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Designing a secure title deed registration model for land transactions in Kenya based on blockchain

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Abstract
The purpose of this study was to design a secure title deed registration model for land transactions in Kenya based on Blockchain. 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: Blockchain technology, NLMIS/Ardhisasa, title deed registration, secure model, land transactions.

INTRODUCTION

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inefficiencies, lengthy processing times, high rates of fraud, and frequent disputes over ownership, primarily due to outdated manual processes and inadequate security measures.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 unauthorised 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).

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 introduction of Blockchain technology presents a transformative opportunity to address these challenges in land registration. Blockchain is a decentralised digital ledger that enables the 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 authorised 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). Blockchain, by eliminating the need for intermediaries, can help improve the registration process, shorten transaction times, and minimise the cost of property 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 the automatic transfer of ownership upon receipt of payment, thus minimising 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 maximum potential of Blockchain can be realised 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 analysing 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.

LITERATURE REVIEW

The land registration ecosystem exhibits significant challenges, particularly in developing countries like Kenya. Mwangi (2021) emphasises 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 per cent of landowners in Kenya have experienced disputes over property, underscoring the urgent need for reform in the registration process.

Blockchain technology is a potential solution to enhance land registration systems. Zhang and Xue (2018) assert that the immutable nature of Blockchain gives a safe and transparent method for recording land transactions, significantly reducing the risks associated with traditional systems. A key feature of Blockchain called smart contracts 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, the 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 their 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 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 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 2021, the Ardhisasa platform was launched with the sole objective of digitising land records in all land registries across Kenya. The digitisation 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. The 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 to engage in transactions or investments involving land (Mwangi, 2021).

One of the primary factors contributing to trust issues is the prevalence of corruption within the land administration system. Ndungu (2020) highlights that corrupt practices, such as bribery and favouritism in the allocation of land, erode public confidence in the authorities responsible for land management. This corruption not only undermines the integrity of land records but also creates an uneven playing field where some individuals exploit the system to acquire land unlawfully. As a result, many citizens perceive the land registration system as a tool of exploitation rather than a mechanism for securing their rights.

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 escalate 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 fulfil 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

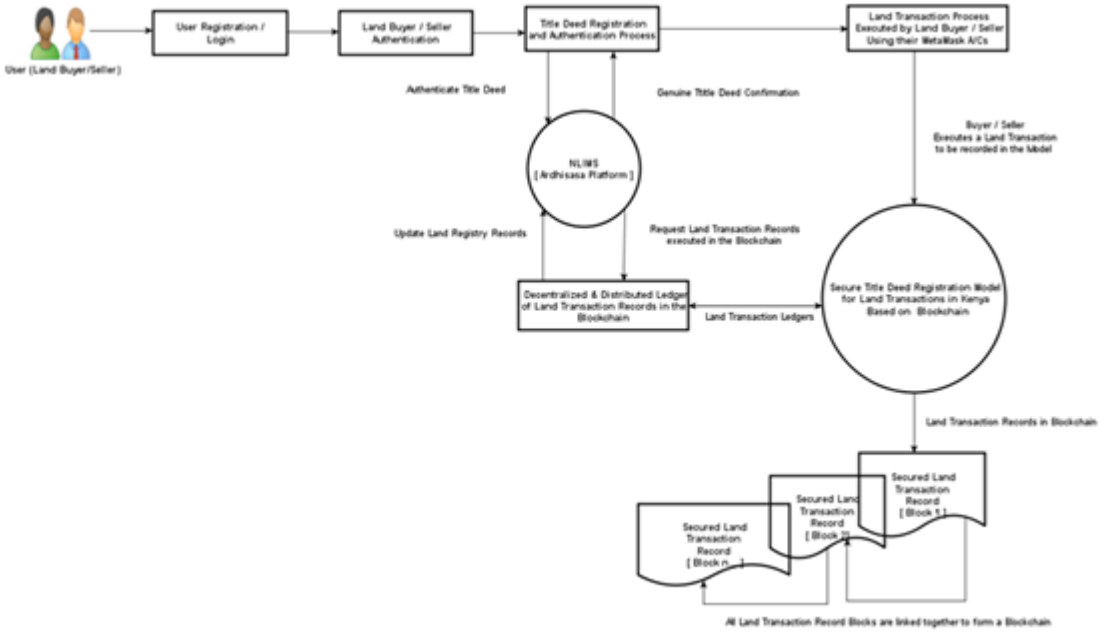

Figure 1: Conceptual Framework

The proposed framework for a Blockchain-based Title Deed Registration Model in Kenya integrates a user-friendly interface for landowners and officials, a decentralised ledger for secure

transactions, and smart contracts for automation. It features a digital land records database and identity verification to prevent fraud while ensuring seamless integration with government databases. Enhanced security protocols, including encryption and access controls, are embedded throughout, aiming to restore trust, promote transparency, and improve efficiency in land transactions.

Framework Operation

The conceptual framework informed the architectural design of the model, which is anchored on Ethereum. In this case, our Ethereum is a decentralised Blockchain whose function is to establish a peer-to-peer network that securely executes and verifies an application code referred to as a 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 and 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 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 hash 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.

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; the second stage is to perform a land search in the Land's Registry; the third stage is to sign a land sale agreement between parties involved in the transaction; the fourth stage is the transfer of the land documents; fifth is the stamped transfer, and lastly, the sixth stage involves the registration of the land title transfer. The whole 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:

a) Persistence
b) Time-stamping of Records
c) Transparency/Approachability
d) Decentralisation

This is summarised in Table 1 below to demonstrate the key assessment criteria 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
Persistence	*1*
Time-stamping of Records	*2*
Transparency/Approachability	*3*
Decentralisation	*4*

The assessment keys shown in Table 1 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 was conducted to assess the current title registration and land transaction 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 are prone to challenges and limitations previously highlighted in this article and do not guarantee the persistence, time-stamping, transparency and decentralisation 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 an 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 ensuring that all entries were transparent to all land buyers and sellers
Land's Registry Officer	Decentralisation	*4*	The model demonstrated that land transactions were able to be executed directly by the users involved without the need for 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 AND RECOMMENDATIONS

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.

Recommendations: 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 take into consideration.

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