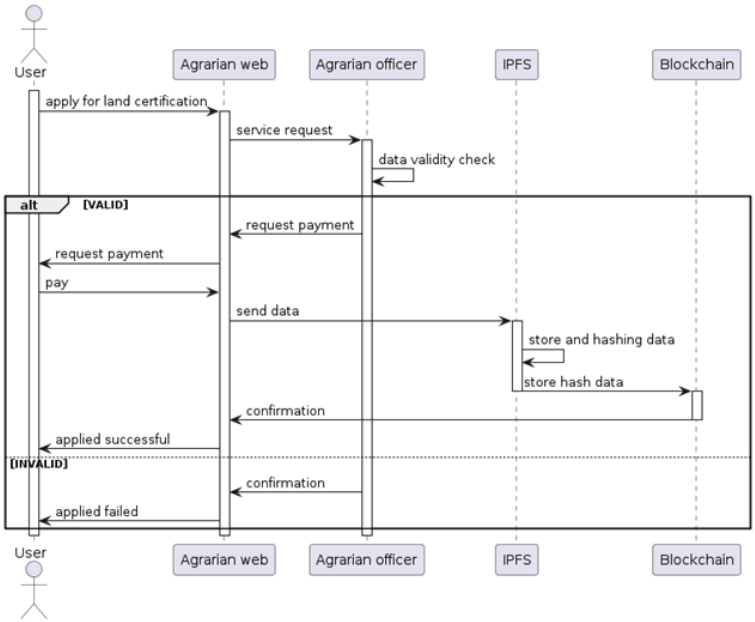

Figure 1. Land application sequence diagram.

2. Methods

2.1. Schema Purpose

The process of land certification is illustrated in Figure 1. Initially, the user applies for

land certification through the agrarian web platform. The application then progresses to the agrarian officer for validation. If the data provided is valid, the next step involves making the necessary payment. After payment is completed, the data is sent to IPFS storage where it undergoes hashing by IPFS. Subsequently, the hashed data is stored on the blockchain. Users receive notifications confirming successful data storage. Conversely, if the data is deemed invalid, users are promptly notified that the validity attempt has failed.

2.2. Architecture System

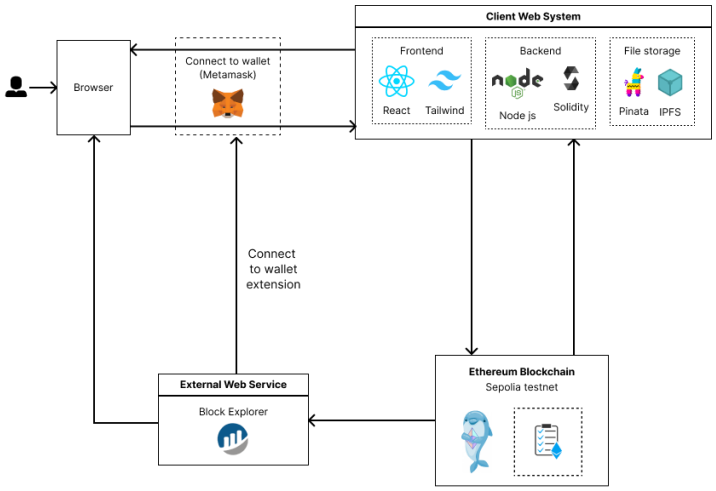

Figure 2. Land registration architecture system.

Figure 2 illustrates the system architecture for this project. This architectural diagram provides information about the technology utilized and the overall system design. The following is a detailed explanation of each software component illustrated in the system architecture diagram:

- User: user is who can interact with the system through a browser.
- Browser: the system is web-based, so it requires a browser to be accessed.
- Crypto Wallet: To be able to view the content on the system, users must be connected to the Ethereum blockchain network using Metamask as a wallet that holds crypto accounts.
- Client Web System: The client web system is a decentralized application that utilizes React and Tailwind for the frontend, providing a responsive and visually appealing user interface. The backend integrates Node.js and Web3.js to facilitate secure interactions with the Ethereum blockchain. For decentralized file storage, the system employs Pinata Cloud for storing data in the InterPlanetary File System (IPFS) format, ensuring data integrity, redundancy, and immutability in a peer-to-peer distributed environment.
- Ethereum: blockchain network used to run smart contracts and store transaction data, The network used is the Sepolia testnet.
- External Web Service: the official web from Ethereum used to view the details of transactions made on the Ethereum network.

3. Results and Discussion

3.1. Authentication

The authentication process in this research utilizes MetaMask, as shown in Figure 3. MetaMask is a popular browser extension that enables users to interact with the Ethereum blockchain. By leveraging MetaMask, the authentication process can be performed in a decentralized and transparent manner, ensuring the accuracy and trustworthiness of the data stored on the blockchain.

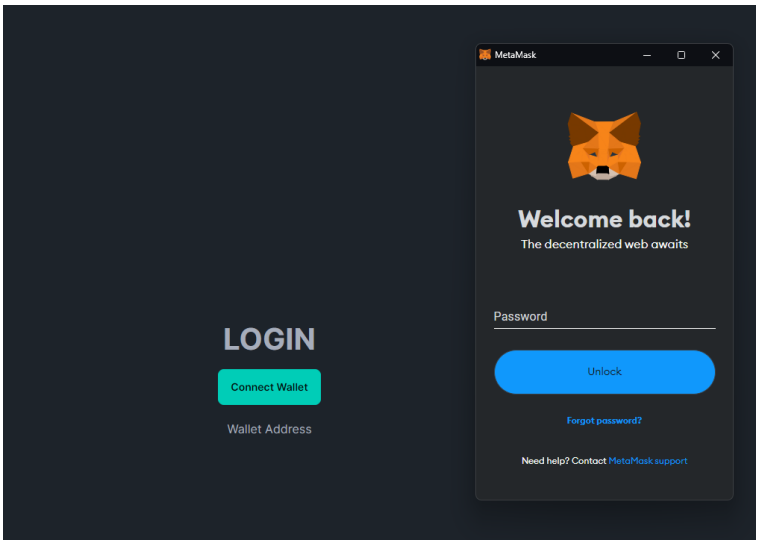

Figure 3. Login page.

3.2. Land certification application

The land certification application process involves several steps. As show in Figure 4, the user is required to fill out a form with the necessary data. Once the form is submitted, the data is converted into metadata and stored in InterPlanetary File System (IPFS). The metadata is then hashed to ensure its integrity and security.

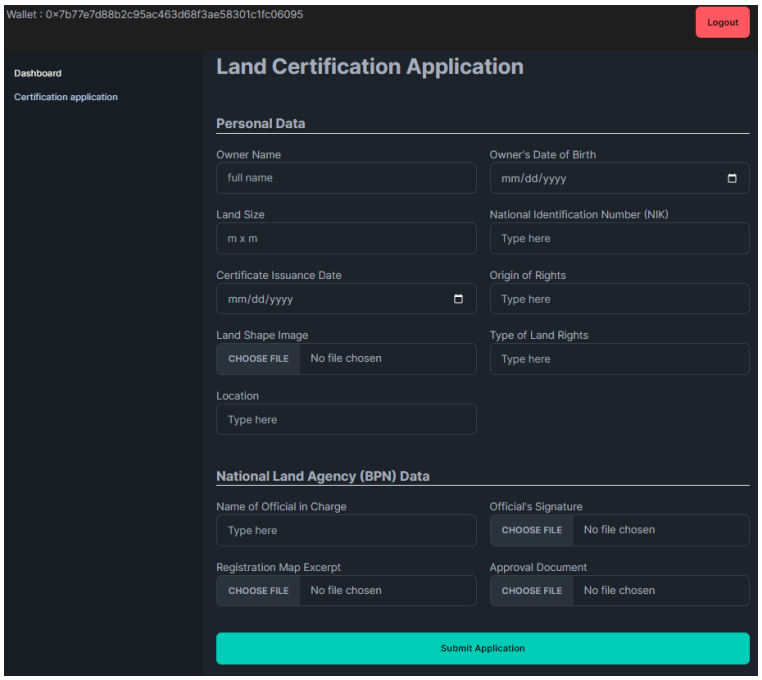

Figure 4. Land certification application page.

3.3. Storing data to blockchain

After storing the data in the InterPlanetary File System (IPFS), the next step involves recording it on a blockchain, as illustrated in Figure 5. This process requires the payment of a gas fee to validate the transaction and store the data on the blockchain. By leveraging blockchain technology, ensures once the data is recorded, it cannot be altered or deleted.

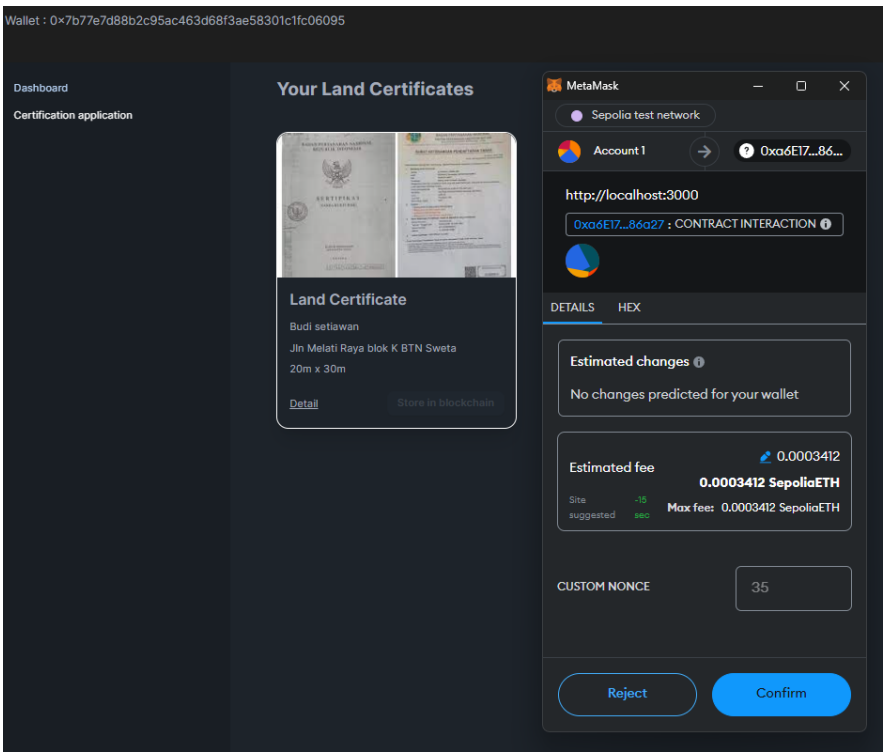

Figure 5. Process of storing data to blockchain.

One notable advantage of this solution is its scalability and adaptability in the context of land registration. While the initial implementation may focus on a specific region or jurisdiction for land certification, the underlying architecture and principles can be extended to other geographical areas or sectors. By leveraging the decentralized nature of blockchain and IPFS, the system can effectively scale to accommodate a growing number of participants and transactions without compromising on performance or security. This scalability ensures that the land registration process remains efficient and reliable, regardless of the scale or complexity of the operation.

4. Conclusions

The authentication of land certification in West Nusa Tenggara is a crucial aspect of ensuring the integrity and security of land ownership data. The prevalence of data manipulation, duplication, and other forms of data tampering has highlighted the need for a robust and secure system to safeguard this information. The implementation of blockchain and InterPlanetary File System (IPFS) technology offers a promising approach to achieving this goal. By leveraging the tamper-proof and secure nature of blockchain and IPFS, the data stored in the land certification system can be protected from unauthorized access, manipulation, and duplication. This can significantly enhance the reliability and trustworthiness of the land certification process, ultimately benefiting the stakeholders involved.

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