

Towards Secure Title Deed Registration Model for Land Transactions in Kenya Based on Block Chain

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Abstract

Blockchain technology creates a publicly accessible distributed database that keeps track of all land transaction records, allowing confirmation of land ownership at any given point in time with the aim of creating a secure and transparent environment that guarantees the much-needed confidentiality and integrity of land transactions. Design Science research methodology was adopted by the research to provide an overall scope in the model design and development requirements, while the Proof of Concept (PoC) research methodology was used to design and develop the essential modules for the model. The research employed subjective sampling to select users to perform a criteria-based model evaluation approach against the evaluation metrics (persistence, time stamping, transparency and decentralisation) set out by the research. Results were presented in the form of a descriptive summary of the users' feedback. From the results, the study established that the model could effectively execute immutable, time-stamped, transparent and decentralised land registration and land transaction processes that can be used as authentic proof of land ownership. The study concluded that the proposed model enhances transparency and security, contributing to a more reliable system that fosters public confidence. The study recommends that future research may focus on the integration of Blockchain with land taxation systems as well as the adoption of cryptocurrency as a legal tender to facilitate the execution of smart contracts for properties in Kenya.

Key Words: *Block Chain Technology, NLMIS/Ardhisasa, Title Deed Registration, Secure Model, Land Transactions*

Introduction

Land ownership is a fundamental aspect of socio-economic development, particularly in countries like Kenya, where it plays a critical role in wealth generation, agriculture, and urban development. However, the land registration system in Kenya faces significant challenges that hinder effective management and ownership of land. The manual processes involved in title deed registration are often slow, inefficient, and susceptible to corruption, leading to disputes and uncertainties surrounding land ownership (Mwangi, 2021). Research has shown that issues such as fraudulent transactions, overlapping claims to the same land, and lost or manipulated records are rampant within the current system (Ndungu, 2020). Such inefficiencies not only impact individual property rights but also undermine the overall economic growth of the nation, as land disputes can deter investment and hinder development projects (Karanja, 2019).

The advent of Blockchain technology presents a transformative opportunity to address these challenges in land registration. Blockchain is a decentralized digital ledger that allows for secure and transparent recording of transactions, ensuring data integrity and immutability (Zhang & Xue, 2018). Each transaction recorded on a Blockchain is time-stamped and linked to previous entries, creating a permanent and verifiable record that is accessible to all authorized parties. This inherent transparency and security make Blockchain particularly suitable for managing land records, as it significantly reduces the risks of fraud and forgery associated with traditional systems (Tapscott & Tapscott, 2016). By eliminating the need for intermediaries, Blockchain can also streamline the registration process, reduce transaction times, and lower costs associated with land transfers.

Smart contracts, another feature of Blockchain technology, can automate the execution of agreements once predefined conditions are met. This functionality can enhance the efficiency of land transactions by ensuring that all parties fulfil their obligations without the need for manual oversight or intervention (Christidis & Devetsikiotis, 2016). For instance, a smart contract could facilitate automatic transfer of ownership upon receipt of payment, thus minimizing delays and increasing trust among stakeholders. The integration of smart contracts within a Blockchain-based land registration system could further enhance legal compliance and enforceability, addressing some of the existing vulnerabilities in the Kenyan land registration framework.

Despite the promising benefits of Blockchain technology in land registration, its adoption in Kenya faces several challenges. Regulatory frameworks must evolve to accommodate this new technology, as existing laws may not adequately address issues related to digital records and transactions (Muriuki, 2022). Additionally, there is a need for public awareness and education on Blockchain technology among stakeholders, including government officials, landowners, and potential investors. Overcoming these hurdles is essential to ensure that the full potential of Blockchain can be realized in transforming land registration processes.

This article proposes a secure Title Deed Registration Model based on Blockchain technology to address the existing inefficiencies in land transactions in Kenya. By analyzing the implications of implementing such a model, the research aims to contribute to the discourse on improving land management systems and fostering a more secure, efficient, and transparent environment for land ownership and transactions. The findings of this study will not only be relevant to Kenya but may also serve as a reference point for other countries grappling with similar challenges in land registration.

Problem Statement

The land registration system in Kenya faces significant challenges, including inefficiencies, lengthy processing times, high rates of fraud, and frequent disputes over ownership, primarily due to outdated manual processes and inadequate security measures. These issues create an environment of distrust among stakeholders and impede economic growth, as fraudulent activities such as multiple title deeds and unauthorized record alterations proliferate (Mwangi, 2021).

Despite the potential of modern technologies to address these problems, the adoption of digital solutions has been slow. Therefore, there is an urgent need for a robust solution that leverages Blockchain technology to enhance security, transparency, and efficiency in land transactions (Zhang & Xue, 2018). This article proposes a Blockchain-based Title Deed Registration Model to mitigate these challenges and provide a reliable framework for land ownership in Kenya.

Research Objectives and Questions

The overall research objectives were:

- i. To review the challenges of Land transactions for Land ownership in Kenya.
- ii. To design a secure title deed registration model for land transactions in Kenya Based on Blockchain and evaluate the output of the designed model against the evaluation metrics set out by the study with the view of recommending it for future implementation in Kenya.

The study sought to address the following research questions:

- i. What challenges exist in Land transactions for Land ownership in Kenya?
- ii. How can a secure title deed registration model for Land transactions in Kenya based on Blockchain be designed? What requirements are needed for a successful evaluation of the designed model as well as the expected outcomes to inform the model's recommendation for future implementation in Kenya?

Literature Review

Land registration ecosystem exhibits significant challenges, particularly in developing countries like Kenya. Mwangi (2021) emphasizes the rampant issues of fraudulent transactions and the issuance of multiple title deeds, eroding public trust in the land management system. Ndungu (2020) further discusses how these inefficiencies impact economic growth, leading to social unrest and hindering investments. Recent studies by

Otieno et al. (2023) reveal that nearly 60 percent of landowners in Kenya have experienced disputes over property, underscoring the urgent need for reform in the registration process.

Blockchain technology has emerged as a potential solution to enhance land registration systems. Zhang and Xue (2018) assert that the immutable nature of Blockchain provides a secure and transparent method for recording land transactions, significantly reducing the risks associated with traditional systems. Smart contracts, a key feature of Blockchain, can automate and enforce agreements, thereby increasing the efficiency of transactions (Christidis & Devetsikiotis, 2016). Recent advancements in Blockchain applications indicate a growing interest in its potential for land management, with studies like those by Wong et al. (2023) demonstrating successful implementations in various jurisdictions, showing enhanced security and trust among stakeholders.

Despite the promising benefits of Blockchain, literature indicates a slow adoption of digital solutions in land registration processes. Muriuki (2022) noted that existing regulatory frameworks in Kenya are inadequate for accommodating new technologies, creating barriers towards its implementation. Moreover, Karanja (2019) highlights the need for public awareness and education on Blockchain technology among stakeholders to facilitate acceptance. A more recent study by Kamau and Mutai (2023) suggests that stakeholder engagement and comprehensive training programs are critical for the successful adoption of Blockchain in land registration.

Trust Issues in Land Registration in Kenya

The United Kingdom introduced a Registry of Deeds scheme in the year 1708 as an efficiency system for land administration and management. The system gained popularity and it was later on adopted and implemented by authorities across several European countries (Nishio, *et al.*, 1998). Kenya, being a former colony of the United Kingdom, adopted a similar scheme in the management and administration of land resources. Over the years, the Registry of Deeds system largely remained manual. The ripple effect of such a system paved the way for a compromised, inefficient, time consuming, unpredictable, inflated and ineffective land administration and management processes that relied on a centrally managed Registry of Deeds by the Ministry of Lands (Gillies *et.al.* 2019).

In response to the challenges, the Government of Kenya in the year 2007 introduced the automation of Land records and transactions by developing and deploying a National Land Management Information System (NLMIS) based on big data technology (Kwanya, 2014).

Furthermore, in the year 2021, the Ardhisasa platform was launched with the sole objective of digitizing land records in all Land registries across Kenya. The digitization process encountered challenges related to matters to do with overlapping institutional responsibilities, absence of proper documentation of Land records, missing Land records in the main registry, illegitimate and non-procedural Land transfers, more than double allocation of the same Land with multiple title deeds issued to it as well as corruption in Government (MoL 2021.)

Trust is a fundamental component of any effective land registration system, as it directly influences stakeholder confidence in property rights and transactions. In Kenya, trust issues have been a significant barrier to the effective management of land resources. Lack of transparency in the land registration process has fostered an environment of suspicion and mistrust among landowners, government officials, and other stakeholders. Many landowners fear that their rights may not be adequately protected, leading to reluctance in engaging in transactions or investments involving Land (Mwangi, 2021).

Additionally, the existence of multiple title deeds for the same property complicates matters further. Otieno et al. (2023) report that overlapping claims to land have become increasingly common, leading to disputes that escalates into lengthy legal battles. This situation not only generates frustration among landowners but also diminishes trust in the ability of the land registration system to provide accurate and reliable information regarding ownership. Without a reliable system to verify land ownership, stakeholders remain sceptical about the security of their investments.

The introduction of Blockchain technology has the potential to address these trust issues effectively. By providing a transparent and immutable ledger of land transactions, Blockchain can enhance accountability and reduce opportunities for corruption (Zhang & Xue, 2018). Furthermore, smart contracts can automate the enforcement of agreements, ensuring that all parties fulfill their obligations, which can bolster trust among stakeholders (Christidis & Devetsikiotis, 2016). This study aims to explore how a Blockchain-based Title Deed Registration Model can help restore trust in the land registration process in Kenya, thereby encouraging more robust participation from all stakeholders involved.

Proposed Framework

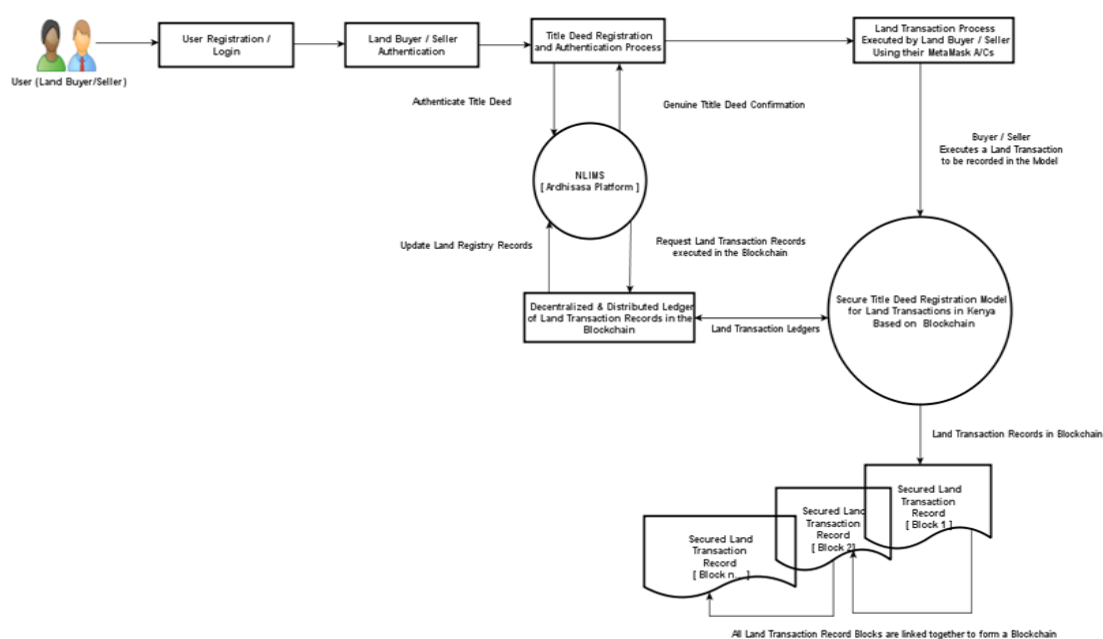


Figure 1: Conceptual Framework

Framework Operation

The conceptual framework informed the architectural design of the model which is anchored on Ethereum. In this case, our Ethereum is decentralized Blockchain whose function is to establish a peer-to-peer network that securely executes and verifies an application code referred to as Land Registry Smart contract. The Smart contract enables land buyers and sellers to execute land transactions amongst themselves without a trusted central authority or an intermediary/Land broker. Once a land has been bought or sold, a transaction record is generated. All transaction records are time stamped, immutable and they can be verified by anyone in the network. User-created Ethereum accounts are used to send and receive transaction records which come along with a cost referred to as Ether. Several transaction records are generated out of the Land Registry Smart contract and updated as a distributed ledger in the entire peer –to-peer network. Every transaction is treated as a Block and each Block is linked to the next Block using a cryptographic harsh value. This forms an effective tamperproof chain that has all the benefits of using Blockchain in Land transactions. With each block having been updated and secured in the Blockchain, the Kenyan Government agencies, for example the Ministry of Lands, or any other interested party, can have access

rights to Land transaction records in the Blockchain for purposes of making informed decisions on matters related to Land transactions and management.

Research Methodology

The model authenticated land ownership in the blockchain-based title deed registration model. Selected users submitted their title deeds and supporting documents, which were validated against predefined criteria and cross-referenced with existing land registry records. Discrepancies prompt alerts for investigation, ensuring only verified information is recorded, thereby enhancing trust and efficiency in land transactions.

Proof of Concept

A prototype was developed to implement the blockchain-based model for secure title deed registration. The system was created using a combination of React.js for the front-end interface and Node.js with MongoDB as the back-end for data management. React.js is a flexible, efficient declarative open-source JavaScript library used to build creative user-interfaces and components for the client-side JavaScript framework. Node.js provides a robust server-side platform while MongoDB is an open-source document database. The prototype effectively demonstrates the functionality of user authentication, document submission, and automated verification processes, showcasing how land ownership details can be securely recorded and managed on the Blockchain Model.

Results and Discussion

Muriuki (2019) highlighted six stages involved in land registrations and transactions. The first stage is the preliminary land identification and informal due diligence; second stage is to perform land search in the Land's Registry; third stage is to sign up land sale agreement between parties involved in the transaction; the fourth stage is the transfer of the land documents; fifth is the stamp transfer and lastly, the sixth stage involves the registration of the land title transfer. The entire process is extremely tedious and time consuming. This research established and adopted a criterion for evaluating the designed model based on the following key areas of model assessment:

- i. Persistence
- ii. Time-stamping of Records
- iii. Transparency/Approachability
- iv. Decentralization

This is summarized in Table 1 below, to demonstrate the key of assessment criterial for the Secure Title Deed Registration Model for Land Transactions in Blockchain.

Table 1: Assignment of the Model’s Assessment Key

Key Areas of Model Evaluation	Assessment Key
i. Persistence	1
ii. Time-stamping of Records	2
iii. Transparency/Approachability	3
iv. Decentralization	4

The assessment keys shown in Table1 above were adopted by the research for the purpose of identifying the key areas of focus during the model evaluation and not necessarily the weights carried by each of the areas of focus for evaluation. Based on the above criteria, the research made and assessment of the current title registration and land transactions processes. This is demonstrated in Table 2 below:

Table 2: Assessment of current title registration and land transaction processes against Assessment Key of the Secure Title Deed Registration Model for Land Transactions in Blockchain

Title Registration	Land Transactions
1	X
2	X
3	X
4	X

Based on the assessment criteria in Table 2 above, the research observed that the current Title Registration and Land transaction processes is prone to challenges and limitations previously

highlighted in this article and does not guarantee the persistence, time-stamping, transparency and the decentralization of land transactions.

Table 3: User Evaluation Assessment of the Secure Title Deed Registration Model for Land Transactions in Kenya Based on Blockchain against Key Areas of Model Evaluation as indicated in Table 1 above.

User	Key Areas of Model Evaluation	Assessment Key	Feedback
Surveyor	Persistence	1	The Model demonstrated persistence in that Land transaction records were stored permanently in the form of immutable ledger containing all the history of transactions.
Land's Registry Officer	Time-stamping of Records	2	The Model demonstrated that all transaction land transaction entries in the Blockchain were digitally recorded at the time of execution, meaning all the transaction blocks were traceable.
Surveyor	Transparency/ Approachability	3	The Model demonstrated that all transaction records were accessible to the entire network participants, thus ensures that all entries were transparent to all land buyers and sellers
Land's Registry Officer	Decentralization	4	The Model demonstrated that land transactions were able to be executed directly by the users involved without the need of a third party. This feature enhances the integrity of the transactions of the Blockchain system.

From Table 3 above, the research observed that upon evaluation by the selected users, the model achieved its objectives.

Conclusion

In conclusion, the research highlighted Blockchain's potential to transform the land registration and transaction processes in Kenya by addressing critical challenges such as fraud and inefficiency. The proposed model enhances transparency and security, contributing to a more reliable system that fosters public confidence. This study adds to the growing literature on Blockchain applications in land management.

Areas For Further Research

This article recommends the adoption of the designed Secure Title Deed Registration Model for Land Transactions in Blockchain by the Government of Kenya to provide an efficient and effective platform through which citizens living anywhere, within the territory of the Republic of Kenya and beyond can execute land transactions without the involvement of a third party. However, the computing power of nodes involved in the Blockchain network needs to be addressed by future research in this domain. This research did not take into consideration the use of Cadastral Maps in the designed model due to time constraints, something that future research may as well take into consideration.

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