# Systematic Mapping and Literature Review: Blockchain Applications in Land Administration with Relevance to Tanzania’s Dual Tenure System

## Abstract

This report examines how blockchain technology might help Tanzania’s complex land system, based on a review of 44 document summaries. Tanzania faces unique challenges because it has two different land systems working side by side - traditional customary rights and official government titles. This creates problems like double land sales, fake documents, confusion, and disputes.

Our review shows blockchain could potentially make land records more transparent, secure, and efficient. However, we found a significant gap in the existing literature: few studies focus on exactly how to bring both customary and official land systems together on one blockchain platform - which is what Tanzania needs most.

Despite this gap, the literature provides valuable insights into choosing the right technology, governance considerations, and implementation lessons. We conclude that while blockchain shows promise for Tanzania, its success will depend on careful design that addresses the specific needs of both land systems, ensures buy-in from traditional authorities, and develops appropriate legal frameworks.

## 1. INTRODUCTION

### 1.1 Background

Land administration systems worldwide face many challenges, including inefficiency, lack of transparency, insecurity of tenure, fraud, and high costs. These problems are often worse in developing countries (Home, 2023; Todorovski, van der Molen, & Zevenbergen, 2016). Traditional paper-based systems - and even some digital ones - struggle to provide the security and reliability needed for effective land governance (de Vries, 2021; Home, 2023; Tshitangano, 2024).

In recent years, blockchain technology has gained attention as a potential solution. It offers a way to keep records that is decentralized, unchangeable, and transparent (Daniel & Speranza, n.d.; Nkwabi, 2021; Paavo & Rodríguez-Puentes, 2024; Racetin, Kilić Pamuković, Zrinjski, & Peko, 2022; Stefanović et al., 2018; Tshitangano, 2024).

### 1.2 Problem Context

Tanzania has a unique challenge as it operates under a dual land tenure system that combines customary rights (traditional, community-based) and statutory rights (government-issued titles). This mixed system creates significant issues such as double land sales, fraudulent documents, confusing processes, excessive bureaucracy, and numerous disputes. These problems make land ownership insecure, discourage investment, and particularly hurt vulnerable groups who rely on customary rights.

While blockchain experiments exist globally, applying this technology to Tanzania’s specific situation - where traditional and formal systems must work together - remains largely unexplored.

### 1.3 Research Aim and Objectives

This review aims to analyze what we know about blockchain and digital technologies in land administration, based on our collection of 44 document summaries, and see how relevant this knowledge is for Tanzania’s unique challenges.

We want to:

1. Map out the scope, focus, context, technologies, stakeholders, and governance models discussed in these documents

2. Bring together evidence about the effectiveness, benefits, challenges, and feasibility of blockchain solutions for land administration

3. Identify what’s missing from the current literature, especially regarding the integration of customary and statutory land systems using blockchain

4. Assess how applicable these findings are to Tanzania’s situation

### 1.4 Research Questions

Based only on our collection of 44 documents, we seek to answer:

1. What aspects of land administration, tenure systems, and related challenges have been addressed by blockchain solutions in the literature?
2. In which contexts (countries, development stages) are these solutions being explored?
3. What specific technologies (blockchain types, platforms, smart contracts) are being discussed?
4. What stakeholders and governance models are mentioned?
5. What evidence exists regarding the effectiveness, benefits, challenges, and feasibility of using blockchain for land administration?
6. What gaps exist in the literature about integrating customary and statutory tenure systems using blockchain, and how might this inform Tanzania’s approach?

### 1.5 Scope and Limitations

This report is strictly limited to analyzing the 44 document summaries provided. It does not include external literature. Our findings represent only the knowledge contained in this specific collection, and the depth of analysis is limited by the summary format of the source material.

## 2. METHODOLOGY

### 2.1 Review Protocol

We employed a combined approach of Systematic Mapping (SM) and Systematic Literature Review (SLR): - Mapping exercise: Categorized literature to provide an overview of the research landscape (addressing RQs 1-4) - Review synthesis: Focused on analyzing findings about effectiveness, challenges, and relevance to the Tanzanian context (addressing RQs 5-6)

### 2.2 Search Strategy and Selection Process

While this review is based on 44 provided summaries, a typical rigorous process would include:

**Keywords across relevant domains:** - *Blockchain Technology*: “blockchain,” “distributed ledger technology,” “smart contract,” “Hyperledger Fabric,” “Ethereum” - *Land Management*: “land registry,” “land administration,” “land governance,” “tenure security,” “land titling” - *Tenure Systems*: “customary tenure,” “statutory tenure,” “dual tenure system,” “CCRO,” “formal land title” - *Geographic Context*: “Tanzania,” “East Africa,” “Sub-Saharan Africa,” “developing countries”

**Search Strings:** Keywords combined using Boolean operators (AND, OR)

**Databases:** Academic databases (Scopus, Web of Science, IEEE Xplore, ACM Digital Library), regional databases (African Journals Online), and broader engines (Google Scholar)

**Gray Literature:** Reports from organizations like UN-Habitat and World Bank, documentation from relevant pilot projects, and technical white papers

**Time Frame:** Typically, 2015-2025, focusing on the relevant emergence of blockchain in this field

### 2.3 Inclusion and Exclusion Criteria

**Inclusion:** Studies that:

1. Focus on blockchain in land management/administration/tenure - Discuss customary, statutory, or dual tenure systems
2. Relate to developing countries or contexts relevant to Tanzania
3. Are peer-reviewed articles, conference papers, or credible gray literature - Are in English and published within the set timeframe

**Exclusion:** Studies that:

1. Discuss blockchain but not land management (e.g., only cryptocurrency)
2. Discuss land management but without technology
3. Focus only on developed countries with low transferability
4. Are not in English or fall outside the timeframe - Are low-quality sources lacking peer review

### 2.4 Data Extraction and Synthesis

For this report, information relevant to the six research questions was systematically extracted from each of the 44 provided summaries:

1. During the mapping phase (RQs 1-4): Key details (location, technology, challenges) were noted and categorized
2. For the synthesis phase (RQs 5-6): We compared findings across summaries to identify common themes, reported benefits, challenges, points of agreement or disagreement, and knowledge gaps, with Tanzania’s dual tenure problem as the focal point

## 3. SYSTEMATIC MAPPING RESULTS

### 3.1 Scope and Focus of Literature (RQ1)

The documents cover a wide range of topics within land administration and technology:

**Core Land Administration Issues:**

1. Land registration and titling
2. Tenure security (formal, customary, perceived)
3. Cadastre and conveyancing
4. Land records management
5. Land information systems
6. Land governance and reform

**Challenges Addressed:**

1. Inefficiency, delays, and bureaucracy (Miller, 2018; Niyibizi, 2024; Paavo & Rodríguez-Puentes, 2024; Adeyinka, 2020)
2. Lack of transparency (Daniel & Speranza, n.d.; Miller, 2018; Tshitangano, 2024; Adeyinka, 2020)
3. Fraud, corruption, document forgery, and double selling (Miller, 2018; Jayabodhi, Rajapakse, & Senanayake, 2020; Nkwabi, 2021; Tshitangano, 2024)
4. Insecure tenure (Kuusaana, n.d.; Hillenbrand, 2025; Abdulai, 2024; Tshitangano, 2024) - Data inaccuracy and incompleteness (Miller, 2018; Tshitangano, 2024; Mwesigwa, 2024; Ntongani, 2024)
5. High costs (Tshitangano, 2024; Ntongani, 2024)
6. Accessibility issues (Tshitangano, 2024; Ntongani, 2024)
7. Disputes and conflicts (Ndubuisi & Nnonyelu, n.d.; Abdulai, 2024; Todorovski, van der Molen, & Zevenbergen, 2016; Adeyinka, 2020)

**Solutions & Concepts:**

1. Blockchain/DLT applications (Daniel & Speranza, n.d.; Ameyaw, n.d.; Niyibizi, 2024; Paavo, 2024; Jayabodhi, Rajapakse, & Senanayake, 2020; Nkwabi, 2021; Tshitangano, 2024; Ameyaw & de Vries, 2021; Paavo & Rodríguez-Puentes, 2024; Stefanović et al., 2018; Racetin, Kilić Pamuković, Zrinjski, & Peko, 2022; Zein & Twinomurinzi, 2024).
2. Digitalization of records and processes (Hillenbrand, 2025; Miller, 2018; Papaskiri et al., 2020; Papaskiri et al., 2021; Tshitangano, 2024; Mwesigwa, 2024)
3. Fit-for-Purpose Land Administration (FFPLA) (numerous authors from Enemark, McLaren, & Lemmen to Hull & Whittal)
4. Smart Contracts (Niyibizi, 2024; Jayabodhi, Rajapakse, & Senanayake, 2020; Tshitangano, 2024; Stefanović et al., 2018)
5. Geospatial Technologies (de Vries, 2021; Bennett, Unger, Lemmen, & Dijkstra, n.d.; Koeva et al., n.d.)
6. Public-Private Partnerships (García-Morán, Ulvund, Unger, & Bennett, n.d.; Tshitangano, 2024; Alhola & Gwaindepi, 2024)

### 3.2 Geographical and Development Contexts (RQ2)

The literature focuses heavily on:

**Sub-Saharan Africa:** - Ghana (Kuusaana, n.d.; Ameyaw, n.d.; García-Morán et al., n.d.; Miller, 2018; Abdulai, 2024; Ameyaw & de Vries, 2021; Alhola & Gwaindepi, 2024) - South Africa (Hull & Whittal, n.d.; Motswenyane, Cooper, & Coetzee, n.d.; Tshitangano, 2024) - East Africa - Tanzania, Kenya, Uganda (Niyibizi, 2024; Nkwabi, 2021; Mwesigwa, 2024; Ntongani, 2024) - Other African countries (Nigeria, Namibia, Rwanda, Ethiopia)

**Other Global South/Developing Contexts:** - Latin America (Colombia, Brazil) - Eastern Europe (Serbia, Georgia) - Asia (Sri Lanka, India, Bangladesh) - Middle East (Afghanistan, Sudan)

**Developed Contexts (often for comparison):** - Northern Europe (Sweden, Netherlands) - North America (US, Canada) - Baltic (Estonia) - East Asia (Japan)

**Specific Situations:** - Post-conflict settings (Augustinus & Tempra, n.d.; Todorovski, van der Molen, & Zevenbergen, 2016) - Peri-urban areas (Kuusaana, n.d.; Abdulai, 2024) - Informal settlements (Mitchell et al., n.d.; Childress, Carter, & Barki, n.d.) - Customary land areas (Ndubuisi & Nnonyelu, n.d.; Kuusaana, n.d.; Chipofya, Jan, & Schwering, n.d.; Abdulai, 2024)

### 3.3 Technologies Discussed (RQ3)

**Blockchain Technologies:** - General concepts (blockchain, distributed ledger technology) - Different types (public, private, permissioned, hybrid blockchains) - Specific platforms (Hyperledger Fabric, Ethereum) - Key features (decentralization, immutability, transparency, cryptography) - Smart contracts

**Land Administration Tools:** - Fit-for-Purpose Land Administration approaches - Land Administration Domain Model (LADM) - Social Tenure Domain Model (STDM) - Integrated Land Management Information System (ILMIS) - Tanzania specific

**Supporting Technologies:** - Geospatial tools (GIS, drones, remote sensing, GPS) - Digital conversion processes - Cloud platforms - Artificial Intelligence / Machine Learning - Mobile technology - Internet of Things (IoT)

### 3.4 Stakeholders and Governance Models (RQ4)

**Key Stakeholders:** - Government bodies (ministries, land offices, municipalities, courts) - Traditional authorities (chiefs, elders, customary land secretariats) - Private sector (banks, lawyers, surveyors, tech companies, developers) - Citizens (landowners, buyers, sellers, farmers, vulnerable groups) - International organizations (World Bank, UN) - NGOs and civil society - Academic researchers

**Governance Approaches:** - Centralized vs. decentralized systems - Public-private partnerships - Institutional Analysis and Development (IAD) framework - Fit-for-Purpose principles - Customary governance systems - Co-management approaches - Smart land management

## 4. SYSTEMATIC LITERATURE REVIEW FINDINGS

### 4.1 Effectiveness and Benefits (RQ5)

The documents consistently highlight several potential benefits of blockchain for land administration:

**Transparency and Accountability:** Blockchain makes land transactions and records more visible to all parties, increasing accountability and reducing opportunities for corruption (Daniel & Speranza, n.d.; Ameyaw, n.d.; García-Morán et al., n.d.; Vos, Lemmen, & Beentjes, n.d.; Miller, 2018; Niyibizi, 2024; Paavo, 2024; Nkwabi, 2021; Tshitangano, 2024; Ameyaw & de Vries, 2021; Paavo & Rodríguez-Puentes, 2024; Stefanović et al., 2018; Racetin et al., 2022; Zein & Twinomurinzi, 2024; Mwesigwa, 2024; Adeyinka, 2020; Ntongani, 2024).

**Security and Integrity:** The unchangeable nature of blockchain prevents tampering and unauthorized changes, making records more secure and reducing fraud and double-selling (Daniel & Speranza, n.d.; García-Morán et al., n.d.; Vos, Lemmen, & Beentjes, n.d.; Miller, 2018; Niyibizi, 2024; Paavo, 2024; Jayabodhi, Rajapakse, & Senanayake, 2020; Nkwabi, 2021; Tshitangano, 2024; Ameyaw & de Vries, 2021; Paavo & Rodríguez-Puentes, 2024; Stefanović et al., 2018; Racetin et al., 2022; Zein & Twinomurinzi, 2024; Mwesigwa, 2024).

**Efficiency and Cost Reduction:** Smart contracts and streamlined processes can make transactions faster and cheaper by reducing paperwork and the need for intermediaries (García-Morán et al., n.d.; Miller, 2018; Jayabodhi, Rajapakse, & Senanayake, 2020; Tshitangano, 2024; Ameyaw & de Vries, 2021; Stefanović et al., 2018; Ntongani, 2024).

**Tenure Security:** More reliable and accessible records can improve confidence in land ownership (Enemark, McLaren, & Lemmen, n.d.; Mitchell et al., n.d.; Byamugisha & Dubosse, n.d.; Motswenyane, Cooper, & Coetzee, n.d.; Tshitangano, 2024).

**Better Access:** Decentralized systems can make land information more accessible to a wider range of users (Mitchell et al., n.d.; Miller, 2018; Paavo, 2024; Tshitangano, 2024; Ntongani, 2024).

**Resilience:** Distributed systems are less vulnerable to single points of failure compared to centralized databases (Daniel & Speranza, n.d.; Vos, Lemmen, & Beentjes, n.d.; Tshitangano, 2024; Racetin et al., 2022).

**Data Quality and Integration:** Digital systems can improve accuracy and consistency while connecting previously fragmented land information systems (Kelm, Antos, & McLaren, n.d.; Miller, 2018; Tshitangano, 2024; Zein & Twinomurinzi, 2024; Ntongani, 2024).

### 4.2 Challenges and Limitations (RQ5)

The literature also identifies significant challenges:

**Technology Issues:** Blockchain is still relatively new for land applications, raising questions about scalability, performance, and long-term viability (Vos, Lemmen, & Beentjes, n.d.; Tshitangano, 2024; Stefanović et al., 2018).

**Integration Problems:** Connecting blockchain with existing systems and ensuring different platforms can work together creates technical hurdles (de Vries, 2021; Koeva et al., n.d.; Tshitangano, 2024; Zein & Twinomurinzi, 2024).

**Data Quality Concerns:** Initial data accuracy is critical - if incorrect information gets onto the blockchain, it’s hard to fix (Daniel & Speranza, n.d.; Vos, Lemmen, & Beentjes, n.d.; Tshitangano, 2024; Paavo & Rodríguez-Puentes, 2024).

**Legal and Regulatory Gaps:** Many countries lack clear legal recognition for blockchain records and smart contracts, especially for real estate (Vos, Lemmen, & Beentjes, n.d.; Tshitangano, 2024; University of Dar es Salaam, n.d.; Paavo & Rodríguez-Puentes, 2024).

**Adoption Barriers:** High implementation costs, limited internet access in rural areas, digital literacy gaps, institutional resistance to change, and lack of technical capacity create significant obstacles (Daniel & Speranza, n.d.; Ameyaw, n.d.; Hillenbrand, 2025; Niyibizi, 2024; Paavo, 2024; Nkwabi, 2021; Tshitangano, 2024; University of Dar es Salaam, n.d.; Ameyaw & de Vries, 2021; Paavo & Rodríguez-Puentes, 2024; Zein & Twinomurinzi, 2024).

**Governance Complexity:** Defining roles in a decentralized system, ensuring accountability, managing potential power imbalances, and getting buy-in from all stakeholders (especially traditional authorities) present complex challenges (Daniel & Speranza, n.d.; Kuusaana, n.d.; Hull & Whittal, n.d.; Hillenbrand, 2025; Jayabodhi, Rajapakse, & Senanayake, 2020; Abdulai, 2024; Tshitangano, 2024; University of Dar es Salaam, n.d.; Ameyaw & de Vries, 2021; Zein & Twinomurinzi, 2024; Alhola & Gwaindepi, 2024).

**Customary Tenure Complexities:** Capturing the nuances of traditional land rights, which are often collective, flexible, and unwritten, within a formal blockchain system poses particular challenges (Ndubuisi & Nnonyelu, n.d.; Kuusaana, n.d.; Home, 2023; Abdulai, 2024; Jayabodhi, Rajapakse, & Senanayake, 2020; Tshitangano, 2024).

### 4.3 Relevance to Tanzania and Identified Gaps (RQ6)

**Relevance to Tanzania:**

The literature is highly relevant to Tanzania’s situation in several ways:

**Problem Validation:** The challenges described in Tanzania’s problem statement (dual tenure complexity, inefficiencies, fraud, disputes, lack of transparency) match those discussed in studies from Ghana, South Africa, Nigeria, Uganda, and other developing contexts (Ndubuisi & Nnonyelu, n.d.; Kuusaana, n.d.; Miller, 2018; Niyibizi, 2024; Abdulai, 2024; Nkwabi, 2021; Tshitangano, 2024; Mwesigwa, 2024; Adeyinka, 2020).

**Technology Potential:** The benefits highlighted (transparency, security, efficiency) directly address Tanzania’s stated problems.

**Technology Choice:** The discussion of permissioned/hybrid blockchains (like Hyperledger Fabric) and smart contracts is relevant for designing a system suitable for government oversight and process automation.

**Governance Models:** Concepts like public-private partnerships, decentralization, and institutional analysis frameworks provide useful approaches for structuring a solution involving multiple stakeholders.

**Implementation Insights:** Experiences from pilots in other countries offer valuable lessons about potential pitfalls and success factors.

**Identified Gaps:**

**The major gap in the literature is the lack of detailed models for integrating both customary and statutory land rights onto a single blockchain platform - which is exactly what Tanzania needs.**

While some papers discuss customary tenure challenges and others explore blockchain for formal registration, the bridge between these two worlds is not well developed. Specifically:

* The literature lacks detailed technical designs for representing both systems in one blockchain solution
* There’s limited exploration of how smart contracts could encode potentially unwritten, flexible customary rules
* Few studies address the governance mechanisms needed for a truly integrated system
* There are no Tanzania-specific blockchain pilots or designs

This gap underscores the novelty and importance of developing a specialized solution for Tanzania’s dual land tenure system.

## 5. DISCUSSION

Our systematic mapping shows that the literature covers key areas relevant to Tanzania’s land challenges: registration problems in developing countries (especially in Africa), blockchain technology features, governance models, and stakeholder dynamics.

The literature review reveals general agreement that blockchain has the potential to address major land administration issues like lack of transparency, fraud, inefficiency, and insecurity. The technology’s core features—immutability, decentralization, transparency, and smart contracts—are seen as powerful tools for improvement.

However, the review also highlights significant concerns about technical feasibility (scalability, integration), legal gaps, adoption barriers (cost, digital divide, capacity), and governance complexities.

Most importantly, regarding Tanzania’s goal of integrating customary and statutory rights, we’ve identified a significant knowledge gap. While many papers acknowledge the challenges of dual tenure systems, none provide detailed proposals for how blockchain can technically and institutionally bridge this divide. The difficulty lies in representing potentially fluid, unwritten customary rights alongside formal titles on an unchangeable digital ledger, and creating the governance structure for such a hybrid system.

Therefore, while the literature confirms that blockchain is worth exploring for Tanzania’s land administration problems and offers insights into potential benefits and challenges, it also highlights the novelty of the proposed research. Designing a solution that specifically bridges the customary-statutory divide using blockchain represents an opportunity to address a clear gap in current knowledge.

The success of such a project, as indicated by the literature, will depend heavily on: - Context-specific design - Strong stakeholder engagement (especially with traditional leaders) - Capacity building - Supportive policy reforms

## 6. Conclusion

Based on our review of 44 document summaries, blockchain technology shows promising potential for addressing persistent challenges in land administration systems, particularly in developing countries like Tanzania. The literature provides strong evidence that blockchain could enhance transparency, security, efficiency, and tenure security in land records.

However, we also found substantial challenges related to technology maturity, legal frameworks, implementation feasibility, and governance. Most significantly, regarding Tanzania’s dual tenure system, we identified a key gap: **the lack of established models for integrating customary and statutory land rights using blockchain technology**.

While the literature confirms the core problems faced in Tanzania and supports exploring blockchain as a potential solution, it emphasizes that success depends on addressing the unique complexities of the dual tenure system. Any proposed solution must involve careful design (possibly using smart contracts for customary aspects), strong engagement with traditional authorities, capacity building, enabling policy reforms, and likely public-private partnerships.

Blockchain offers transformative potential, but its effective use in complex dual tenure environments requires moving beyond general promises to address the specific integration and governance challenges we’ve identified as gaps in the current literature.

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