BUQS8000A MSc (BLG & QS) Dissertation

An assessment of the necessity of implementing a blockchain based land registry in South Africa

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Abstract

Background statement: Several nations have recently implemented blockchain-based land management systems, focusing on land registration, titling, recordation, and information management, to enhance transparency, trust, data security, data quality, and immutability through consensus mechanisms. This technology streamlines access and tracking of land records, reducing fraud, corruption, record manipulation, and property resale while lowering transaction costs. These advantages aim to address issues of inefficient and untrustworthy land records in less developed countries. **Problem**: South Africa faces challenges, ranking 108 out of 190 in property registration according to the World Bank, with lengthy procedures (7), extended transaction times (23 days), and high costs (8% of property value). In contrast, blockchain-adopting countries like Sweden and Georgia are ranked at 9 and 5, respectively. Despite these inefficiencies blockchain technology has not yet made an inroad into the land registration or transaction process. Aim – The aim of this study is to investigate the potential use of blockchain technology to digitize land registration in South Africa. **Methods**: This paper investigates a blockchain property registry pilot project in Khayelitsha, South Africa, using Peled's theoretical framework and employs qualitative research methodologies, including case study analysis and expert interviews, supplemented by a systematic literature review. **Outcomes**: The study reveals significant challenges in South Africa's land registration, including unreliable land records, informal land tenure systems, limited access for marginalized communities, corruption, weak legal frameworks, post-colonial property rights legacy, and inefficient real estate transactions. Despite the promise of blockchain, these issues persist, hindering progress. Eight key factors obstruct blockchain adoption in South Africa's land registry, including legal barriers, organizational resistance, technological hurdles, resource constraints, political and social factors, and trust-related issues. The case study identifies additional obstacles, such as misalignment of interests, lack of formal agreements, data quality issues, and further legal barriers. Nonetheless, the pilot project managed to create a "pseudo title deed" with potential benefits for the city. This study suggests the application of blockchain in state-subsidized housing developments to enhance data security and enable electronic land transactions. It emphasizes the need for a combination of expertise, infrastructure readiness, and procedural changes to facilitate innovation in the public sector. Despite the potential, the study concludes that South Africa's land registry is not yet prepared for widespread blockchain implementation, citing legal, technological, and organizational challenges. **Significance**: This research is the first to explore the limited adoption of blockchain technology for land registration in South Africa, contributing valuable insights to the field. This paper identifies critical factors for successful blockchain-based property registry implementation, offering insights for legislation, policy development, and land registration system design to address inequalities and improve land tenure in developing countries. It outlines a potential path for South Africa's Deeds Registry to implement blockchain technology in state-subsidized housing developments.

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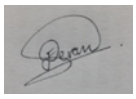
Declaration

I declare that this Research Report is my own, unaided work. It is submitted in partial fulfilment of the **Masters in Building** in the field of Property Development and management at the University of the Witwatersrand, Johannesburg.

It has not been submitted before for any degree or examination in any other university.

Signature of Candidate: 

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List of Abbreviations

Abbreviation	Description
BIM	Building Information Model
DLT	Distributed Ledger Technology
e-DRS	Electronic Deeds Registration System
P2P	Peer to Peer
IoT	Internet of things
GDP	Gross Domestic Product
SDGs	Sustainable Development Goals
IBREA	International Blockchain Real Estate Association
ELRA	European Land Registry Association
LADM	Land Administration Domain Model
ISO	International Standards Organization
PropTech	Property Technology
IFMS	Integrated Financial Management Information Systems
PPP	Private Public Partnership
ICO	Initial Coin Offering
DAO	Decentralized Autonomous Organization
OGC	Open Geospatial Consortium
NAPR	National Agency of the Public Registry of Georgia
IT	Information Technology
EGDI	E-Government Development Index
IS	Information Systems
SDI	Spatial Development Initiatives
ICT	Information-Communication Technology
NGO	Non-Governmental Organization
TPX	Tenure Project X
NPO	Non-Profit Organization
IP	Intellectual Property
MOU	Memorandum Of Understanding
CAHF	Centre for Housing Finance
RDP	Reconstruction and Development Programme
NDHSWS	National Department of Human Settlements, Water and Sanitation

1 Introduction

1.1 Background to the Study

South Africa is a unique and large country with a racially segregated past. The colonial and apartheid legal systems have methodically excluded black Africans from owning land have a broad legacy affecting the land ownership, security and tenure of roughly 30 million South Africans (Kollamparambil, 2021). Current landowners and their relationship with the laws governing land ownership have been influenced by past inequalities and presently by the current political climate which will influence future land ownership for the country's citizens.

Various land reform programs have been taken by the post-apartheid government however, since 2018 a constitutional review has been debating additional drastic measures - state custodianship of the land complemented by expropriation without compensation (Home, 2022). The various land reform programs implemented to date fail to meet the objectives of legislators or the hopes and demands of South Africans (Sihlangu and Odeku, 2021). Statutory and customary tenure are the two core forms of tenure in South Africa (Kollamparambil, 2021).

South Africa's land tenure system is complex due to the coexistence of statutory and customary land ownership. Statutory laws, originating from colonial and apartheid periods, emphasize individual ownership and market activities (Claassens, 2014). In contrast, customary land tenure, rooted in indigenous traditions, focuses on communal land use managed by local chiefs or traditional authorities (Cousins, 2007). This dual system often leads to disputes and uncertainty, especially in rural areas where traditional practices are prevalent (Hall, 2010). The disparity between these systems can hinder equitable land allocation, exacerbate socioeconomic inequalities, and challenge land reform efforts (Hornby *et al.*, 2017). Addressing these issues requires a nuanced approach that integrates legal plurality with the need for consistent land administration respecting both statutory rights and customary practices (Turner, 2005).

Supporters of private property rights contend that land titling is the lone scheme that will realize tenure security in South Africa however opposing contentions claim that greater tenure insecurity will result as individual titling dilutes community identity and exposes low-income earners to financial establishments which are permitted to repossess their property and expose these individuals to elevated interest rates (Kollamparambil, 2021). As stated by (Sihlangu and Odeku, 2021) the

distribution of land to black South Africans without adequate support to assist the recipients in using their property productively will not tackle the societal and financial status of the recipients, instead a poverty-stricken lifestyle will be sustained for black South Africans. In addition to these property ownership related inequalities South Africans must deal with an inefficient real estate transaction procedure.

South Africa's current real estate purchasing process can be described as inefficient because of dependence on multiple 3rd parties resulting in high transaction costs, manual assessment, authentication, and updating of financial and legal documents, as well as several systems with redundant information which prolongs transaction times and is susceptible to error and fraud. Blockchain technology presents a potential tool to overhaul South Africa's traditional land registry, improve other outdated real estate transaction systems and possibly enable wealth creation for its citizens.

The 4th industrial revolution comprises technologies such as artificial intelligence, 3D printing, virtual reality, predictive analytics, augmented reality and big data (Broncker and Veuger, 2018; Beznosov, Skvortsov and Skvortsova, 2021). One of the new technologies that has grown in importance is Blockchain, a technology on which decentralized digital currencies called cryptocurrencies are stored (Sandberg, 2021). The data stored on a blockchain is fixed over time and controlled by several actors not a single entity (Panda *et al.*, 2021).

Blockchain is thus a chain of analogous, linked, immutable and cryptographically linked blocks of information stored on a decentralized peer-to-peer network. Popular and effective implementations of blockchain technology include the cryptocurrencies Bitcoin and Ethereum (Bhatia *et al.*, 2019; Sladić *et al.*, 2021). As a Distributed Ledger Technology (DLT), it is a distributed, communal, encrypted database that serves as a permanent and incorruptible store of transactions or digital events among participating parties. It can enable the transfer of assets or anything of value (Kakavand, Kost De Sevres and Chilton, 2017; Nijland and Veuger, 2019; Shang and Price, 2019; Beznosov, Skvortsov and Skvortsova, 2021). The South African real estate economy, its assets and the transaction process could therefore benefit from this technology by making it transparent, secure, and decentralize it through the removal of 3rd parties (Hermansson, 2020).

Additional benefits include time savings, decreased transaction costs, increased data security/un-hackability, reduced susceptibility to fraud, enhanced cross-border real estate transactions, the ability

to verify legal and physical features, tokenise real rights and take on payments through smart contracts (Corluka and Lindh, 2017; Savu *et al.*, 2017; Nasarre-Aznar, 2018; Seuren, 2018; Ameyaw and de Vries, 2021). The technology is already being tested for land registration through pilot projects for specific land registries in Sweden, the Republic of Georgia, Ghana, Australia, the US, and the Netherlands. Other implementations of the technology include several companies who are exploring the use of a distributed ledger for finishing the complete procedure needed for the sale of a property, the "tokenisation" of mortgages, applications to Building Information Model (BIM), information related property management and the implementation of blockchain for renting properties in the Netherlands (Veuger, 2018; Garcia-Teruel, 2020; Konashevych, 2020).

There are however some drawbacks to its implementation and use such as legal impediments, lack of interoperability, lack of recognition of digital signatures, legal merging of the status of the digital currencies and the legal structure governing its use (Kalyuzhnova, 2018; Garcia-Teruel, 2020). Nevertheless, the benefits result in an improved understanding of individual assets as all information relating to that asset is securely stored in a single place (Wouda and Opdenakker, 2019).

Land registries hold substantial real estate data and early October 2019 saw South Africa's president pass the Electronic Deeds Registration Systems Act 19 (Electronic Deeds Registration Systems Act 19, 2019). The need for such a bill comes from a need for electronic service delivery, to accommodate a projected 20 million parcels of land for the government's land reform strategy. There is also the need to decentralize and deliver services close to users. Moreover, the unification with the digital Cadastral Information System will enhance the effectiveness and precision of South Africa's land data administration, consolidate varied legacy registration measures and to provide for increased capability for forthcoming methods of land tenure that could be instituted (Benaters Attorneys, 2019; Eversheds Sutherland, 2019; Botha, 2020). The Electronic Deeds Registration Systems Act provides a foundation for an Electronic Deeds Registration System (e-DRS). The act has been described as a "preliminary life jacket" as it does not go into vigorous detail; crucially the act does not elaborate on the type of technology that will be used but does envisage acceptance of online signatures to perform the same function as their paper based counterparts (Coetzee, 2019; Johnson, 2019).

A change stemming from government will move throughout the economy to the businesses within the real estate sector, with major effects on most if not all parts of the economy. Consequently a government that implements Blockchain to reshape their land registration system would concurrently

transform their nation's economy (Heil, 2018). Georgia, Sweden, Dubai, Ghana and others which can be considered early blockchain land registry implementers have realized excellent results in the form of cost savings, better quality of service and the elimination of fraud and corruption (Benbunan-Fich and Castellanos, 2018; Themistocleous, 2018). The benefits of blockchain technology are being realized by those nations who adopt the technology while those who do not are left idling and unable to achieve technological accomplishments (Heil, 2018). Studies in India and Pakistan have recommended that their governments take serious note of the impacts of the technology and implement blockchain, so they are not left behind unable to benefit from the technology (Uzair *et al.*, 2018; Bhatia *et al.*, 2019; Sharmila, Nijanthan and Shanthi, 2019). The digitization of the country's land registry should thus be of concern to the citizens of South Africa, landowners, and current intermediaries in the land transaction process.

1.2 Problem Statement

Recently nations such as Georgia, India, Ghana, Honduras, Canada, Brazil and Sweden have launched blockchain based land management system pilot projects for functions such as, land registration and/or titling, land recordation, and land information management (Ameyaw and de Vries, 2021). The use of blockchain technology in land management systems and land transactions has the advantages of greater transparency, trust and data security as well as improved data quality, accuracy, and immutability achieved through the consensus process (Ameyaw and de Vries, 2021; Shuaib, Alam and Daud, 2021). This allows for easier access and trackability of land records which reduces fraud, corruption, manipulation of records and multiple sales of land, further efficiency is achieved through the reduction of the land transaction expense (Ameyaw and de Vries, 2021; Mintah *et al.*, 2021; Shuaib, Alam and Daud, 2021). These advantages presented by blockchain technology to land registration, transactions, and management hope to reduce the following shortcomings that exist in the market currently. In contrast the quality of land records in developing nations is deemed to be inefficient and unreliable (Kaczorowska, 2019). Other shortcomings include the double sales of land, trouble acquiring reliable land information, numerous high transaction costs, fraudulent transactions and prolonged transaction times (Ameyaw and de Vries, 2021; Shuaib, Alam and Daud, 2021). The World Bank's report on "Doing Business 2020" grades 190 countries on various measures of doing business, one of which is registering property where the following is considered - processes, time, and price to convey a property and the quality of the land administration structure

for men and women (The World Bank Group, 2019). South Africa ranks low down on registering property with a ranking of 108 out of 190, which is also further down lower than the Honduras at 101, while the blockchain adopters Sweden and Georgia rank at 9 and 5, respectively. South Africa can be characterized by a high number of procedures – 7, a long transaction time – 23 days and high costs that make up – 8% of the property's value. Despite these inefficiencies, the technology has not yet made an inroad into the land registration or transaction process. This raises the question as to why has blockchain technology not been implemented in South Africa's land registry.

1.3 Research aims and objectives.

The aim of this study is to investigate the potential use of blockchain technology to digitize land registration in South Africa.

To achieve this aim, the study sought to:

- Identify the existing land registration challenges in developing countries and South Africa.
- Examine why blockchain technology has not been implemented in South Africa´s land registration system.
- Determine factors that would contribute to the successful implementation of a blockchain based land registry.

1.4 Research Questions

The primary research question is:

- How can blockchain technology be used to digitize the land registry?

The secondary research questions are:

- What are the existing land registration challenges in developing countries and South Africa?
- Why has blockchain technology not been implemented in South Africa's land registry?
- What factors would contribute to the successful implementation of a blockchain based land registry in South Africa?

1.5 Limitations and assumptions

The research has the following limitations:

- Lack of knowledge/expertise on blockchain technology might undermine the quality of responses from some stakeholders. To mitigate this the interviewees chosen all had a high degree of knowledge and/or experience with the pilot project investigated.
- The limited number of current initiatives may limit the amount of empirical information available to gauge the readiness of South Africa to adopt the technology. This was mitigated by investigating the current imitative in-depth through interviews with project members as well as secondary data.

This study assumes the following:

- Blockchain technology's advantages found in other countries will hold in South Africa
- Respondents will be truthful, and the sample sizes chosen is representative of the population.
- This study bases its findings on analytical generalisation, which means that the insights gained from the investigation of the case study are utilised to create and refine wider theoretical ideas rather than being statistically generalised to a larger population.

1.6 Significance of study

Land registration through land registries documents property rights and fosters confidence among individuals and businesses. and the government, by undertaking this responsibility, they assist countries in preserving stability inside their borders and their economic expansion into the rest of the world (Themistocleous, 2018). For land registries blockchain technology can be applied in the following ways: title deed registration, time-stamped transactions, multi-party transparent governance instruments, immutable recording system, disaster recovery system and restitution and compensation in post-conflict zones (Anand, McKibbin and Pichel, 2016).

Land ownership in South Africa is affected by past inequalities where black South Africans were excluded from owning land (Kollamparambil, 2021). Consequently, the current political climate is characterised by ongoing debate about state ownership of land, complemented by expropriation without compensation (Home, 2022). The passing of the Electronic Deeds Registration Systems Act

19 and the aims it hopes to address (as mentioned above) further underscore the importance of the study (Electronic Deeds Registration Systems Act 19, 2019).

This study is thus of concern to the citizens of South Africa, landowners, and current intermediaries in the land transaction process. Notaries or licensed conveyancers, administrators or registrars and brokers are some of the intermediaries that will be affected by the digitization of the land registry and possible implementation of blockchain technology (Peiró and García, 2017; Vos, Lemmen and Beentjes, 2017; Seuren, 2018). The digitization of South Africa's land registry is also of interest to those professionals who rely on the land registry for information such as surveyors and valuers.

The undertaking of this study places stakeholders in the real estate industry, current intermediaries in the real estate transaction process and government officials in a better position to debate the possible implementation of blockchain technology for the digitization of South Africa's land registry.

An added reason for this research is to investigate in existing real estate markets if blockchain technology is a disruptive modernization or a significant technological evolution and if the market's complete value chain will adopt this (Veuger, 2020). Moreover, this research will help create a framework to evaluate the preparedness of land management and land administration systems for blockchain consideration in developing markets (Ameyaw and de Vries, 2021). South Africa has two forms of land tenure: statutory and customary tenure (Kollamparambil, 2021).This unique quality provides further justification for assessing blockchain's implementation to the country's registration system (Ameyaw and de Vries, 2021).

This study adds to the current frame of knowledge by investigating real world use cases of blockchain based land registration where findings can be compared to other use cases. The study also contributes to land reform and land registration discussions in the South African context. Additional research is necessary in evaluating what factors would contribute to the successful implementation of a blockchain based land registry in South Africa and developing countries.

1.7 Summary

The colonial and apartheid legal systems have methodically excluded Black Africans from owning land have a broad legacy affecting the land ownership, security, and tenure of most South Africans. The land reform programs implemented to date have been inadequate with measures such as expropriation without compensation dominating current political debate. In addition to these property

ownership related inequalities, South Africans must deal with an inefficient, costly, and time-consuming process that is susceptible to fraud. Blockchain technology presents a potential tool to overhaul South Africa's traditional land registry, improve other outdated real estate transaction systems and possibly enable wealth creation for its citizens. Georgia, Sweden, Dubai, Ghana, and other early adopters have realized excellent results in the form of cost savings, better quality of service and the elimination of fraud and corruption.

Registering property in South Africa involves a high number of procedures – 7, long transaction time – 23 days and high costs which make up – 8% of the property's value. Despite these inefficiencies blockchain technology has not yet made an inroad into the land registration or transaction process. This raises the question as to why has blockchain technology not been implemented in South Africa's land registry? This study is important as an effective land registration process documents property rights and fosters internal confidence among individuals and businesses. The government, by undertaking this responsibility, assists the development of the property market and creates additional opportunities to right the wrongs of the past.

2 Literature Review

2.1. Introduction to the literature review

The motive of this chapter is to review, analyse and synthesize prior research in the use of Blockchain technology for land registration. This chapter covers past and present land ownership issues in South Africa, definition of blockchain technology, definition of smart contracts, a classification of blockchain technology, a definition of land registries, blockchain technology and real estate transactions, actors in the use of blockchain technology in real estate transactions and the benefits and drawbacks of blockchain technology when applied to land registries. The chapter also reviews recommendations for implementing blockchain based land registries, as well as cases of blockchain based land registries. It compares South African land registry against existing blockchain land registries, barriers to technology adoption, critical success factors in the adoption of blockchain technology, the methodologies used in previous studies, a summary of the critical success factors for technology adoption and the key unanswered issues this study covers.

2.2. Land ownership issues in South Africa

South Africa is a unique and large country with a racially segregated past. Current landowners and their relationship with the laws governing land ownership have been influenced by past inequalities and presently by the current political climate which will influence future land ownership for the country's citizens. This section will cover past inequalities, land reform, security of title and the uniqueness of South Africa's situation.

The legacy of colonization and apartheid has denied non-white Africans of their indigenous rights to land (Shamase and Nicolaides, 2022). The apartheid government spatially segregated by race and ethnic group majority of the country's black population to barren and desolate lands called Bantustans, these areas experienced no significant industrial growth. The majority black African population received 13 percent of the land while the minority white African population received 87 percent of the land (Shamase and Nicolaides, 2022). The colonial and apartheid legal systems which methodically excluded black Africans from owning land have a broad legacy affecting land ownership, security and tenure of roughly 30 million South Africans (Kollamparambil, 2021).

South Africa celebrated its coming into democracy in 1994 with land redistribution and restitution the primary objective of the new government so that black Africans could attain equal economic and social position of their fellow white citizens (Sihlangu and Odeku, 2021). The rectifying of past wrongs became a core focus of the governing party and elected government which required land reform programmes in the form on redistribution, restitution and tenure reform to be adopted (Sihlangu and Odeku, 2021). Despite their great intentions, these policies mentioned below, have mainly failed owing to structural, administrative, and economic issues.

Land restitution is restoring land to people or communities that were dispossessed under apartheid laws.. The Restitution of Land Rights Act of 1994: This legislation establishes a legal basis for land restitution in South Africa. It strives to restore or compensate people and communities that have lost their land rights as a result of racially discriminatory legislation and practices enacted after 1913. The act creates the Commission on Restitution of Land Rights and the Land Claims Court to handle and resolve restitution claims (Restitution of Land Rights Act 22, 1994). However, the process has been hampered by bureaucratic delays, limited money, and inadequate support for claimants to utilise the property productively (Hall, 2004).

Land redistribution tries to lessen inequality by transferring land from white to black South Africans. Provisions of the Land and Assistance Act, 1993: This statute makes it easier to acquire land for agricultural uses and offers financial incentives to support land redistribution. It allows the Minister of Agriculture and Land Affairs to give grants and subsidies for land purchases, assisting historically disadvantaged persons in gaining access to productive land (Provision of Land and Assistance Act 126, 1993). This legislation was later updated, with the Provision of Land and Assistance Amendment Act of 1998. The amendment broadens the scope of the 1993 act and improves support for recipients. While high goals were established, implementation has been delayed and fraught with corruption and incompetence. Many recipients lack the tools and expertise required for sustainable agriculture, resulting in underutilization of redistributed land (Lahiff, 2007).

Tenure Reform seeks to protect land rights for persons who live on communal or informally owned properties. There are three examples of legislation for land reform. First, The Land Reform (Labour Tenants) Act, 1996: This statute seeks to protect the tenure rights of labour tenants who live on farms. It establishes methods for labour renters to obtain ownership of the land they inhabit and protects them from arbitrary eviction (Land Reform (Labour Tenants) Act 3, 1996). Second, the Communal Property Associations Act, 1996: permits communities to organise legal entities (Communal Property Associations) to buy, own, and administer land communally. It is intended to provide stable tenure for communities that have historically lived on community land (Communal Property Associations Act 28, 1996).

Third is the Extension of the Security of Tenure Act, 1997: This statute protects rural and peri-urban landowners by ensuring their tenure and restricting the conditions under which evictions can take place (Extension of Security of Tenure Act 62, 1997). However, traditional authority have objected to these measures, and formalising property rights in the setting of complicated, overlapping claims has been difficult (Cousins, 2007).

The overriding failings of these three types of programmes may be attributed to a lack of consistent policy direction, insufficient support mechanisms for new landowners, and competing stakeholder interests. Furthermore, political reasons have frequently outweighed practical and economic issues, hampering the reform process (Walker, 2008). Blockchain technology represents a tool that could be used to assist in overcoming some of these challenges, as a system for transferring or storing a ledger of rights or transactions.

Various land reform programs have been taken by the post-apartheid government however, since 2018 a constitutional review has been debating additional drastic measures - state custodianship of the land complemented by expropriation without compensation (Home, 2022). The study by (Sihlangu and Odeku, 2021) found that the various land reform programs have failed to meet the objectives of legislators or the hopes and demands of land reform recipients.

The state is committed to land reform as the land expropriation bill was delivered to parliament in October 2020, but the government is not certain or prepared to alter the terms of section 25 of the constitution (provisions tackling the problem of land specifically the compensation clause). The bill is willing to include sections that emphasize conditions where the state must compensate the landowner and conditions where nil compensation is utilized (Sihlangu and Odeku, 2021).

Statutory and customary tenure are the two core forms of tenure in South Africa. As stated by (Kollamparambil, 2021).

South Africa's land tenure system is complicated, with a mix of customary and statutory features that provide substantial hurdles to successful land registration and ownership. The customary land tenure system is strongly ingrained in the country's history and cultural norms, with land being held communally and governed by a traditional authority. This system coexists with the statutory land tenure system, which is controlled by a set of legal frameworks and constitutional requirements aimed at formalising land ownership and correcting historical injustices.

The legal system governing land ownership in South Africa is founded on many significant pieces of law and constitutional requirements. The Republic of South Africa's Constitution of 1996, specifically Section 25, sometimes known as the property clause, serves as the framework for land reform and restitution (Constitution of the Republic of South Africa, 1996). It states that the state must adopt reasonable legislative and other actions to provide individuals with fair access to land, as well as encourage circumstances that allow them to do so.

Court decisions have also played an important influence in determining land tenure in South Africa. For example, the landmark decision of Alexkor Ltd v The Richtersveld Community (2003) upheld the Richtersveld community's customary law-based rights to their ancestral property. The court recognised the community's customary law claim to the land, which had to be upheld under the constitutional property provision (Alexkor Ltd and Another v Richtersveld Community and Others,

2003). This decision emphasised the constitutional preservation of customary land rights and established a precedent for future groups pursuing reparations.

This complex legal system confers diverse rights and protections on different types of landowners. Farm dwellers and other vulnerable populations are protected against unlawful eviction by the Extension of Security of Tenure Act 62 of 1997 (ESTA) and the Prevention of Illegal Eviction from and Unlawful Occupation of Land Act 19 of 1998 (PIE), assuring their tenure security (Extension of Security of Tenure Act 62, 1997; Prevention of Illegal Eviction from and Unlawful Occupation of Land Act 19, 1998). Furthermore, the Traditional Leadership and Governance Framework Act 41 of 2003 recognises the role of traditional authorities in land management within communal areas, establishing a legal foundation for the coexistence of statutory and traditional systems (Traditional Leadership and Governance Framework Act 41, 2003).

The Communal Land Tenure Bill, introduced in 2017, intends to offer more clarity on the rights of persons living on common land. It advocates vesting ownership of community property in communities, represented by legal entities, so formalising communal land rights while retaining traditional leaders' role in land management (Communal Land Tenure Bill, 2017). However, this measure has raised discussions concerning the power dynamics between traditional authority and community people.

Traditional authority frequently govern land in South Africa's rural areas, therefore community-based or customary land tenure systems are critical. These systems are distinguished by communal ownership, in which land is assigned according to community laws and overseen by traditional authorities. This concept offers a social safety net and makes land available to community members for residential, agricultural, and other purposes.

However, the customary land tenure system has limitations, especially in terms of property registration and individual land rights. The absence of formal documentation and legal acknowledgment of customary land rights can result in disputes and uncertainty. Furthermore, the participation of traditional authority can occasionally result in power imbalances and disputes over land distribution and use. Blockchain technology presents a system to acknowledge property registration and individual land rights in a customary setting.

The combination of statutory and customary land ownership in South Africa's land tenure system results in a complicated and sometimes controversial framework for property ownership. Statutory laws, retained from the colonial and apartheid eras, give formal legal acknowledgment and protection of land rights, with an emphasis on individual ownership and market activities (Claassens, 2014). In comparison, customary land tenure, which is strongly founded in indigenous traditions and practices, places a premium on communal land usage and management under the authority of local chiefs or traditional authorities (Cousins, 2007).

This dual system frequently causes disputes and uncertainty, especially in rural regions where traditional practices predominate (Hall, 2010). The gap between these systems can impede equitable land allocation, create socioeconomic disparities, and undermine effective land reform efforts (Hornby *et al.*, 2017). Addressing these concerns necessitates a sophisticated strategy that balances legal plurality with the requirement for consistent land administration that respects both statutory rights and customary practices (Turner, 2005).

Supporters of private property rights contend that land titling is the lone scheme that will create tenure security in South Africa. On the contrary, others argue that greater tenure insecurity will result as individual titling dilutes community identity and exposes low-income earners to financial institutions who can repossess their property when they default on borrowing with their land as collateral (Kollamparambil, 2021). The private property rights against state holding and management of land is a central debate around the nationalisation of land.

The law-making process of land reform in South Africa is a sluggish, multifaceted and political process with indeterminate results; home-grown methods are desirable as opposed to centralized top-down approaches (Home, 2022). The state's policies may prioritize large business enterprises which opens the door for multinational investment movements and exports instead of addressing local needs and ambitions (Home, 2022).

For black South Africans there are several benefits of owning land, not only in terms of the income producing capability of land but the psychological and social benefits of land ownership (Kollamparambil, 2021). Private property rights supporters state that land holds intrinsic value which ought to be recognized by the state by law, this enables landowners to utilize their property for maximum gain in terms of passing down wealth and financial gain such as trading the asset or lending against it (Kollamparambil, 2021).

The distribution of land to black South Africans without support to enable the recipients in using their property productively will not change the societal and financial status of the recipients. It is imperative that sound legislation addresses not only past injustices but also improves the socioeconomic status for all South Africans (Sihlangu and Odeku, 2021).

Current debates imply that South Africa's land reform program has failed to meet neither the objectives of legislators nor the hopes and demands of land reform recipients (Sihlangu and Odeku, 2021). Furthermore, while supporters of private property rights contend that land titling is the lone scheme that will realize tenure security in South Africa, others argue that greater tenure insecurity will result, as individual titling dilutes community identity. It also exposes low-income earners to financial establishments which are permitted to repossess their property and expose these individuals to elevated interest rates (Kollamparambil, 2021). The land reform and land titling goals of the current administration require a robust and efficient land registration process for these goals to be realized, currently South Africans must deal with an inefficient land transaction and registration process.

Tilbury, de la Rey and van der Schyff (2019) describes the inefficiency of the South African real estate transaction procedure and finds there are a minimum of 12 fixed stakeholders with other types of transactions permitting 5 additional stakeholders. The number of documents required is 25 with an additional 10 documents needed if a mortgage is recorded or annulled. In terms of costs there are seven fixed costs possibly leading to 11 additional costs contingent on the type of transaction. Thus, there is potential in the current system for a real estate transaction to require a maximum of 35 documents and a maximum of 18 cost items. Blockchain presents a potential tool to overhaul South Africa's traditional land registry and improve other outdated real estate systems.

2.3 Blockchain and land registration

This section defines blockchain technology and smart contracts, classifies blockchain technology. It defines land registries, explains how blockchain is used in real estate transactions, and identifies who the actors involved in blockchain technology and real estate transactions are and their roles. Then follows a description of the benefits and drawbacks of blockchain technology in land registries as well as some recommendations for implementing blockchain based land registries. The section ends with a summary of some cases of blockchain based land registries.

2.3.1 Definition of blockchain technology

At the present time we are in 4th industrial revolution which comprises of technologies such as artificial intelligence, 3D printing, virtual reality, predictive analytics, augmented reality and big data (Broncker and Veuger, 2018; Beznosov, Skvortsov and Skvortsova, 2021). One of these new technologies that has grown in fame during the digital revolution is Blockchain, the technology on which decentralized digital currencies called cryptocurrencies are stored (Sandberg, 2021). Blockchain is associated with the attributes of, immutability and decentralization (Zheng, Song and Sun, 2020; Panda *et al.*, 2021).

Blockchain is a chain of analogous, linked, immutable and cryptographically linked blocks of information stored on a decentralized peer to peer network, popular and effective implementations of blockchain technology include the cryptocurrencies Bitcoin and Ethereum (Bhatia *et al.*, 2019; Sladić *et al.*, 2021). Blockchain is also identified as Distributed Ledger Technology (DLT) and can be described as a distributed, communal, encrypted database that serves as a permanent and incorruptible store of transactions or digital events among participating parties, blockchain can enable the transfer of assets or anything of value (Kakavand, Kost De Sevres and Chilton, 2017; Nijland and Veuger, 2019; Shang and Price, 2019; Beznosov, Skvortsov and Skvortsova, 2021). The ledger described is delineated as a system of records for business transactions (Panda *et al.*, 2021).

DLT is different from typical accounting ledgers as DLTs are sustained by a distributed network of participants known as "nodes" as opposed to a central entity (Kakavand, Kost De Sevres and Chilton, 2017). Blockchain technology is a digital peer-to-peer (P2P) network that permits transaction of tokens of value among two parties with no interference from a central institution, with control based on the networks own standards and processes which are distributed amid different nodes/computers on the P2P network (Kakavand, Kost De Sevres and Chilton, 2017; Karamitsos, Papadaki and Barghuthi, 2018; Nijland and Veuger, 2019; Thota, 2019). These tokens of value can be used to represent a form of currency e.g. Bitcoin or other shapes of value such as votes, bonds, stocks, as well as real estate transaction information, a quote from Patrick Byrne the CEO of Overstock.com comments "If the advent of the Internet allowed for the transfer of information, blockchain allows for the transfer of value." (Thota, 2019).

Blockchain technology has also fixed the double-spend problem by using combining the P2P network and public/private key cryptography, Satoshi Nakamoto (2008), the inventor of Blockchain

notes: ‘The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work’ (Karamitsos, Papadaki and Barghuthi, 2018; Nijland and Veuger, 2019). Each block within the blockchain holds the list of transactions and a block header. The hashes referred to are a unique identifier code, produced through cryptography which connect the blocks together (Panda *et al.*, 2021). The hash from a preceding block is hashed together with other blocks, hence a change in the preceding block’s data will produce a different hash for that block resulting in a mismatch of hashes and a broken chain (Sladić *et al.*, 2021).

This means that the technology uses cryptography to securely record transactions between parities into blocks of information which form part of a chain onto the ledger which is stored among each node in the network. Cryptography and the P2P network form the foundation of trust within the blockchain architecture, each node in a blockchain preserves and validates a comprehensive time stamped history of the transactions executed across the network, additionally there is no main source of entry for attack or malfunction (Shang and Price, 2019; Thota, 2019). This means that no single network participant can fraudulently alter the data. Trust in blockchain technology is replaced with cryptographic proof, permitting the trust-less transaction of value inside the network without specific intermediaries (Sladić *et al.*, 2021).

The operation of the blockchain is guaranteed by means of a system termed mining, whereby nodes that increase computing capacity to the network are rewarded through its functioning algorithm with more blocks or block-parts (Sandberg, 2021). The miners are all interested users part of the network and are liable for validating all transactions (Sladić *et al.*, 2021). As computing power on the network increases so does the reliability and speed of the network’s operations (Sandberg, 2021).

2.3.2 Smart contracts

Smart contracts represent contracts which are able to be executed devoid of human interaction, through smart contracts an individual can exchange anything of value, e.g. real estate, shares or any legal binding contract utilizing a transparent process which is executed only when the conditions of the contract are met all without the need for a trusted 3rd party (Uzair *et al.*, 2018; Garcia-Teruel, 2020; Zheng, Song and Sun, 2020). The conditions of the agreement amongst the participants are fulfilled and validated by electronic signatures from the participants, the smart contract is then

attached to the blockchain and amendments can only be made by the parties involved (Hermansson, 2020).

Smart contracts do not represent a variation in contract protocol instead the significant change smart contracts represent is the independent application and completing of a contract not including a 3rd party intermediary (Kundu, 2019; Panda *et al.*, 2021). Smart contracts are described as electronic transaction protocol for participants on the blockchain that implements contractual terms documented in programming language as a set of instructions, simply put a smart contract is a section of code entrenched in business logic (Panda *et al.*, 2021; Sladić *et al.*, 2021). By virtue of being on the blockchain the consensus mechanism enables immutability of the smart contract. For real estate, smart contracts and tokens are keystones as they permit the digitising of property rights and make online contracts viable (Konashevych, 2020).

2.3.3 Classification of blockchain technology

Blockchains can be private or public, (Garcia-Teruel, 2020) outlines the following: A public blockchain can be described as permissionless, this refers to the ability of any network user to make a transaction valid e.g. mining bitcoin. Private blockchains are permissioned, here only certain network users may validate a transaction. A further classification of blockchain technology by (Bhatia *et al.*, 2019) notes there are 3 important groups of blockchain: Private blockchain- here nodes have complete trust on each other, typically found in companies and can be described as a database. Consortium blockchain- here the trust is constrained to few nodes and those nodes must achieve rights to enter the chain, this makes it permissioned and allowing more flexibility than a private chain. Public Blockchain: here a central organization governing the network is absent, it functions with a consensus algorithm such as proof of work or proof of stake through cryptography, this establishes a trust-less network in which a node may enter and leave at any time they desire, this is the most used chain with notable examples being the cryptocurrency platforms Bitcoin and Ether. Public blockchains have elevated computational costs, whereas private blockchains are further centralized but provide greater speeds and data processing with lesser computational costs (Sladić *et al.*, 2021).

Blockchain technology is constantly evolving, this has lead researchers and developers to define different generations of blockchain. According to (Karamitsos, Papadaki and Barghuthi, 2018) the application of blockchain technologies on various industries could result in three cohorts of

Blockchain, namely Blockchain 1.0, Blockchain 2.0 and Blockchain 3.0: Blockchain 1.0 refers to digital currency and the decentralization of payments and money. Blockchain 2.0 is contemplates the decentralization of finance and is implemented for smart contracts, assets, and properties. Blockchain 3.0 refers to the decentralization of the digital civilization, implementations are for programs that relate to the Internet of things (IoT) as well as healthcare and government bodies.

The benefit of blockchain technology lies in its aim of transparency, security, decentralization and the removal of 3rd parties (Hermansson, 2020). Blockchain technology is already being tested for land registration through pilot projects for specific land registries in Sweden, the Republic of Georgia, Ghana, Australia, Honduras, the US and the Netherlands, other implementations of the technology include several companies who are exploring the use of a distributed ledger for finishing the complete procedure needed for the sale of a property, the "tokenisation" of mortgages, applications to Building Information Model (BIM) technology, information related property management and the implementation of blockchain for renting properties in the Netherlands (Veuger, 2018; Garcia-Teruel, 2020; Konashevych, 2020).

2.3.4 Definition of land registries

Land registry establishments document property rights and exalt internal confidence among individuals, businesses and the government by undertaking this responsibility, they assist countries in preserving stability inside their borders and their economic expansion into the rest of the world (Themistocleous, 2018). The process or recording ownership and land associated data by a third-party organisation such as a government is referred to as land registration, these record store information, assist in preventing fraud and enable transactions (Panda *et al.*, 2021). Land registries serve an important function however only a few counties have developed advanced land registries.

A study conducted by (Themistocleous, 2018) classifies counties into 3 main categories: Category 1- nations with well-organized land registries which adopt advanced technologies and promote extensive security of title e.g. USA, UK, the Netherlands and Sweden, Category 2- nations with less organized land registries which may have the issues such as old-fashioned systems and practices, bureaucracy, complex processes and fraud/corruption e.g. Greece, and Category 3- nations without land registries or inefficient registries which have the same issues as category 2 counties but with increased levels of fraud and corruption.

The structural organization of land registries differs from one country to the next, but the conventional design of land administration systems remains largely the same. The system referred to comprises of a "triple" made up of: Object- the spatial unit, Right- personal rights and/or rights in rem and Subject- this is the possessor of the right directly linked to the object (Lemmen, Vos and Beentjes, 2017). The relationship between the triple in land registration systems define the required functionality due to the complexity of the triple, who is the subject, diversity within a bundle of rights and the different types of spatial units (Vos, Lemmen and Beentjes, 2017). The complexity in dealing with land registration should not be underestimated, this complexity indicates that land registries have limitations. The key limitations faced by land registries are: difficulty in introducing new business models, high costs and long transaction periods, numerous intermediaries, centralization, fraud and corruption (Themistocleous, 2018)

2.3.5 Blockchain in real estate transactions

Recent research suggest that blockchain technology can improve real estate data managing and the transaction procedure by enhancing efficiency, transparency and trust (Wouda and Opdenakker, 2019; Mintah *et al.*, 2020). A major aspect of real estate transactions is data structure and quality which are crucial in modernizing the process (Wouda and Opdenakker, 2019). The key value add of blockchain technology in real estate is blockchain as a data sharing software package that offers a less risky, more secure manner for sharing data (Nijland and Veuger, 2019; Zheng, Song and Sun, 2020). Through blockchain and smart contract technology the reliability, efficiency and protection of data shared over the network is enhanced.

The algorithmic mechanism ensures trust between two transacting parties allowing for a comprehensive audit trace of transactions (Tilbury, de la Rey and van der Schyff, 2019). Blockchain technology does not allow for already recorded information to be altered while allowing for transparency of the transactions (Tilbury, de la Rey and van der Schyff, 2019). According to (Wouda and Opdenakker, 2019) banks can benefit from blockchain application to real estate transactions, assuming there is consistency of documentation being used, by increasing the following: reliability - data on the network is authenticated by all participants and fulfils obligations, the resulting audit trail can be used to generate reports e.g. financial reports; transparency - data shared amongst participants is the same; efficiency - organized and uniform data could allow for internal systems

and assessments e.g. risk assessments; reduction of fraud in real estate financing - through enhanced reliability and transparency of information.

2.3.5.1 Opportunities and challenges in real estate transactions for blockchain technology

The discussion by (Tilbury, de la Rey and van der Schyff, 2019) mentions that in real estate transactions blockchain has five areas of opportunity, these are: immutable record keeping; cost alleviation, through less third parties and quicker transaction times, simultaneous completion of payment and transfer as well as less hardcopy documentation processes; smart contracts which are less costly, more accessible and quicker; transparency of agreed upon information which is able to be viewed by all participants simultaneously; accessibility and speed as blockchain allows for transactions to be followed in real time on a single system (Mintah *et al.*, 2020). The following challenges are also mentioned: initial information capture referring to the applicable preliminary agreed upon information that is captured on the blockchain; human involvement in terms of potential job losses with a more streamlined system; adoption as input from all stakeholders is essential to develop and implement a blockchain based system; fraud as blockchain has distinct weaknesses e.g. 51% attack; legality which refers to a legal framework that is vital for the adoption of blockchain real estate transactions internationally (Tilbury, de la Rey and van der Schyff, 2019). Blockchain technology is still hackable which raises the question of if it is the correct software to use for transferring data (Nijland and Veuger, 2019). Furthermore, (Zheng *et al.*, 2017) demonstrated that privacy leakage may occur in blockchain even when individuals only utilise their public and private keys for transactions. Other issues include, proof of work consuming too much power, but the phenomena that miners can generate more money than their fair share through selfish mining strategies may persist (Zheng *et al.*, 2017).

There are numerous challenges in implementing a blockchain real estate transaction system such as managing the participants identification, the enforceability of the contract and defence of rights in rem, recording of co-ownership and correction of the ledger (Garcia-Teruel, 2020). There are several proposed cases of real estate transactions where blockchain presents benefits and challenges, these are renting a property, purchasing a property and purchasing a property with a mortgage (Garcia-Teruel, 2020).

For renting a property the benefits are guaranteeing of registration and the legality of the contract, no major challenges are included in this type of transaction on condition the benefits of smart contracts, the agreed upon contract clauses and the participants ID's are leveraged (Garcia-Teruel, 2020). The benefits when purchasing a property are quicker transactions, avoidance of double sales and protection of owners' rights. Challenges for purchasing a property are outlined by (Garcia-Teruel, 2020) begin with notaries who facilitate property registration, secondly the blockchain needs to be linked to an official ID of the transaction participants as ID's are not inspected by the blockchain, third the capacity of participants ought to be supervised through notaries or artificial intelligence, lastly regulation of smart contract costs is required to prevent financial exclusion. When purchasing with a mortgage benefits in the form of time and cost savings may be realized as blockchain could link the entire mortgage granting process of credit check, property appraisal and registration (Garcia-Teruel, 2020). The same challenges that apply to purchasing a property are applicable for purchasing with a mortgage as mortgages are registered thus blockchain must accommodate for rights in rem, this may be possible through tokenisation of mortgages (Garcia-Teruel, 2020).

Other challenges for blockchain technology in land registries arise from issues related to government spending on publicly funded real estate projects such as the cost of building and preserving the system responsible for administering property rights, these costs are for upgrading and maintain technology as well as specialized professionals to carry out the works (Mintah *et al.*, 2021; Shuaib, Alam and Daud, 2021). Other more central challenges come in the form of weak administration and lack of access to the formal land organisations (Shuaib, Alam and Daud, 2021). The transfer of land can become very complex and there are various rules that need to be accounted for, there are also socio-economic consequences relevance of real estate transactions as these assets are unique and represent a high value (Kaczorowska, 2019). Further, regarding rural areas and their residents, there are participation challenges for non-tech savvy landholders and internet connectivity issues, also there is the problem of acceptability of a new system by powerful chiefs (Mintah *et al.*, 2021).

Several challenges exist with blockchain technology in its purest form (public blockchain), these are a lack of independent verification, anonymity of network participants and the resulting risks of these challenges may result in an increased conveyancing cost (Kaczorowska, 2019). While the problems of a public blockchain may be overcome by a hybrid or private blockchain, this contradicts the public distributed nature of the technology i.e. (decentralization or its key advantage) (Kaczorowska, 2019).

Another challenge for blockchain technology in land registration is trust which is needed in land transactions, trust is deemed unnecessary in blockchain technology's pure form (Kaczorowska, 2019).

2.3.5.2 Blockchain technology and real estate transaction theory

Blockchain technology in real estate transactions can be also viewed through real estate transaction theory. The central theories which control the market for real estate are: efficient market hypothesis, behavioural economics, real estate transparency theory, transaction cost theory and transaction process theory (Hoxha and Sadiku, 2019). As per the efficient market hypothesis, market price considers all the information obtainable and assumes purchasers make decisions rationally (Salzman and Zwinkels, 2017). Property prices are also explained by consumer behaviour as well as the numerous mental and emotional influences of persons and organizations (Hoxha and Sadiku, 2019).

Real estate transparency theory states that strict transparency occurs once information sharing happens equally between market participants and market information asymmetry is a result of a deficiency of transparency (Yun and Chau, 2013). Conversely real estate transaction theory explains the choices of consumers in the real estate market that are pushed not just by monetary costs but likewise other difficulties and time delays throughout the transaction (Hoxha and Sadiku, 2019).

Two types of transaction costs are defined by real estate transaction theory. The first being ex-ante transaction costs which relate to creating asset purchasing contract and is typified by information asymmetry, the second type are ex-post costs which refer to the validation of participants implicated in the purchasing contract (Hoxha and Sadiku, 2019). Present day transactions are characterized by a lack of trust and incomplete information hence ex-post costs are unable to be avoided (Hoxha and Sadiku, 2019). Blockchain technology can transform real estate transaction process theory by enhancing the pace of property registration processes, simplifying multifaceted transactions, improving the due diligence process and quicker transaction completion times (Wessels, 2016).

An enhancement in trust and credibility decreases ex-post transaction costs as outlined in real estate transaction theory (Hoxha and Sadiku, 2019). Blockchain technology permits increased security and transparency of real estate transactions (Spielman, 2016), this reduces ex-post costs as explained by real estate transaction theory, with increased security a crucial aspect in adding certainty to the transaction process (Hoxha and Sadiku, 2019). The study by (Anand, McKibbin and Pichel, 2016) argues that blockchain technology decreases ex-post costs, lowers the opportunity costs of

participants, decreased transaction times and quicker verification of transacting parties as explained by real estate transaction theory.

Similarly (Dijkstra, 2017) contends that adoption of blockchain technology and smart contracts addresses transaction cost theory as ex-post transaction costs are reduced with verification of the transacting parties is done in less time, real estate transaction process theory is also addressed through enhanced transparency of the technology. Smart contract technology allow for quicker transfer, management and registration of ownership rights decreasing ex-ante and ex-post transaction theory related costs (Hoxha and Sadiku, 2019). Further, a transparent real estate market with more effective, efficient and less costly transaction processes may result in more liquid real estate market (Dijkstra, 2017).

2.3.5.3 Land registries and blockchain real estate transactions

For land registries blockchain technology can be applied in the following ways: title deed registration, time-stamped transactions, multi-party transparent governance instruments, immutable recording system, disaster recovery system and restitution and compensation in post-conflict zones (Anand, McKibbin and Pichel, 2016). The real estate sector can use blockchain technology to allow electronic real estate blocks to be split into numerous parts to unlock a way for crowd investment for real estate purchases, this is similar to the issuing of cryptocurrencies through an ICO (Initial Coin Offering) where a bitcoin block is split between numerous buyers at differing prices (Sandberg, 2021).

Coloured coins are a layer over bitcoin which enhance its usefulness. Simply put coloured coins allow a user to assign a value of a particular asset to a single token or many tokens, e.g. a token can be stained to show tenure of a property, other land administration attributes can be captured including GPS coordinates, size and an audit trail showing the exchange of the particular token (Spielman, 2016). It should be noted that in majority blockchain applications and with coloured coins ownership of property is linked to a private key rather than a single person, assuming that this individual is the only person possesses the key (Spielman, 2016). With the use of blockchain technology various principles of good governance in land administration can or will be realized.

Aspects of beneficial governance such as efficiency, transparency and the record of transactions or chain of title are achieved. According to (Vos, Lemmen and Beentjes, 2017) blockchain technology offers equivalent functionalities as a well-organized land registry: a blockchain based system will be

able to show land parcels and their owners at a particular point in time, it guarantees single-ownership, it can pin-point the exact time a transaction has taken place, the record of transactions make it possible to track transactions and thus offer the ability to guarantee title. Blockchain based solutions could provide additional certainty compared to traditional land registration systems (Vos, Lemmen and Beentjes, 2017).

The paper by (Sandberg, 2021) elaborates on why blockchain will not replace land registries and makes the following points. A blockchain networks participants may agree that the transfer of each block be considered the transfer of one such unit as shown by the network's programs in the consent of network participants. The operation of a chain of blocks to represent a specific asset establishes a ledger of transactions and property rights for the asset. The digitization of property rights this way is not a new idea. Existing land registration systems already have the attributes of being public and transparent but current registries are unable to show to everybody all transactions in a certain country. Current systems instead show a map of the rights to a specific unit a person is interested in.

The application of private blockchains damages the attribute of decentralization, which is blockchains principal innovation (Sandberg, 2021). The distributed nature of blockchain where information is backed up on every network participant can be achieved through simpler means e.g., government clouds. Today's literature and use cases propose blockchain systems integrated into existing registration systems to enhance control and not to replace land registries (Sandberg, 2021).

2.3.5.4 Actors in the use of blockchain technology and real estate transactions

The digitization of the country's land registry is of concern to the citizens of South Africa, landowners, and current intermediaries in the land transaction process. Notaries or licensed conveyancers, administrators or registrars and brokers are some of the intermediaries that will be affected by the digitization of the land registry and possible implementation of blockchain technology (Peiró and García, 2017; Vos, Lemmen and Beentjes, 2017; Seuren, 2018). The digitization of South Africa's land registry is also of interest to those professionals who rely on the land registry for information such as surveyors and valuers. The intermediaries affected in the implementation of blockchain technology are agents, brokers, banks, notaries or licensed conveyancers and administrators or registrars.

The real estate agent is usually the first professional a party may seek assistance from when searching for, selling or buying a property along with the associated contract (Garcia-Teruel, 2020). As

mentioned above there are several types of real estate transactions each with several actors present, these are renting a property, purchasing a property and purchasing a property with a mortgage (Garcia-Teruel, 2020). These actors range from property owners, builders, users, brokers and notaries (Hoxha and Sadiku, 2019). In general notaries are responsible for: verification of the identity of transacting parties also stopping fraudulent sales, the laundering of money or any other illegal activities; second is to protect the consumer by stopping premature contracting via legal advice; third is to secure title by examining the registered title documentation and ensuring the appropriate recording procedure is followed; forth is to guarantee legality of the transaction (Garcia-Teruel, 2020).

Real estate agents are intermediaries when renting property and buying a property with or without a mortgage loan (Garcia-Teruel, 2020). Notaries are present only when a property is purchased with or without a mortgage loan, but they are not an intermediary when renting a property. The land registry is involved when buying a property with or without a mortgage but it is not involved in renting a property (Garcia-Teruel, 2020). When purchasing a property with a mortgage, attorneys, managers, property valuers and banks become intermediaries of the transaction as they all play a role i.e. granting the loan, drafting legal contracts, paying taxes, paperwork etc (Garcia-Teruel, 2020). In South Africa majority of the abovementioned intermediaries are present. According to (Tilbury, de la Rey and van der Schyff, 2019) the following actors are present in a sale of property transaction: buyer, seller, conveyancing attorneys, financial institutions, public services (municipal agents), real estate agents, land registry personnel and the Deeds office.

The number of middlemen in real estate transactions is high which means the cost foreign real estate investment is high, not to mention the lawyer and accountancy fees one has to pay (Sharmila, Nijanthan and Shanthi, 2019). Smart contracts and blockchain technology would have a lower legal cost, lower transaction fee and ultimately lower the barriers to entry for real estate transactions when compared to the current practices (Sharmila, Nijanthan and Shanthi, 2019). Commission on real estate transactions is earned by intermediaries such as brokers and attorneys from what is generally an individual’s biggest financial decision (Sharmila, Nijanthan and Shanthi, 2019).

Brokers who are most affected by this phenomenon are against the implementation of this technology (Sharmila, Nijanthan and Shanthi, 2019), brokers along with other intermediaries may have their work tasks changed due to a shortened transaction process. However it is challenging to ensure safe

real estate transactions devoid of some of the intermediaries such as real estate agents (Huh and Kim, 2020). As mentioned in the above section, banks can benefit from blockchain application to real estate transactions by increasing: reliability, transparency, efficiency and reduced fraud in real estate financing (Wouda and Opdenakker, 2019). Banks may be against the implementation of blockchain technology due to the technology's novelty and because banks are traditionally risk averse in nature, however banks are also the leading sector in funding blockchain start-ups (Spielman, 2016).

Blockchain's principal innovation is decentralization and the removal of 3rd parties, however it is not possible to remove intermediaries such as a notary in real estate dealings. We may see the function of this intermediary change with blockchain implementation but the total removal of 3rd parties is rejected (Nijland and Veuger, 2019). The land register of a country also needs to be regulated which contradicts blockchain's decentralized peer-to-peer nature, this highlights the need for a trusted 3rd party to avert manipulation and abuse of the register (Thomas and Huang, 2017).

Greater reliability, transparency, efficiency, and reduced fraud in real estate trades can be realized through blockchain implementation for the various actors involved. Smart contracts are being made to replace intermediaries, however (Sharmila, Nijanthan and Shanthi, 2019) believes the technology will make advisers in the transaction more efficient. Lowering the barriers to entry for real estate transactions my work against the incentives for some intermediaries who earn commission from the transaction, hence a collaborative approach is needed to blockchain implementation. A cooperative approach in South Africa would require a secure and transparent platform which has a single entry point for a complete transaction from sale to payment which works jointly with banks, real estate, legal and other government and private sectors as part of the business process (Tilbury, de la Rey and van der Schyff, 2019).

2.3.6 Benefits and drawbacks of Blockchain technology if applied to land registries.

2.3.6.1 Benefits

The benefits of blockchain technology and smart contracts are increased transparency for participants, time savings, decreased transaction costs, increased data security/un-hackability, less fraud, enhanced cross-border real estate transactions, the ability to verify legal and physical features, tokenise real rights and take on payments through smart contracts (Corluka and Lindh, 2017; Savu *et al.*, 2017; Nasarre-Aznar, 2018; Seuren, 2018; Ameyaw and de Vries, 2021).

Blockchain technology enables land transactions to take place without intermediaries, which further reduces the risk of fraud (Beznosov, Skvortsov and Skvortsova, 2021). The attributes of blockchain technology such as being distributed, dementalized and immutable are what enable security and privacy to be improved (Panda *et al.*, 2021). Cost savings and removal of unofficial charges can be realized through the blockchain framework as land information will be accessible through a simpler process which reduces intermediaries, unqualified middlemen and bureaucracies (Ameyaw and de Vries, 2021).

The implementation of blockchain technology for the land registration process and land ownership will enhance transparency of ownership and valuation while also reducing illegal transactions. These advantages are bound to result in improved conveyancing and land management which can boost the Gross Domestic Product (GDP) of the country (Thakur *et al.*, 2020). Blockchain technology assists in realizing Sustainable Development Goals (SDGs), for example the accurate and protected land records will reinforce the SDG goal of strong institutions and peace justice as these institutes will be advantageous and more answerable due to land transactions being non-repudiable and unenclosed providing access for all (Thakur *et al.*, 2020).

In any country land rights are essential in the following: contributing to economic expansion, addressing economic disparities, to ease conflict management, and to aid local governance processes, additionally trustworthy land ownership records enhance property values, and decrease lender risk (Benbunan-Fich and Castellanos, 2018). A blockchain based land registry solution can also boost citizens' trust in the government and make the consumer practice less burdensome, most importantly this type of solution will heighten data security and safeguard legitimacy of land records (Oprunenco and Akmeemana, 2018). Independence and decentralization are the major legal innovation brought forward by blockchain technology where the registration of real estate rights is concerned (Sandberg, 2021).

By way of a blockchain based land registry dead assets become liquid, sovereign rights of people are defended, transparency in government is increased and a more liquid and shareable economy can be realised (Kundu, 2019). A change stemming from government will move throughout the economy to the businesses within the real estate segment, this segment has a major effect on most of not all parts of the economy, consequently a government that implements Blockchain to reshape their land registration system would concurrently transform their economy (Heil, 2018). Moreover, countries

such as Georgia, Sweden, Dubai, Ghana and others which can be considered early blockchain land registry implementers have realized excellent results in the form of cost savings, better quality of service and the elimination of fraud and corruption (Benbunan-Fich and Castellanos, 2018; Themistocleous, 2018).

The realization of benefits and possibilities bought by blockchain technology has led to the formation of the "International Blockchain Real Estate Association" (IBREA) in Orange County California 2013, this is a non-profit, affiliate-focused support, educational, and trade organization devoted to applying Bitcoin and other blockchain knowledges in real estate. IBREA and has rapidly grown to approximately 3000 members across 17 countries (Thota, 2019). The cost of devices is decreasing while computing power is improving every day hence blockchain offers vast opportunity in Internet of Things (IoT) and providing security (Singh and Singh, 2016). Blockchain technology is still considered nascent in its application to land registries, it saves costs because of remediation of intermediaries such as agents, brokers, banks, notaries or conveyancers and administrators or registrars (Vos, Lemmen and Beentjes, 2017; Seuren, 2018). Blockchain technology can consequently be seen as an alternative for traditional Land Registers.

In table 1 below the key advantages and disadvantages of blockchain technology implemented in real estate transactions from the literature review are ranked by number of citations from Google Scholar per author, this table assisted in identifying the advantages and disadvantages of blockchain technology in land registries:

Table 1: Benefits and drawbacks of blockchain technology:

		Theme of key findings relates to blockchain technology and real estate												
		Advantages of implementation					**Disadvantages and challenges**							
Author	**Number of citations**	Greater security / reduced fraud	Smart contracts	Cost savings	Time savings	Transparency	Legal framework	Current intermediaries	Amendment of the ledger	Data quality	Link to official ID	Lack of blockchain expertise or blockchain education	Need for trusted 3rd party	Private Public Partnership (PPP) with blockchain experts
(Spielman, 2016)	98	X		X							X			
(Shang and Price, 2019)	64									X		X		
(Wouda and Opdenakker, 2019)	41	X			X	X				X				
(Benbunan-Fich and Castellanos, 2018).	41						X			X		X		
(Garcia-Teruel, 2020)	36						X	X	X		X		X	
(Nasarre-Aznar, 2018)	36	X	X	X	X	X								
(Konashevych, 2020)	25						X		X					
(Hoxha and Sadiku, 2019)	23			X	X	X								
(Corluka and Lindh, 2017;	15	X	X	X	X	X								
(Nijland and Veuger, 2019)	13	X											X	
(Kalyuzhnova, 2018)	12						X							
(Tilbury et al., 2019)	11	X	X	X	X	X	X	X		X				X
(Savu et al., 2017)	6	X	X	X	X	X								
(Ameyaw and de Vries, 2021)	4	X	X	X	X	X		X						X
(Seuren, 2018)	2	X	X	X	X	X								

2.3.6.2 Drawbacks

There are however some drawbacks to blockchain's implementation and use as seen in table 1 above. These include legal impediments, lack of interoperability, and recognition of digital signatures. Additional drawbacks include digital identity, legal merging of the standing of the digital currencies,

recording of co-ownership, the adjustment of the ledger, scalability of the ledger and the legal structure governing the usage of the blockchain and the enforceability of smart contracts (Kalyuzhnova, 2018; Garcia-Teruel, 2020; Konashevych, 2020; Zheng, Song and Sun, 2020). The implementation of blockchain involves proper structural design of the overlaid technologies to provide for adjustments of antiquated and inaccurate data in an effort to beat the challenge of immutability (Konashevych, 2020). Much of the potential advantages of employing the blockchain in land registries presumes a foundation layer of real estate information including titles, deeds and survey plans and that this information is authentic, a situation that does not hold in the majority of developing economies (Anand, McKibbin and Pichel, 2016).

One of the primary advantages of blockchains is the immutability of a block, which prevents duplicitous changes, but this weakens the critical ability to affect required changes. In real estate a unit acquires several types of rights, for example, ownership, rental, or mortgages over the lifetime of that unit, having this information locked unable to be edited becomes problematic as these rights change over time and do not remain the same from inception (Sandberg, 2021). Blockchain shares a common problem that affects electronic information systems, that being self-identification when accessing the system which may result in dishonesty. A block-holder on the blockchain has a monopoly over the actions of the block based on entry passwords. This becomes problematic when the block-holder is incapable of personally effecting changes to the block where the individual is deemed to be legally incompetent necessitating the nomination of a guardian, the death of an individual or where rights have been transferred to his/her heirs (Sandberg, 2021).

Several regulators have noted their intent to study the application of blockchain technology in the financial sector due to the benefits provided by blockchain technology and smart contracts: increased security and decreased costs, the implementation of these technologies may raise problematic regulatory and legal challenges. This outlines the need for worldwide technological and commercial blockchain standards to further advance the technology and prevent its misuse. Hence effective governance is fundamental to the successful application of blockchain and smart contract technology to protect all participants and ensure the system is able to deal with systemic risk, privacy issues and cybersecurity threats (Kakavand, Kost De Sevres and Chilton, 2017). Currently the legal requirement for the transfer of property rights requires these rights to be registered in a public registry, so the transfer of asset holder rights through a decentralized blockchain have no legal validity as opposed to transfer through a public registry. Hence blockchain use in land administration will not progress

naturally as was observed in cryptocurrencies where public registries are absent (Sandberg, 2021).

To start a digital land administration standardization is necessary. The European Land Registry Association (ELRA) has planned a venture on generating a model for structuring land registry data called the European Land Register Document, which is to be advanced in a consecutive project (IMOLA II), could be put on a European e-Justice blockchain in future (Lemmen, Vos and Beentjes, 2017). In relation to standardisation a situation where many groups are creating blockchain-based Land Administration system separately, as we see today, is to be avoided (Lemmen, Vos and Beentjes, 2017). LADM I (Land Administration Domain Model) was published by the ISO in 2012 and outlines the standardization of the processes for land transactions. Furthermore in 2018 the European Commission publicized a Financial Technology (Fintech) plan focusing on blockchain, they note "Blockchain is set to lead to a major breakthrough that will transform the way information or assets are exchanged, validated, shared and accessed through digital networks" (Hermansson, 2020).

Another the key issue relates to the physical location of data being stored, which is a concern of national law. Blockchain is fundamentally a decentralized instrument, discovering the precise location of a particular piece of information may be challenging (Pouwelse *et al.*, 2017). The enforcement of smart contracts legally is problematic as a contract necessitates notions such as certainty, consideration and acceptance all of which entail human decision making, computer code and the digital domain do not contemplate or abide by these contractual concepts (Pouwelse *et al.*, 2017). Smart contracts have the attribute of being are immutable and will only execute the programmed conditions of the contract. This is problematic if errors appear within the program's code, the DAO (Decentralized Autonomous Organization) attack where a hacker took advantage of a flawed smart contract on the Ethereum network, is an example which signifies a major security fear around smart contracts (Sladić *et al.*, 2021).

According to (Thomas, 2017) blockchain does not address one of the central concerns for real estate transactions, which is the demand for separate verification and control. Blockchain cannot be considered a replacement for current land administration inspection processes which scrutinize legal validity, legitimacy and identity of transactions and information by notaries, attorneys and registration clerks (Sandberg, 2021). Blockchain supporters seemed to have neglected a registry's major purpose of delivering an aspect of independent verification of the source of the data being

stored, they also overlooked the vital role courts play in executing binding rulings, which crucially includes the legal success of any blockchain system.

The most significant of these problems is pinpointing who of the prospective contributors assumes the risk, and if that risk is tolerable in terms of how the system was designed (Thomas, 2017). It is argued that for land a certain form of regulating is required so that abuses and misuses of the blockchain based system are circumvented (Thomas and Huang, 2017). Based on the need for regulating the land register, some form of state or other "trusted" third party intermediation is necessary to prevent abuse and misuse of the register. This suggestion seems to contradict a central attraction of blockchain technology, which is its disintermediating and decentralized capability to operate P2P without a 3rd party (Thomas and Huang, 2017).

The earning of peoples trust in a digital system and how people value their properties are still one of the largest challenges faced by the realisation of a blockchain based land registry (Corluka and Lindh, 2017). The complex land registration process requires the participation of numerous stakeholders, such as landowners, government agencies, and financial institutions. It is essential that all these parties trust the system that tracks land ownership, and the legality of the titles registered therein (Benbunan-Fich and Castellanos, 2018).

Nevertheless, a number of the problems mentioned above may well be dealt with through a private blockchain, a reduction of miners to particular land record-keepers, development of a new protocol in the nodes to control official and extensive aspects and a hierarchy of accountability must be noted to deal with errors (Peiró and García, 2017). The legal system surrounding land registry systems should not be underestimated as it is complex dealing with a large variety of different transactions of real property and real rights, (Vos, Lemmen and Beentjes, 2017) notes that without the standardization of portions and aspects of the land registration process its complexity represents a limit to success.

Blockchain technology presently has the drawbacks of deficient knowledge , lack of solutions, lack of standards for implementation and no overview of the international experience of applying the technology in land administration (Beznosov, Skvortsov and Skvortsova, 2021). Blockchain technology is in its formative years and the tools available are not sufficiently mature for the market. Blockchain ought to not be used as primary store of data as it is not effective in storing vast data quantities, instead it should be implemented as a type of index or transaction layer (Sladić *et al.*,

2021). The system of blockchain technology entails the need for increased processing or computing power and electricity consumption which results in a distributed computer network which is slower than centralized systems (Sandberg, 2021). Consequently, due to these drawbacks, (Sandberg, 2021; Sladić *et al.*, 2021) find that the advantages of blockchain technology do not yet surpass the costs, risk and challenges of adopting the technology for land registration.

2.3.7 Recommendations for implementing blockchain based land registries.

According to (Sladić *et al.*, 2021) the principal reasons for adopting a blockchain based land registry are: quicker transactions, automatic announcements of adjustments in the land register, more secure and transparent transactions and digital records of official papers and contracts hashed onto the blockchain. As stated previously some authors are of the view that blockchain technology is not mature enough to impact land management practices while other authors believe the opposite, that blockchain technology can impact land administration (Ameyaw and de Vries, 2021).

Blockchain technology promotes decentralization and the removal of 3rd parties, but individuals still need to be able to trust those who control the system (Lemieux, 2017a). Nijland and Veuger (2019) find that in the implementation of blockchain technology, stakeholders of the land registration process see the possibility for an advisory stakeholder or trusted 3rd party. A suggested solution is a private/permissioned blockchain controlled by the public authorities, this offers the equal assurances for both signatories and 3rd parties as present practices (Garcia-Teruel, 2020). The re-introduction of a trusted third party goes against the P2P nature of blockchain. However, this type of private or hybrid blockchain register offers equal trust and functionality of a traditional land register, furthermore this authority can function as the technical manager of the blockchain (Verheye, 2017a).

It is also recommended that IT specialists, surveyors, notaries, registrars, and other stakeholders work closely together around blockchains possible implementation (Lemmen, Vos and Beentjes, 2017; Vos, Lemmen and Beentjes, 2017). It is possible to implement blockchain technology by standardizing elements of the "triple" (object, right and subject), consequently a technical standpoint allows us to note it is conceivable to connect and employ blockchain technology through a recognized transaction or data framework, for instance LADM (Lemmen, Vos and Beentjes, 2017). The following standard: ISO/TC 307, has scope for the standardisation of blockchains and DLTs to support interoperability and data exchange between users, applications, and systems. This standard ISO/TC 307 is being developed by Standards Australia along with the standards related to land

administration, presently there are 15 other nations who are participants of this proposal comprising of Canada, Germany, the UK, the USA, and China, there are also 17 observing nations including: the Republic of Ireland, Switzerland, Argentina, Spain and South Africa (Velpuri, 2017).

Few studies focused on geospatial data as opposed to the majority, which focused on land registers, and data relating to property rights, properties themselves, and those holding rights. The study by (Sladić *et al.*, 2021) notes the introduction of FOAM Protocol as the standard for sharing geospatial data on the secure, decentralized Ethereum network. Geospatial data or survey data about a properties location and boundaries can be incorporated through the FOAM Protocol, which functions as a location overlay for smart contracts and generates a consensus powered map. This proof of location provides a spatial context which is absent from usual blockchains. The FOAM protocol is considered as a standard by the Open Geospatial Consortium (OGC).

The implementation of blockchain technology calls for a co-evolution between a developing technology and a governance response, which stimulates positive effects and mitigates negative ones. Experimentation by governments on blockchain applications seems crucial in achieving a better understanding of how blockchain works and refining their own functions and roles in a shifting institutional environment (Lemmen, Vos and Beentjes, 2017). To enable experimentation governments must compensate for their lack of knowledge in blockchain technologies, this can be done by partnering up with 3rd party start-ups specializing in Property Technology (PropTech) (Heil, 2018). The study conducted by (Baum, 2017) finds that PropTech firms are being invested into heavily and are here for the long term, he also notes that successful PropTech firms are fixated on implementing products which bring efficiency and alignment to the market, not firms who are trying to be disruptive.

The study conducted by (Ameyaw and de Vries, 2021) recommends that a legal foundation for PPP be established to ensure blockchain experts of a permanent position in the land market. It is also recommended that there are strict legal penalties opposed to illegal activities, which are a threat to the system. Further policy recommendations include an inclusive approach to digitization of land records for all participants and education for the public on the blockchain system and how it functions (Ameyaw and de Vries, 2021).

2.3.8 Cases of blockchain based land registry pilot projects.

Despite blockchain being sometimes seen as threatening, several pilot projects are underway which have tested blockchain technology-based solutions in their land registries. Countries such as Sweden, the Republic of Georgia, Ghana, Australia, Honduras, the US and the Netherlands have such pilot projects in place (Veuger, 2018; Garcia-Teruel, 2020; Konashevych, 2020). Majority of these pilot projects focused on the implementation of Blockchain 2.0 which relates to the archiving functionality, a way to ensure the preservation of certain information or documents by placing hash pointers on the blockchain, other pilots have researched Blockchain 3.0, these attempt the entire transfer of ownership process using smart contracts (Vos, 2017). The study conducted by (Themistocleous, 2018) organizes blockchain land registry adopting countries by category of land registry: Category 1- Dubai, USA- Cook County, Sweden, and UK-HM land registry; Category 2- Republic of Georgia, Ukraine and Category 3- Ghana, Honduras; the early adopters have realized exceptional results including cost savings, improved quality of service, and the eradication of fraud and corruption. While distributed database use is increasing, it is still mostly in the proof-of-concept, demonstration, or pilot stage. These distributed databases appear to be under-exploited or at least under-explored within the land sector (Bennett *et al.*, 2021). With only one nation (Georgia) having institutionalised the technology.

2.3.8.1 Sweden

The venture of shifting cadastral processes to blockchain began in 2016 and is a collaboration between the home-grown blockchain start-up Chromaway, the state Swedish National Land Administration Service, the telecommunication provider Tellia and the consulting company Kairos Future. This project makes use of smart contracts with a restricted number of participants able to view and enter data (Kalyuzhnova, 2018). There are 3 important issues which the blockchain solution in Sweden intends to address, those are: a lack of transparency, a slow and complex process which leads to inefficiencies; the value added by the blockchain solution: quicker time to market, elimination of corruption/fraud as well as liquid assets and a liquid economy (Kundu, 2019).

In recent updates, Chromaway has emphasised the project's development, including technical issues. The technology now incorporates smart contracts and digital signatures to speed up and protect property transfers. Despite these achievements, the initiative is waiting for new legislation to fully

digitise property transfers, as present Swedish law still needs paper signatures (Mizrahi, 2017b; Modin, 2021).

2.3.8.2 USA

In 2016, the Cook County Recorder of Deeds in Chicago launched a trial initiative with Velox.re, a blockchain technology firm. This project sought to investigate the potential of blockchain for creating digital property extracts, transferring property titles, filing liens, and combating fraudulent activity. The experimental programme aimed to determine the interoperability of distributed ledgers with traditional server-based databases. It also attempted to streamline the recording process, reduce fraud, and minimise residents' bills. The project focused on producing a permanent, unchanging public record and investigating the possibility of paperless property transactions and electronic deeds (Coleman, 2016; EconoTimes, 2016; Wheatley, 2016). A similar project is also underway in the city of South Burlington, Vt. Various other local governments within the USA are investigating the possible use of blockchain technology (Kundu, 2019).

2.3.8.3 Republic of Georgia

In 2017 the National Agency of the Public Registry of Georgia (NAPR), the Blockchain Trust Accelerator, the software provider BitFury Group, and renowned economist Hernando De Soto began a piloting the project for land registration on the basis of blockchain (Kalyuzhnova, 2018; Kshetri and Voas, 2018; Shang and Price, 2019). The Private Public Partnership with a PropTech firm will prove to be a critical element of this project’s success as the BitFury Group brings the necessary expertise surrounding this technology which the Georgian government lacks (Benbunan-Fich and Castellanos, 2018). This blockchain contains over 200 000 archives of rights of land parcels, transactions are done via the blockchain with the records accessible to be audited (Jardine, 2018; Kalyuzhnova, 2018).

Research conducted by (Shang and Price, 2019) indicate the following: The NAPR implemented policies to make the process or registering land simpler, permitted additional stakeholders to partake in land associated public services, and introduced the restructuring of legislation relating to the procedures of composing then verifying property transactions. Additionally, the NAPR formed NAPReg, which is a digitized land registry archive for storing data such as property tiles, names, address, cadastral code, and photographs can be easily found. These improvements have drastically reduced the time and cost of property transactions; conversely, Georgia faces the challenge of

guaranteeing the integrity of data and protecting the system from domestic misuse and outside cyberattacks. Analysts identify potential future hazards such as a loss of developer support, problems in blockchain code or smart contracts, and vulnerability to quantum computing breakthroughs. Despite these dangers, the stakeholders have a strong long-term vision for trustworthy and auditable data trails and responsible governance (Inge Snip, 2017)

Bitfury did not create an ultramodern blockchain founded land registry system but rather a timestamping tier on top of the NAPR's current digital land registration system. Phase 2 of Georgia's project expects to further integrate the sale and transfer of property process into the blockchain, BitFury has proposed using Exonum, this is a private blockchain scaffold the firm created which anchors data to the Bitcoin Blockchain. According to (Shang and Price, 2019) anchoring stands as the procedure of depositing a fingerprint (a hash) of a system to a public resource, Bitfury clarifies that "anchoring removes the need to trust the administrators of an Exonum Blockchain unconditionally; at the same time, it keeps sensitive data private".

The initiative now covers more than just land title registration, including mortgages and notary services. This expansion intends to simplify all aspects of property administration using the blockchain architecture (Inge Snip, 2017; Jardine, 2018). BitFury's custom-designed technology ensures safe and verifiable documentation for crucial information and evidence of ownership, without compromising confidentiality. NAPR plans to integrate smart contracts to further automate and safeguard company processes (Jardine, 2018).

Two key success factors contributed to the Georgian project, namely data quality and education (Jardine, 2018; Shang and Price, 2019). For successful implementation it is essential that every stakeholder be knowledgeable in blockchain technology and problems it can help overcome, the technology is able to ensure immutability and security of information but it cannot be a replacement for the established infrastructure within institutions which is crucial for guaranteeing data quality (Shang and Price, 2019). The results of implementing a blockchain based land registry in Georgia are: citizens can claim to owning their country, removal of the trust deficit and corruption, decreases operational costs and improved time to market (Inge Snip, 2017; Jardine, 2018; Kundu, 2019). Georgia's leading involvement in blockchain-based land registration has gained global recognition. This initiative's success serves as an example for other countries looking into comparable technology to better public record-keeping and governance. The Georgian government aims to further employ

blockchain technology to create a secure and transparent National Repository of Governmental and Official Documents (Jardine, 2018).

2.3.8.4 Ukraine

The Ukrainian President signed a law on the State Land Cadastre taking effect from 01 January 2012. This law establishes a solid foundation for the further digital transformation and implementation of blockchain technology into the land cadastre system. It focuses on eliminating human interaction in land registry operations, improving data security, and maintaining openness(Kushniruk, 2011). The National Agency for the Electronic Government of Ukraine entered into an agreement with Bitfury regarding the shifting of Ukraine's State Land Cadastre to the blockchain in June of 2017.. Significant progress has been made since Ukraine's blockchain-based land registration project was launched in 2017.

The initiative to digitise auctions for leasing state land has moved forward. The project makes use of Bitfury's Exonum platform, a private blockchain framework that securely and transparently attaches data to the Bitcoin network (EconoTimes, 2017; Kalyuzhnova, 2018). This phase focuses on decreasing human error and corruption, with subsequent phases aiming to better integrate property sale and transfer operations onto the blockchain. The latest developments intend to improve information exchange, with a special emphasis on damage assessments to help communities recover from the effects of the war. In February 2024, the UNDP (United Nations Development Programme) signed a Memorandum of Understanding with the State Service of Ukraine for Geodesy, Cartography, and Cadastre. The integration of UNDP damage assessment data with StateGeoCadastre systems is intended to make restoration planning more efficient and effective at various administrative levels (Samus, 2024).

These initiatives aim to minimise property transaction time and costs, increase data quality, and safeguard against cyberattacks. The blockchain-based solution aims to increase public confidence by maintaining the immutability and security of property data, allowing for a more transparent and efficient land register procedure (Kushniruk, 2011; Samus, 2024)

2.3.8.5 Ghana

Bitland, a US established program for property registration revealed in 2016, the beginnings of a blockchain based land registry system in Ghana. This is a nation where 78% of land is not registered

and a large bottleneck of land dispute cases in the courts exists (Kshetri and Voas, 2018). This project is founded on the Bitshares blockchain on the Graphene platform, cadastral tokens have been distributed, through which the registration of land rights will be enabled, land and tenure disputes can be resolved, corrupt practices reduced and the transaction of land can take place (Kalyuzhnova, 2018; Kshetri and Voas, 2018). The middle of 2016 saw 24 communities within Ghana show curiosity in the project, Bitland also plans to grow into Nigeria (Kshetri and Voas, 2018).

Expanding into other nations and areas includes the idea of establishing solar-powered centres that act as hardware hubs for land registration, as well as educational centres to teach residents about blockchain technology(Bitcoin PR Buzz, 2016; Dob, 2016). Bitland gathered funding for the project via an Initial Coin Offering (ICO), with the objective of creating the first operational Bitland Centre. The programme also plans to integrate a voting system so that community people may participate in land management and infrastructure project decision-making (Bitcoin PR Buzz, 2016). While Bitland's blockchain programme shows promise in terms of eliminating corruption and boosting transparency in land transactions, combining blockchain technology with current legal frameworks presents some hurdles. Ensuring the accuracy and security of blockchain records in a way that complements established traditional legal systems remains a major challenge (Konashevych, 2019).

2.3.8.6 Honduras

In 2016 the Honduras government introduced a joint project with the firm Factom regarding the implementation of blockchain technology to enable the registration of land rights (Kalyuzhnova, 2018). The Honduran system uses Factom technology and Epigraph Operations Framework, these reduce the implementation and operating costs while also offering maximum level data integrity and transparency, these directly solve the country’s land registration issues (Collindres, Regan and Panting, 2016). However, in mid-2017 the project was reported to have stalled due to an impending presidential election and has not been restarted since.

The PPP in the Honduras could not be established successfully due to the misalignment of interest between the Honduran government, who wanted to keep the project under wraps, and the private partner who sought to advertise the project (Benbunan-Fich and Castellanos, 2018). Another factor contributing to this project’s failure is the lack of digitized paper records in the Honduras which would make the move onto blockchain much easier (Benbunan-Fich and Castellanos, 2018). These

developments underscore the complexities of integrating blockchain technology in land register systems, particularly in areas with current administrative and political issues.

2.3.8.7 India

Here the states of Telangana and Andhra Pradesh broadcast their plan to employ blockchain technology for their land registries, October 2017 saw the Andhra Pradesh authority team up with Swedish start-up Chromaway for the city of Amaravati (Kshetri and Voas, 2018).. The Andhra Pradesh state government is focusing on using blockchain to speed land registration processes, prevent fraud, and improve the efficiency of property transactions. This programme is part of the larger ambition to make Amaravati a technologically sophisticated metropolis (Mizrahi, 2017a)

The Telangana government continues to explore the integration of blockchain technology to dynamically protect and update land records. This project seeks to avoid fraudulent actions such as tampering with land records, which has been a major problem in the past. The project entails developing a database with Geographic Information Systems (GIS) to correctly map and verify properties. This attempt is part of a bigger initiative to promote openness and eliminate conflicts in property purchases. The National Institute of Smart Governance has been contracted to manage the Request for Proposal (RFP) process for choosing technology partners (Y. Lasania, 2017).

From section 2.3 we have found that there are various benefits and drawbacks when implementing blockchain technology in real estate transactions and land registries. Given the already mentioned benefits and drawbacks of implementing blockchain in land registration and real estate transactions, blockchain technology accommodates the major transaction theories in real estate while also showing that there may be changes in store for the current actors involved in real estate transactions. We have also seen that the nations, which have experimented or implemented the technology report positive outcomes in the real-estate transaction process.

2.4 Comparison of South African land registry against existing blockchain registries

Real estate forms a major part South Africa’s economy. South Africa's existing real estate acquisition process is inefficient due to reliance on various third parties, which results in high transaction costs, as well as extensive manual examination and verification of financial and legal papers. It is also time demanding since it necessitates the manual updating of many systems with redundant information

that is prone to mistakes and fraudulent behaviour. Blockchain presents a tool to overhaul South Africa's traditional land registry and improve other outdated real estate systems.

Tilbury, de la Rey and van der Schyff (2019) describe the inefficiency of the South African real estate transaction procedure and finds there are a minimum of 12 fixed stakeholders with other types of transactions permitting 5 additional stakeholders. The number of documents required is 25 with an additional 10 documents needed if a mortgage is recorded, or annulled. In addition, there are 7 fixed costs possibly leading to 11 additional costs based on the type of transaction. Thus, the current system for a real estate transaction requires up to 35 documents and 18 cost items.

Benbunan-Fich and Castellanos (2018) as well as Shang and Price (2019) use the following measures to compare the quality of the Georgia and the Honduras land registry service: the first measure is through the World Bank's report on "Doing Business 2020" which grades 190 countries on various measures of doing business, one of which is registering property. In measuring a country´s property registration process, the following criteria is studied- processes, time, and cost to convey a property and the quality of the land administration (quality is made up of five attributes: reliability of infrastructure, transparency of information, geographic coverage, land dispute resolution, and equal access to property rights.) (The World Bank Group, 2019). These attributes are then measured, scored, and then ranked by the World Bank, as seen in table 2 below.

The second measure analysed is the sophistication of a country's IT (Information Technology) infrastructure through a ranking of 193 countries provided by the United Nations e-Government Survey and an E-Government Development Index (EGDI). The final aspect analysed was the worldwide Corruption Perception Index, a ranking of perceived public sector corruption among 180 countries which delivers a suggestion of the established political interests that might pose a threat to a system that improves transparency. The higher a nation's ranking the less corrupt it is.

Sweden, Georgia, and the Honduras have all implemented blockchain based land registries with varying degrees of success. Sweden and Georgia implemented the technology successfully, but the project has stalled in Honduras. Based on the above-mentioned measures of land registry quality Sweden, Honduras, the Republic of Georgia and South Africa achieve the following scores in table 2 below (Division for Public Institutions and Digital Government (DPIDG), UNDESA., 2018; The World Bank Group, 2019; Transparency International, 2020):

Table 2: Measures of land registry quality

	Sweden	**Georgia**	**Honduras**	**South Africa**
Registering Property (rank) – World Bank report	9	5	101	108
Score of registering property (0-100)	90,1	92,9	62,3	59,5
Procedures (number)	1	1	6	7
Time (days)	7	1	28,5	23
Cost (% of property value)	4,3	0	5,7	8
Quality of the land administration index (0-30)	27,5	21,5	12,5	15,5
United Nations e-Government Survey ranking	5	60	123	68
EGDI	0,8882	0,6893	0,4474	0,6618
Corruption Perception Index ranking	4	44	146	70

From the table 2 we can see that South Africa lags far behind Georgia and Sweden (blockchain adopters) in all aspects measuring the quality of a nation's land registry. South Africa has a high number of procedures – 7, long transaction time – 23 days and high costs which make up – 8% of the property's value. In contrast, Sweden and Georgia which have a single procedure, transaction times of 7 and 1 days, and costs of 4.3% and 0% of property value, respectively. This shows that blockchain based land registries result in minimal procedures, drastically shortened transaction times and significantly lower costs. The seven procedures in South Africa comprise of preregistration procedures (e.g., analysis for liens, notarizing sales agreement, outlay on property transfer taxes), actual registration procedures in the nation's city with the largest economy, and post-registration procedures (e.g., filling title with municipality). The seven steps are outlined in table 3 below (The World Bank Group, 2019):

Table 3: Procedures to register a property in the City of Johannesburg

Procedure	Agency involved	Time taken to complete	Cost in Rands
1. Obtain a rates clearance certificate from the City of Johannesburg's Revenue Department.	Municipality (City of Johannesburg's Revenue Department)	11 days	R248.03
2. The conveyancer prepares and collects all the required documentation.	Companies and Intellectual Property Commission	10 days	Included in procedure 6
3. Obtain an electrical compliance certificate.	Certified electrician	7 days	R1,250.00
4. Obtain a transfer duty receipt from the South African Revenue Services	South African Revenue Services	2 days	*See breakdown below
5. The conveyancer conducts a title search and checks encumbrances on the property at the	Deeds Registry	Less than 1 day	Included in procedure 6
6. Parties sign all the documentation at the conveyancer's office	Conveyancer's office	1 day	**R 40,815;
7. The conveyancer lodges the deed at the Deeds Registry	Deeds Registry	11 days	***R1,846

This table assumes: that the buyer and seller are limited liability companies; the property is fully owned by the seller, has no mortgages, is registered in the land registry, has no ownership disputes and is a warehouse in good condition available for commercial use. Procedures 2, 3, 4 and 5 run concurrently with their previous procedure.

* The scale for the transfer duty was changed for properties acquired on or after March 1st, 2017.
The current scale is as follows:

- R 0 to R 900, 000 - exempt.
- R 900, 001 to R 1 250,000 3% on value above R 900,000 but not exceeding R 1,250,000.
- R 1 250,001 to R 1 750, 000 - R 10,500 + 6% on value above R 1 250,000 but not exceeding R 1,750,000.
- R 1 750,001 to R 2 250, 000 - R 40,500 + 8% on value above R 1 750,000 but not exceeding R 2,250,000.
- R 2 250,001 to R 10 000, 000 - R 80,500 + 11% on value above R 2 250,000 but not exceeding R 10,000,000.
- R 10 000 000 and above - R 933,000 + 13% on value above R 10 000, 000.

** Conveyancing fees depend on the property value (per Conveyancing Fees Guidelines published by the Law Society):

- R100,000 or less: R 4,800
- Over R 100,000 - including R 500,000: R 4,800 plus R735 per R50,000 or part thereof above that.
- Over R 500,000 - including R 1,000,000: R 10,680 for the first R 500,000 plus R 1,470 per R 100,000 or part thereof above that.
- Over R 1,000,000 - including R 5,000,000: R 18, 030 for the first R 1,000,000 plus R
- 735 per R 100,000 or part thereof above that
- Over R 5,000,000: R 47 430 for the first R 5,000,000 plus R 370 per R 100,000 or part thereof above that)

*** The fees for registering a transfer and a bond are as follows, purchase price / value of property, whichever is the greater:

- does not exceed R100,000 is R36,00
- exceeds R100,000 but does not exceed R200,000 is R78,00
- exceeds R200,000 but does not exceed R300,000 is R486,00
- exceeds R300,000 but does not exceed R600,000 is R606,00

- exceeds R600,000 but does not exceed R800,000 is R852,00
- exceeds R800,000 but does not exceed R1,000,000 is R978,00
- exceeds R1,000,000 but does not exceed R2,000,000 is R1 098,00
- exceeds R2,000,000 but does not exceed R4,000,000 is R1 522,00
- exceeds R4,000,000but does not exceed R6,000,000 is R1 846,00

Regionally South Africa ranks just above the regional average for registering property of 56.3 with a score of 59.5. This is however worse than neighbours Botswana and Mauritius who have scores of 65.8 and 82.5 and are ranked 82nd and 23rd respectively. This shows there is room for improvement in South Africa's land registration systems. South Africa also ranks well below Sweden, just below Georgia but above the Honduras in terms of the United Nations e-Government Survey (68) and EGDI (0.6618), with South Africa classified as having a high EGDI (Division for Public Institutions and Digital Government (DPIDG), UNDESA., 2018). A similar comparison is made when analysing South Africa's public sector corruption, on the worldwide Corruption Perception Index for 2019 South Africa was ranked at 70, this is better than the Honduras 146 but some level below that of blockchain adopters Sweden at 4 and Georgia at 44. From the above data it can be noted that nations considered to be early blockchain land registry implementers have realized excellent results in the form of cost savings, better quality of service and the elimination of fraud and corruption (Benbunan-Fich and Castellanos, 2018; Themistocleous, 2018)

2.4.1 Recent developments in land registration

October 2019 saw South Africa's president pass the Electronic Deeds Registration Systems Act 19 (Electronic Deeds Registration Systems Act 19, 2019). The demand for such a bill comes from the bigger need for electronic service delivery, to accommodate for a projected 20 million packages of land for the government's land reform strategy. It also comes from the need to decentralize service delivery at place of need, unify with the digital Cadastral Information System to enhance effectiveness and precision of South Africa's land data administration, as well as consolidate varied legacy registration measures. It was also meant to provide for increased capability for future methods of land tenure that may be instituted (Benaters Attorneys, 2019; Eversheds Sutherland, 2019; Botha, 2020). The Electronic Deeds Registration Systems Act provides a foundation for an Electronic Deeds Registration System (e-DRS). The act has been described as a "preliminary life jacket" as it does not go into vigorous detail; crucially the act does not elaborate on the type of technology that will be used but does outline the accepting of online signatures to perform the same function as their paper based counterpart's (Coetzee, 2019; Johnson, 2019).

The benefits of blockchain technology are being realized by those nations who adopt the technology while those who do not have been unable to benefit from its advantages (Heil, 2018). Studies in India and Pakistan have recommended that their governments take serious note of the impacts of the technology and implement blockchain, so they are not left behind from accessing the benefits from the technology (Uzair *et al.*, 2018; Bhatia *et al.*, 2019; Sharmila, Nijanthan and Shanthi, 2019). It is imperative for South Africa to recognize blockchain technology as a way of transforming the real estate sector so that the sector is modernized to enhance the country's economy for the benefit of all South Africans. This section shows that South Africa's current real estate transaction system is grossly inefficient when compared to blockchain adopting nations resulting in a need for modernization of the country's land registry and the laws governing real estate transactions.

2.5 Barriers to technology adoption

Even though the adoption of multiple technologies brings a variety of deficits, research shows that public sector entities can be slow in adopting these technologies. Slow adoption of these technologies is due to multiple barriers that found in the literature. Table 4 below categorizes barriers to technology adoption found in literature based on the number of citations on Google Scholar. This was done to establish common barriers to technology adoption in the public sector. The following barriers were identified in the table below:

Table 4: Barriers to technology adoption

		Legal barriers	Administrative barriers										Infrastructural barriers				
Author	**Number of citations**	Establishment of a legal framework	Interdepartmental co-ordination and communication	Redesign of organisational / business processes	Acceptance or commitment to change from all role players	Lack of trust between implementers and users	Resistance to change	Financial cost and resource allocation	Quality of leadership	Lack of shared understanding	Organizational structure, practices, and culture	Insufficient time for understanding and	Weak IT infrastructure	Technological barriers (flexibility, security, and	Technological expertise / skills	Information security and privacy	Ability to innovate and handle daily operations
(Ebrahim and Irani, 2005)	1150		X	X				X						X	X		
(Ismail, 2013)	303	X			X												
(Batubara, Ubacht and Janssen, 2018)	290	X			X									X			
(Cinar, Trott and Simms, 2019)	246	X	X			X	X	X	X	X	X	X	X		X		X
(Allen, Kern and Havenhand, 2002)	244		X	X				X									
(Hendriks, 2013)	165	X	X	X	X												
(Alshehri and Drew, 2012)	154	X	X			X	X	X					X		X	X	
(Beaumaster, 1999)	51		X	X				X							X		
(Nwakanma *et al.*, 2013)	31		X	X				X									
(Wang *et al.*, 2020)	21		X					X				X			X		
(Bjerke-Busch and Aspelund, 2021)	5					X	X	X	X	X	X				X		X
(Atique *et al.*, 2021)	4					X									X	X	

The above barriers have been grouped according to legal, administrative, and infrastructural barriers based on each barrier's characteristics. This will allow for easier classification and give a relative guide as to which type of barriers are most common. The most common barriers are interdepartmental co-ordination and communication as well as financial cost and resource allocation, both being cited 8 times. The next most cited barrier with 7 citations is technological expertise or skills. Third most common is the establishment of a legal framework barrier and the redesign of organisational / business processes, both being cited by 5 times. Next is the lack of trust between implementers and user's barrier with 4 citations, followed by the acceptance or commitment to

change from all role players with 3 citations. The remaining barriers are all cited twice each. Below is an explanation and classification of each barrier.

Financial costs and resource allocation, which involves insufficient funding and a lack of available resources for technology adoption (Beaumaster, 1999; Allen, Kern and Havenhand, 2002; Ebrahim and Irani, 2005; Alshehri and Drew, 2012; Nwakanma *et al.*, 2013a; Cinar, Trott and Simms, 2019; Wang *et al.*, 2020; Bjerke-Busch and Aspelund, 2021). This is classified as an administrative barrier as the government's current resources was well as their fiscal and municipal budgets ultimately dictate the allocation of funds and resources to the organisations involved in land registration.

Lack of technological skills or expertise and interdepartmental co-ordination and communication are a key barrier to technology adoption. This includes low technical knowhow at various levels (Beaumaster, 1999; Ebrahim and Irani, 2005; Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019; Wang *et al.*, 2020; Atique *et al.*, 2021; Bjerke-Busch and Aspelund, 2021). This also includes poor communication, coordination and information sharing between departments or organizations (Beaumaster, 1999; Allen, Kern and Havenhand, 2002; Ebrahim and Irani, 2005; Alshehri and Drew, 2012; Nwakanma *et al.*, 2013a; Cinar, Trott and Simms, 2019; Wang *et al.*, 2020). Lack of technological skills or expertise is classified as an infrastructural barrier as it limits the extent to which benefits from technology can be realized. Interdepartmental co-ordination and communication represent an administrative barrier as the organizations or government departments involved in land registration are required to communicate with each other.

The absence of a legal or policy framework for technology adoption, characterised by the absence of appropriate policies and regulations also hinders effective governance and technology adoption (Alshehri and Drew, 2012; Ismail, 2013; Batubara, Ubacht and Janssen, 2018; Cinar, Trott and Simms, 2019). The establishment of a legal framework represents a legal barrier as electronic land registration needs to be legally permissible. Moreover, lack of trust between implementers and users and need to redesign organizational/business processes could also slow technology adoption (Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019; Atique *et al.*, 2021; Bjerke-Busch and Aspelund, 2021; Beaumaster, 1999; Allen, Kern and Havenhand, 2002; Ebrahim and Irani, 2005; Nwakanma *et al.*, 2013a). This is an administrative barrier. Users and implementers would engage in the clerical task of land registration in an electronic system, where trust needs to be equal to that in experienced in the current manual land registration system.

Resistance to change and lack of acceptance/commitment to change from all role players is another barrier. Some actors may resist new technology due to professional culture or potential changes in roles (Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019; Bjerke-Busch and Aspelund, 2021). Successful adoption requires commitment and acceptance from all involved (Ismail, 2013; Batubara, Ubacht and Janssen, 2018). These represent an administrative barrier as the organisations and departments involved in land registration must accept or commit to the digitization of the process, with measures in place for any resistance that may be encountered.

Weak IT infrastructure (Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019), information security and privacy concerns (Alshehri and Drew, 2012; Atique *et al.*, 2021), insufficient time to understand and implement a new technology (Cinar, Trott and Simms, 2019; Wang *et al.*, 2020) also impedes adoption. Weak IT infrastructure and information security concerns represent infrastructural barriers as they directly impact the technology being employed for land registration and the quality of information uploaded. Time represents a resource and is classified as an administrative barrier. This is because in digitizing land registration, the organizations involved will require enough time to educate themselves, understand the new technology and different processes that would be involved.

The ability to handle day-to-day operations and innovate, the quality of leadership in organizations involved, lack of a shared understanding of goals and strategy, and organizational structures, practices, and cultures (Cinar, Trott and Simms, 2019; Bjerke-Busch and Aspelund, 2021) can also hinder technology adoption in the public sector. The ability to handle day-to-day operations and innovate is an infrastructural barrier as it deals directly with the technology employed to digitize land registration. Quality of leadership, a lack of shared understanding and the organizational structure, practices, and culture, all represent administrative barriers as they manifest themselves within the organisations involved in land registration. The classification into administrative, legal, and infrastructural barriers underscores the importance of governments role as in the land registration process as it plays a role in all barriers that have been identified. How each these barriers manifest themselves and their relative importance to the study and is explained under sections 4.3 and 5.2 where the barriers are classified in further detail.

2.6 Critical success factors for adoption of blockchain technology

This section discusses some of the common critical success factors for implementing a new technology in the public sector from an international perspective as well as then critical success factors from a South African public sector perspective.

2.6.1 Critical success factors in the adoption of a new technology in the public sector

The literature surveyed investigated critical success factors for the adoption of a new information technology in various cases in the public sectors of countries such as Malaysia, Uganda, Nigeria, Tanzania, Australia, USA, UK, and South Africa. Some of the common critical success factors are listed below.

Relating to the skills needed in adopting a new technology, one of the critical success factors is the level of IT (Information Technology) skills and expertise available to the teams implementing the technology (Beaumaster, 1999; Ebrahim and Irani, 2005; Ejiaku, 2014). To the effect of IT skills, when the public sector lacks the necessary expertise, it is common that they partner up with private firms to supplement their lack of knowledge. The critical success factors emanating from the need for private public partnerships (PPPs) are that outsourcing some activities, guaranteeing effective technology transfer to in-house staff by the private company, and appointing experienced consultants proved to be crucial to implementing the technology (Tan *et al.*, 2007; Basheka, Oluka and Mugurusi, 2012).

Project management skills are also mentioned as a critical success factor to implementing a new technology in the private sector. Effective project management skills such as change management skills, strategic planning, project scheduling and risk management are mentioned as critical success factors in their various case studies (Beaumaster, 1999; Tan *et al.*, 2007; Basheka, Oluka and Mugurusi, 2012; Nwakanma *et al.*, 2013b). The nature of IT is that it is always evolving and this requires a provision for education on the subject information technology in question, this is crucial factor in successfully implementing a new information technology in the public sector (Ejiaku, 2014).

2.6.2 Critical success factors in the adoption of a new technology in South Africa's public sector

From a South African perspective the study conducted by (Hendriks, 2013) outlines guidelines for the successful implementation of an Integrated Financial Management Information Systems (IFMS) by the municipal sector of South Africa. This study finds that a capacity-building plan, gaining the of commitment of all participants, the establishment of a legal framework, an outline for productive change management, a robust project management team, a method for enactment which is phased, and a definite project implementation plan are critical to successful implementation of this system.

Another noteworthy finding is that for exceeding the risks, the contributing departments must be aware of the need for a new system and institutional challenges such as organisational arrangements. For the legal framework implementation of this technology to be successful there needs to be a commitment to change from all involved as there will be changes in technology, processes and procedures, tasks, responsibilities, and behaviours. Furthermore, the study notes that decision-makers ought to be satisfied that the benefits of an IFMIS exceed the risks.

2.7 Methodologies used in previous studies.

Various authors have investigated the application of blockchain technology to land registers from several different viewpoints including a legal outlook, information systems perspective, archival science, SWOT analysis and blockchain land registry model creation. The common methodology used by all studies is a literature review and case studies consisting of mostly peer reviewed articles, institutional publications and other sources, this methodology was always used in combination with another.

Another common methodology used was receiving primary data from structured and semi-structured interviews where participants and stakeholders in the land transaction process were interviewed, this methodology was used in studies by (Corluka and Lindh, 2017; Nijland and Veuger, 2019; Sharmila, Nijanthan and Shanthi, 2019; Hermansson, 2020). The study conducted by (Garcia-Teruel, 2020) follows a legal methodology.

The methodology applied in the study by (Konashevych, 2020) is similar to methodologies found in "The understanding of ICTs in public sector and its impact on governance" (Malinauskienė, 2013) and "Conceptual Framework for Context-Based E-Government Interoperability Development"

(Jansen, 2012). An interesting and noteworthy methodology used in the study by (Benbunan-Fich and Castellanos, 2018) was the combination of interviews and investigation of secondary data for the cases of Honduras and Georgia from an IS (Information Systems) perspective using Peled's framework. This framework outlines that public technological innovation is a self-organizing system through 3 stages: issue-networks, coalitions, and institutions. The study investigated two ground-breaking projects of blockchain based land registry to recognize in what way socio-political and technological matters impact the IS readiness of public administrations using an inductive approach.

The study assessing the utilization of blockchain in land transactions conducted by (Lemieux, 2017c) uses an archival science approach, archival science is concerns itself with the creation and preservation of trustworthy records which represent transactions and acts. The same author analyses blockchain recordkeeping through a SWOT analysis (Lemieux, 2017b). Lastly certain studies propose blockchain based land registry solutions, one such study by (Tilbury, de la Rey and van der Schyff, 2019) proposed a blockchain business model for real estate transactions in South Africa. Where the study was conducted within the interpretivist paradigm combined with a case study.

2.8 Summary

The implementation of Blockchain technology in land registries has some drawbacks. These include legal impediments, lack of interoperability, lack of recognition of digital signatures and digital identity, legal merging of the standing of the digital currencies, the recording of co-ownership, the adjustment of the ledger, scalability of the ledger and the legal structure governing the usage of the Blockchain and enforceability of smart contracts has not been formed as yet (Kalyuzhnova, 2018; Garcia-Teruel, 2020; Konashevych, 2020). The benefits of blockchain technology and smart contracts are increased transparency for participants, time savings, decreased transaction costs, increased data security/un-hackability, less fraud, enhanced cross-border real estate transactions, the ability to verify legal and physical features, tokenise real rights and take on payments through smart contracts (Corluka and Lindh, 2017; Savu *et al.*, 2017; Nasarre-Aznar, 2018; Seuren, 2018; Ameyaw and de Vries, 2021).

In relation to South Africa digitizing it's land administration The Electronic Deeds Registration Systems Act outlines a basic foundation for an Electronic Deeds Registration System (e-DRS) and the act has been described as a "preliminary life jacket" as it does not go into vigorous detail, crucially the act does not elaborate on the type of technology that will be used but does outline the accepting

of online signatures to perform the same function as their paper based counterpart's (Coetzee, 2019; Johnson, 2019). This paves the way for property transactions to be executed electronically.

As mentioned by (Sihlangu and Odeku, 2021) South Africa's land reform program has failed to meet the objectives of legislators or the hopes and demands of land reform recipients. Supporters of private property rights contend that land titling is the lone scheme that will realize tenure security in South Africa though opposing contentions claim that greater tenure insecurity will result as individual titling dilutes community identity and exposes low-income earners to financial establishments which are permitted to repossess their property and expose these individuals to elevated interest rates (Kollamparambil, 2021).

The real estate transaction process in South Africa is inefficient, there are a minimum of 12 fixed stakeholders with other types of transactions permitting 5 additional stakeholders. The number of documents required is 25 with an additional 10 documents needed if a bond is recorded or annulled. In terms of costs there are 7 fixed costs possibly leading to 11 additional costs contingent on the type of transaction. Thus there is potential in the current system for a real estate transaction to require a maximum of 35 documents and a maximum of 18 costs (Tilbury, de la Rey and van der Schyff, 2019). Despite these inefficiencies, South Africa has not yet adopted blockchain technology for land registration. They key question is, therefore, why has South Africa not adopted the technology and which barriers identified in the literature could explain this phenomenon.

From the investigations into barriers to implementation for a new technology in the public sector it was found that the following factors common internationally and in South Africa are, for a legal framework to be established, an outline for productive change management, a robust project management team, strategic planning, interdepartmental co-ordination, redesign of organisational/business processes and acceptance or commitment to change from all the role players involved. Should South Africa implement blockchain technology some of the possible barriers to implementation in land registries based on the literature review are effective governance, the standardization of parts and elements of the land registration process, an existing digitized land registry database, land registry data quality, blockchain education and the formation of a PPP (Private Public Partnership) with a PropTech firm. Factors which have contributed to a failure of adoption identified in this paper are the misalignment of interests between parties involved in the blockchain land registry project and the lack of a digital database for blockchain to be overlaid upon.

The undertaking of this study places stakeholders in the real estate industry, current intermediaries in the real estate transaction process and government officials in a better position to debate the possible implementation of blockchain technology for the digitization of South Africa's land registry. Further research is needed in evaluating what factors would contribute to the successful implementation of a blockchain based land registry in South Africa and why blockchain technology has not been implemented.

A research gap has been identified in proving if blockchain technology represents an actual innovation and whether all real estate market participants will accept blockchain technology as an innovation (Veuger, 2020). A further gap that exists is creating a framework to evaluate the preparedness of land management and land administration systems for blockchain consideration in developing markets (Ameyaw and de Vries, 2021). A gap also exists in research where blockchain is applied to nations with multiple land tenure systems (Ameyaw and de Vries, 2021).

3 Research Design

3.1 Introduction

This section covers the research design and theoretical framework required to answer the research question. It contains the research methodology, data collection method, population, research instruments, data analysis, ethical risks, validity, and reliability techniques to be used in the study.

3.1.1 Theoretical framework

This study utilized a theoretical framework consistent with research conducted by (Benbunan-Fich and Castellanos, 2018) in which IS readiness (Information Systems readiness) is defined as a the forerunning set of conditions for the successful implementation of an IT modernization, or as how well an institution can adopt an IT (information technology) innovation and benefit from its implementation. Organizational and technological factors influence IS readiness, with entities in the public sector also having a political influence.

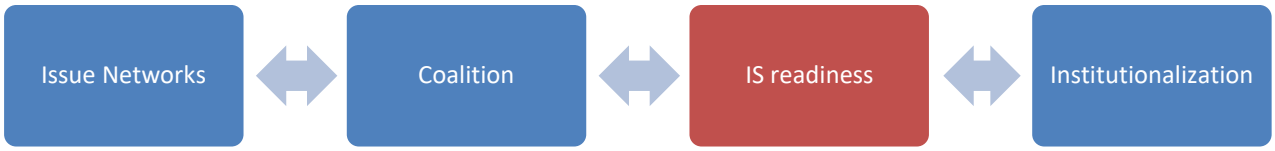
Previous work by (Peled, 2001) lead to the development of a theoretical framework which describes the success and/or failure of public sector IT endeavours, this framework views modernization projects in the public sector as a noticeably political process which revises structures, processes, roles and regulations. These types of projects entail the redesign of procedures and technical competency, hence individuals whose control or influence are affected by the new technology will be hostile to the project's implementation.

Figure 1 below developed by (Peled, 2001), technological innovation is defined as a self-organizing system with three stages: issue-networks, coalitions, and institutions (IS readiness as an extension put forward by (Benbunan-Fich and Castellanos, 2018) is also included) :

- Issue-networks - are impromptu alliances of politicians, bureaucrats, technologists, and other persons where new technological concepts or developments meet but without material plans.
- Coalitions - are established when concerns meet, and a real project outline materializes, here more than a few coalitions may challenge one another advocating alternate technologies.
- IS readiness - is defined as the forerunning set of conditions for the successful implementation of an IT modernization, or as how well an institution can adopt an IT innovation and benefit from its implementation.

- Institutionalization - happens once the successful coalition creates the leading design.

Figure 1 – Peled's suggested framework for public sector innovation including IS readiness.



The above model illustrates the procedure when innovative ideas enter establishments and how role players from issue-networks to investigate these innovations. The coalescence of role players and innovative ideas results in a material plan. In the coalition phase role players with power will protect their concerns while other parties are quashed. The institutionalization phase sees successful solutions being incorporated which serves as proof of a successful innovation. On the other hand, not reaching these stages indicates a failure of innovation. See annexure A for the variables and their differences in issue network, coalition, and institution phases outlined by (Peled, 2001), this table will help guide the investigation.

Technological innovation occurs through a coalition where a formal agreement is present between the government and a private entity to deliver a public asset or service. Existing laws and characteristics of the project bind the contractual responsibilities of the government and private entity. The private entity takes on some risk while producing the required expertise in this Public Private Partnership (PPP). The blockchain projects in Georgia and the Honduras saw the PPP emerge as crucial for allowing the projects to commence, in so the required technological expertise for the coalition was acquired which boosted the level of IS readiness (Benbunan-Fich and Castellanos, 2018). This research considers the alignment between the technological, governmental, and private entity strategies to be coherent with prior IS research.

A theoretical framework is essential in research because it serves numerous important purposes in structuring and guiding the investigation. The first essential purpose of theory is to offer researchers with a systematic and organised lens through which to interpret, analyse, and make sense of the events under examination (Becker, Bryman and Ferguson, 2012). Theoretical frameworks provide a platform for understanding the interactions between variables, allowing researchers to produce testable hypotheses and predictions. Theory also helps with idea clarity and operationalization,

ensuring that the terminology and concepts utilised in the study are well-defined and conceptually consistent (Lindlof and Taylor, 2017).

Furthermore, theories aid in situating the study within a larger intellectual context, emphasising its relevance and significance in the area (Creswell and Creswell, 2018). Finally, theories serve as a foundation for expanding on existing knowledge and adding to the body of research, supporting scientific progress and the emergence of new insights (Kuhn, 2012). To summarise, using theory in research not only improves the rigour and coherence of the study, but it also adds to the larger scientific discourse by providing a framework for producing and advancing knowledge.

3.2 Research methodology

The study followed a qualitative research strategy as conducted by (Benbunan-Fich and Castellanos, 2018). A literature review is defined as a systematic approach to gathering and combining previous research (Snyder, 2019). Hence literature relating to the existing land registration challenges in developing countries and South Africa was collected and reviewed systematically using a meta-analysis approach. According to (Creswell and Creswell, 2018) qualitative research is an approach for investigating a social problem which involves: developing inquiries and techniques, data gathering from the participants environment, inductive data examination to form themes, the investigator's interpretations of the meaning of the data and the complexity of the context must be reported with the final report having a flexible structure. A qualitative approach was utilized as a multifaceted, real-world phenomenon in its natural setting was investigated (Leedy and Ormrod, 2005).

A case study research design was utilized in this study due to the unique nature of the problem being investigated with the private company and local government involved in the project as the unit of analysis. This similar to the methodology used by (Benbunan-Fich and Castellanos, 2018) which analysed use cases of blockchain for land registration in Georgia and the Honduras. A use case of blockchain technology-based property registry for a housing development in Cape Town, South Africa's was investigated (Robey, 2019). A case study was relevant for this research as it investigates a specific organization, technology, location and pilot for a particular time period (Leedy and Ormrod, 2005). Case studies are bound by time and activity with the data that can be collected from a variety of procedures over a prolonged time period (Creswell and Creswell, 2018).

The analysis of this single case seeks to extend the theoretical framework developed by (Peled, 2001) and further advanced by (Benbunan-Fich and Castellanos, 2018), this study is dependent on an inductive approach due to its exploratory nature. The case study allows for a variety of perspectives from IT professionals to property and public sector professionals involved in the project. As stated by (Galliers, 2003) a trans-disciplinary approach is needed in IS research as the field has multiple components and stages, this approach combined with the theoretical framework help define the boundary between the organization and society, the central artifact (blockchain technology and people/information, define the scope and reference different disciplines in this opportunity.

The case study design allows for this research to not be limited to a single source of data but rather include others which may be unknown as so to further understand the research problem within its specific context (Saunders, Lewis and Thornhill, 2009). Case studies allow for a more in-depth, contextualized and realistic explanation of the phenomenon when compared to other methods of research because of its capacity to obtain a vast range of contextual data (Bhattacherjee, 2012).. A single case was used in this study as the South African deeds registry represents a unique, critical case that few have studied before (Saunders, Lewis and Thornhill, 2009). A qualitative research design was chosen as it produces a more graphic and engaged picture of current events and views which may lead to greater interest from readers (Barley, 2006). Below is a summary of the research questions, methodology used and an explanation of why this methodology was chosen.

Table 5: Research methodology

Research question	(1) What are the existing land registration challenges in developing countries and South Africa?	(2) Why has blockchain technology not yet been implemented by South Africa to digitize its land registry?	(2) What factors would contribute to the successful implementation of a blockchain based land registry in South Africa?
Methodology used.	Literature review – meta-synthesis	Case study design – Qualitative research strategy	Case study design – Qualitative research strategy
Why this methodology was chosen.	A literature review is defined as a systematic approach to gathering and combining previous research (Snyder, 2019). Hence literature relating to the existing land registration challenges in developing countries and South Africa will be collected and reviewed systematically using a meta-analysis approach	According to (Saunders, Lewis and Thornhill, 2009; Creswell and Creswell, 2018) qualitative research is an approach for investigating a social problem which involves: developing inquiries and techniques, data gathering from the participants environment, inductive data examination to form themes, the investigator's interpretations of the meaning of the data and the complexity of the context must be reported with the final report having a flexible structure.	According to (Saunders, Lewis and Thornhill, 2009; Creswell and Creswell, 2018) qualitative research is an approach for investigating a social problem which involves: developing inquiries and techniques, data gathering from the participants environment, inductive data examination to form themes, the investigator's interpretations of the meaning of the data and the complexity of the context must be reported with the final report having a flexible structure.

3.3 Data collection

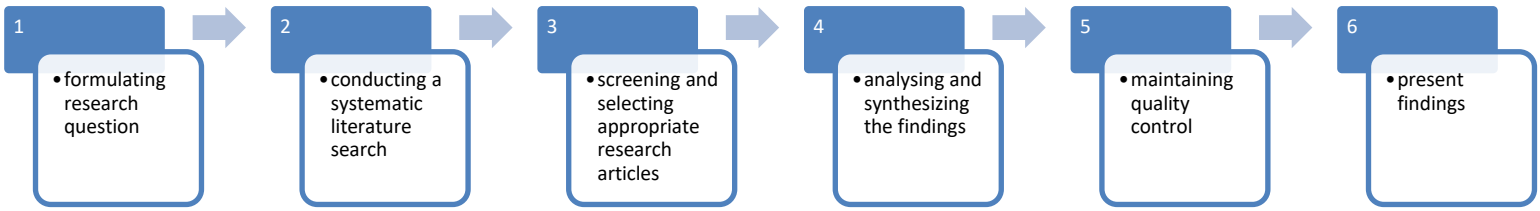
This study took the perspectives of politicians, bureaucrats, technologists, and other persons (i.e. individuals part of the issue-network (Peled, 2001) involved in this project to address the research question through semi-structured face to face interviews using open ended questions and observation to address research sub questions (2) and (3). Due to a case study research design being chosen with the private company and local government involved in the project as the unit of analysis, the study is not be limited to a single source of data and include available documentation as well as observation. (Leedy and Ormrod, 2005; Saunders, Lewis and Thornhill, 2009; Bhattacherjee, 2012). A total of 3 project participants were interviewed, who provided 2 more sources of secondary data relating to the project and research questions. The meta-analysis made use of a literature review to collect 31 research articles relating to sub question (1).

3.4 Data collection techniques

3.4.1 Meta-synthesis approach

To address sub question (1) a systematic review of literature by way of a meta-synthesis approach was used. This was targeted at producing a structure of qualitative research to find common themes and/or to assess and differentiate different groups on a broad subject and present greater understandings that is not obtainable in a specific study (Erwin, Brotherson and Summers, 2011). Meta-analysis is a type of qualitative study which applies results and findings from other works which are associated with the same research area, the studies forming the sample of the meta-analysis are gathered based on their applicability to the research question (Zimmer, 2006). This methodology strives to integrate and offers an analysis and insight of information methodically across a variety of studies (Erwin, Brotherson and Summers, 2011). The systematic approach has clearly illustrated some of the land registration challenges being faced by developing countries and South Africa. The meta-analysis followed 6 steps as outlined in the study by (Sandelowski and Barroso, 2006; Erwin, Brotherson and Summers, 2011) in the figure below:

Figure 2 – Meta-synthesis steps (Sandelowski and Barroso, 2006; Erwin, Brotherson and Summers, 2011)



1) Formulating research question

The first stage in performing a meta-synthesis is to design a research question based on integrating available information to generate findings for practise (Sandelowski and Barroso, 2006). The question designed is - what are the existing land registration challenges in developing countries and South Africa? This is targeted at producing a structure of qualitative research to find common land registration challenges and/or to assess based on different countries experiences with land registration and present greater understandings that are not obtainable in a single study.

2) Conducting a systematic literature search

The second stage is to conduct a systematic literature search for papers that are related to the study goal. Reliable scientific databases must be identified and searched for data to ensure the quality of papers. Some keywords such as “land registration”, “property rights”, “title registration” and “property transactions” were used to search for relevant literature. For this study, a systematic literature search in scientific databases available from Google Scholar was undertaken using keywords based on the research topics.

3) Screening and selecting appropriate research articles.

The third stage is to screen and choose suitable research papers. To do so, a set of acceptance and rejection criteria must be specified to answer the study question (Yahyapour, Shamizanjani and Mosakhani, 2015). This study's initial inclusion criterion is research publications with a focus on land registration. The second criterion is the study's context: was the study conducted in relation to a developing nation or South Africa? Keywords were employed as the initial step in searching for relevant publications, followed by an evaluation of paper titles and abstracts to decide their inclusion in this study. The content of the articles' texts is reviewed once again. The articles' quality is evaluated using based on the number of citations on Google Scholar, as it is a comprehensive tool for social sciences where conference and academic articles are published online (Kousha and Thelwall, 2007).

4) Analysing and synthesizing the findings

The fourth stage is to examine and synthesise the results. A full evaluation of findings, according to (Sandelowski and Barroso, 2006), is required at this time. The issue of concern was selected in this investigation, and the findings were further classified into themes. Codes are allocated to each finding (descriptive analysis) obtained from publications in accordance with the meta-synthesis technique. To build categories, similar or related codes with shared content are identified and incorporated into a group with a common code (pattern coding). The codes are also known as ideas. A notion is a chunk of data that has been identified as being essential to the facts represented by the data (Yahyapour, Shamizanjani and Mosakhani, 2015). The NVIVO programme was used to analyse the data for this investigation.

5) Maintaining quality control

The fifth stage is to maintain quality, which is critical when performing meta-synthesis investigations. The quality of the papers included in this study was maintained by looking at their relevance to the research question and the number of citations from Google Scholar. Coding was utilised to improve data quality by evaluating the material again and categorising the data properly. In this procedure, coding, and classification of retrieved data from literature was consistent with the initial codes; hence, quality control is maintained in this study.

6) Present findings

The final stage is to present the study findings. After going through all the phases, the findings of the meta-synthesis technique are provided in Section 4.2 of this study.

3.4.2 Interviews

3.4.2.1 Population and sampling

The population for this study included participants from the private and public sectors involved in the project i.e. politicians, bureaucrats, technologists, and other persons in the issue-network (Peled, 2001). It focused on real estate practitioners, blockchain technology and use case experts, related to the use case and public sector or government stakeholders in the implementation of the e-DRS system in South Africa. To narrow down this population into a workable sample size this study followed a purposive sampling or known/judgement sampling design which looked at the professionals involved in the operations of this project, purposive sampling was used because of the uniqueness of the project and the expertise of those professionals involved (Leedy and Ormrod, 2005). This sampling technique is the use of the researchers own judgment to select cases which allow the researcher to answer his/her research questions, using a small sample which is typical in case study research (Leedy and Ormrod, 2005; Saunders, Lewis and Thornhill, 2009). This entailed disregarding elements that do not fit the research purpose and using a very small sample which was very informative on the subject.

The purposive sampling followed an expert sampling strategy. Expert sampling utilizes professionals in a particular field as the subjects of the purposive sampling (Bhattacherjee, 2012), this strategy is practical when there is a shortage of observational evidence and is a constructive tool for investigating recently developed areas of research (Etikan, Musa and Alkassim, 2016). The rationale for purposive sampling was to select participants from the property/real estate, blockchain and

government/public sectors who were most involved with and knowledgeable about the developing field of blockchain technology and the implementation of an e-DRS system in South Africa.

3.4.2.2 Research instruments

This study can be described as a qualitative case study which followed an expert sampling technique. The primary data collection method for case research was to conduct face to face interviews (Bhattacherjee, 2012), which can be explained as a focused discussion among two or more individuals where responses are documented. The intention of qualitative interviews was to extract the views and opinions of the participants through a small number of unstructured or open-ended questions (Creswell and Creswell, 2018).

Semi-structured interviews were employed in this study based on a list of questions from the investigation by (Benbunan-Fich and Castellanos, 2018), the main research questions and key themes identified in literature. The interview questions can be found under annexure D – research instrument. In semi-structured interviews the catalogue of questions may have differed from one interview to the next given the organisational context of the respondent and the sequence of questions may also change depending on the flow of conversation (Saunders, Lewis and Thornhill, 2009). A primary benefit of using semi-structured interviews to pose questions for respondents out of expert sampling was that this type of interview successfully enables reciprocity amid the interviewer and participant, allowing the interviewer to pose follow-up questions stemming from participant answers (Kallio *et al.*, 2016). The flexible nature of semi-structured interviews allowed the research instrument (see annexure A for the interview protocol) to be piloted in the initial interviews and be streamlined for those that followed.

3.4.2.3 Data collection protocol

The nature of semi-structured interviews, their open-ended questions and the resulting conversation required that data be logged by audio-recording and note taking (Saunders, Lewis and Thornhill, 2009). Due to the Covid-19 pandemic face to face interviews were not possible and interviews were held via telephone or internet intranet-mediated (electronic) interviews such as Skype, Zoom or Microsoft Teams.

In addition to data from interviews qualitative documents or qualitative audio-visual/digital material were collected (Creswell and Creswell, 2018). Qualitative documents may be public or private

documents such as documents, memorandums, annual reports, newspaper articles etc. Qualitative audio-visual/digital material refer to photographs, videotapes, website pages, emails, social media content or audio content (Leedy and Ormrod, 2005). Prior to the interviews background research was conducted on the use case in question from qualitative documents and/or digital material. Observation also formed part of the data collected when observing the interactions between interviewer and interviewee, this was recorded through note taking.

Table 6: Data collection

Research question	(1) What are the existing land registration challenges in developing countries and South Africa?	(2) Why has blockchain technology not yet been implemented by South Africa to digitize its land registry?	(3) What factors would contribute to the successful implementation of a blockchain based land registry in South Africa?
Data collection method used.	Literature review of appropriate research articles – Meta-analysis	Primary method – semi-structured interviews, expert sampling strategy from population of blockchain technology and use case experts, real estate practitioners and stakeholders in the public and private sectors related to the use case Secondary method – qualitative documents or qualitative audio-visual/digital material related to the use case	Primary method – semi-structured interviews, expert sampling strategy from population of blockchain technology and use case experts, real estate practitioners and stakeholders in the public and private sectors related to the use case Secondary method – qualitative documents or qualitative audio-visual/digital material related to the use case
Why this methodology was chosen.	In conducting a systematic analysis, a literature review is the preferred data collection method for in the meta-analysis methodology (Zimmer, 2006).	These methodologies were chosen as they clearly define the unit of analysis and allow for multiple sources of data specific to the context of the use case being investigated. This allowed for greater comprehension of the case and data triangulation (Creswell and Creswell, 2018)	These methodologies were chosen as they clearly define the unit of analysis and allow for multiple sources of data specific to the context of the use case being investigated. This allowed for greater comprehension of the case and data triangulation (Creswell and Creswell, 2018)

3.5 Data Analysis

The meta-analysis made use of the NVIVO software to structure and order the data found. This software is suitable for text analysis in qualitative studies as it was developed to offer excellent coding procedures (Agbaxode, Dlamini and Saghatforoush, 2021). The NVIVO software was also

used to analyse the interview and secondary data (Welsh, 2002; Leedy and Ormrod, 2005; Creswell and Creswell, 2018).

This case study research required a thorough description of the setting and participants, subsequently an analysis of the data for themes or issues was followed (Welsh, 2002; Creswell and Creswell, 2018). The multiple sources of data entailed triangulation of the various data collection techniques to identify common themes and or patterns (Saunders, Lewis and Thornhill, 2009). As data is collected through the various semi-structured interviews the data was simultaneously examined with the initial data analysis influencing later data collection, this describes the constant comparative method which was implemented in this research (Leedy and Ormrod, 2005).

As this research seeks to extend the theoretical framework developed by (Peled, 2001) in answering the research questions an explanation building analytical procedure was followed in analysing the data collected. Explanation building is a type of pattern matching, which entailed forecasting a pattern of results centred on theoretical propositions to describe what was found (Saunders, Lewis and Thornhill, 2009). Hence explanation building can be defined as attempting to construct an explanation while data is collected and examined instead of assessing a forecasted explanation (Saunders, Lewis and Thornhill, 2009). The data analysis procedure in qualitative research ran simultaneously with other parts of the study such as data collection and the write-up of findings.

In this data analysis the researcher had to "winnow" the data or focus on the relevant parts while disregarding others, the effect of this process was to aggregate data into five or seven themes (Welsh, 2002; Creswell and Creswell, 2018), based on the variables and factors outlined in the theoretical framework (see annexure A) and the literature review. This research made use of the qualitative software program NVIVO as it aided the researcher in organizing, categorizing, and searching for specific information in text databases. To begin using the software the interview data was transcribed from audio recording to actual words (Saunders, Lewis and Thornhill, 2009). The following sequential step data analysis process was used as outlined by (Creswell and Creswell, 2018)

1. Organize and prepare the data for analysis.
2. Analyse/read or look at all the data.
3. Begin coding all the data.
4. Produce a description and themes.
5. Represent the description and themes.

In interpreting the data the following procedures were followed: summarize findings, assess findings against literature, analysis of personal understanding of findings and listing the limitations as well as future research (Creswell and Creswell, 2018).

Table 7: how research questions were addressed

Research question	**Objectives**	**Method**	**Data collection method**	**Data analysis method**	**Software**
(1) What are the existing land registration challenges in developing countries and South Africa?	To identify the existing land registration challenges in developing countries and South Africa	Literature review of appropriate research articles	Systematic review – Meta-synthesis	Meta-Synthesis	NVIVO
(2) Why has blockchain technology not yet been implemented by South Africa to digitize its land registry?	To examine why blockchain technology has not yet been implemented in South Africa´s land registration system	Qualitative research strategy, constructivist and inductive approach, case study research design	Semi-Structured face to face interviews and secondary data	Qualitative, explanation building	NVIVO
(3) What factors would contribute to the successful implementation of a blockchain based land registry in South Africa?	To determine factors that would contribute to the successful implementation of a blockchain based land registry	Qualitative research strategy, constructivist and inductive approach, case study research design	Semi-Structured face to face interviews and secondary data	Qualitative, explanation building	NVIVO

3.6.1 Ethical risks and mitigation strategy

There are several main classifications of ethical risks, they are security from harm, voluntary and advised participation, right to privacy and honesty with professional colleagues (Leedy and Ormrod, 2005). In terms of protection from harm the Covid-19 pandemic was a significant risk for conducting face to face interviews. Due to this, contacted participants were all given the option to conduct electronic interviews first with face-to-face interviews as the last option, in such a case where an interviewee wishes for a face-to-face interview Covid-19 regulations (social distancing, mask wearing and sanitation) were mandatory. Participants were also not exposed to psychological harm such as being subject to uncommon stress, embarrassment or loss of self-esteem through the questions asked (Leedy and Ormrod, 2005).

Interviewees also received an informed consent form for signature which informed them regarding the nature of the study and described their right to participate or retract from the study before their responses were recorded (Bhattacherjee, 2012). Participants were also not forced to sign consent forms as participation is voluntary, before signature the researcher explained the study and informed participants that they could decide against being part of the study (Creswell and Creswell, 2018).

Participants to the study have the right to privacy, as such their names were kept confidential. Pseudonyms based on the interviewee's expertise were used to refer to participants and thus protect their identities (Creswell and Creswell, 2018).

Honesty is an ethical concern that needs to be taken seriously, from advising participants about the nature of the study to the collection and analysis of data, honestly was maintained. In analysing and reporting of the study, unexpected findings were fully disclosed and responses were not misrepresented (Bhattacherjee, 2012).

3.6.2 Validity and reliability

In qualitative research (Creswell and Creswell, 2018) noted validity implied a researcher verifies the accuracy of his findings by utilizing specified procedures, and reliability is noted as an indication that the researcher's methodology was consistent in covering distinct researchers and projects.

A high level of validity was possible in qualitative interviews which are conducted carefully due to the interviewer being able to clarify questions, the responses of the interviewee were probed for meaning and themes were be discussed from multiple angles (Saunders, Lewis and Thornhill, 2009). To ensure the validity of findings, (Creswell and Creswell, 2018) suggested that the researcher make use of multiple validity strategies. The use of qualitative software NVIVO added more thoroughness to this qualitative research (Welsh, 2002).

The first validity strategy this study employed was triangulation. Triangulation can simply be described as the comparison of multiple data sources to find common themes (Leedy and Ormrod, 2005; Noble and Smith, 2015). Another strategy this study employed was the clarification of personal biases, this entails the researcher describing the manner in which their understanding of the findings is influenced by their personal history, such as gender, culture, history, and socioeconomic origin (Leedy and Ormrod, 2005; Noble and Smith, 2015; Creswell and Creswell, 2018). The final strategy this study employed was respondent validation, this required the researcher to take outcomes back

to the partakers and establishing if they feel the findings were correct (Leedy and Ormrod, 2005; Noble and Smith, 2015; Creswell and Creswell, 2018).

Qualitative reliability is termed as having consistent analytical techniques and taking into account method and personal biases which may have impacted findings (Brink, 1993; Noble and Smith, 2015). For qualitative reliability (Saunders, Lewis and Thornhill, 2009) noted that it was concerned with whether different researchers would reveal analogous information. The reliability of interviews was dependent of bias, there are two types of bias the researcher encountered when undertaking the semi-structured interviews. The first was termed interviewer bias and refers to the remarks, tone or non-verbal actions of the interviewer which produces bias in the interviewees responses, the second was interviewee or response bias which is instigated by perceptions of the interviewer or perceived interviewer bias from the interviewee (Saunders, Lewis and Thornhill, 2009).

To mitigate these biases and their effect on reliability (Creswell and Creswell, 2018) noted that qualitative researchers document as many of the steps of the procedures involved in the case study as possible. The first qualitative reliability procedure this study used was the checking of transcripts to ensure they do not have obvious mistakes from the transcription process, the second procedure was ensuring there was no change in the definition of codes or a shift in the meaning of the codes in the coding process, this was done through continuous comparison of the data and codes (Brink, 1993; Creswell and Creswell, 2018).

The researcher predicted that should South Africa fail to test blockchain's applicability to digitising the land registry the nation will suffer as the benefits of blockchain technology are being realized by those nations who adopt the technology (Heil, 2018). Further should blockchain technology be tested and implemented the researcher expected South Africa's ranking to improve under registering property in the World Bank's "Doing Business report" just as the rankings of blockchain adopting nations improved (The World Bank Group, 2019).

The researcher expected this improved ranking to come with the benefits of cost savings, better quality of service and the elimination of fraud and corruption as seen in the early blockchain land registry implementers of Georgia, Sweden, Dubai, Ghana (Benbunan-Fich and Castellanos, 2018; Themistocleous, 2018). These cost, time and fraud savings would be realized because of the remediation of intermediaries such as agents, brokers, banks, notaries or conveyancers and

administrators or registrars who will have their work tasks changed (Vos, Lemmen and Beentjes, 2017; Seuren, 2018).

These individuals, according to the researcher will be against the implementation of blockchain technology as they earn commission from the transaction. Banks on the other hand may be against the implementation of blockchain technology due to their risk averse nature, however they continue to fund blockchain start-ups (Spielman, 2016), the researcher predicts banks will not be against the implementation of the technology as the technology will mature in the coming years.

3.7 Summary

This study utilized Peled's theoretical framework in which IS readiness (Information Systems readiness) is defined as the forerunning set of conditions for the successful implementation of an IT modernization, or as how well an institution can adopt an IT (information technology) innovation and benefit from its implementation. The theoretical framework developed by (Peled, 2001) defines technological innovation as a self-organizing system with three stages: issue-networks, coalitions, and institutions.

This study relied on an inductive approach through a qualitative research strategy and a meta-synthesis approach with a case study research design. The meta-synthesis utilized peer-reviewed or published literature to answer research sub question (1). While sub questions (2) and (3) were addressed by viewing the perspectives of blockchain technology experts and real estate practitioners involved in this project through semi-structured face to face interviews using open ended questions. The interviewees were not prejudiced in any way and their consent was confirmed, with validity of data collected ensured through triangulation, clarification of personal biases, and respondent validation. Reliability was ensured through checking of transcripts and not changing the definition of codes during the coding process.

4 Results

4.1 Introduction

South Africa still follows a manual property transaction process and blockchain technology has not been integrated into this process. To begin addressing this issue a systematic literature review was completed to address the first research objective, which is to identify the existing land registration challenges in developing countries and South Africa. These challenges as well as barriers to adoption identified in literature assisted in providing the basis for variables for the empirical investigations of the study. This is followed by presentation of the results from the case study and interviews conducted to address the second and third research objectives. Which are, to examine why blockchain technology has not been implemented in South Africa´s land registration system, and to determine factors that would contribute to the successful implementation of a blockchain based land registry.

4.2 Existing land registration challenges in developing countries and South Africa

The analysis as presented in this section is based on the various steps of meta-synthesis.

4.2.1 Formulating research question

To address sub question 1 - what are the existing land registration challenges in developing countries and South Africa? - a systematic review of literature by way of a meta-synthesis approach was used. This is targeted at producing a structure of qualitative research to find common land registration challenges and/or to assess based on different countries experiences with land registration and present greater understandings that are not obtainable in a single study.

4.2.2 Conducting a systematic literature search

A systematic literature search was conducted on Google Scholar selecting keywords based on the research questions. Some keywords used were “land registration”, “land registration challenges”, “developing countries/nations”, “South Africa”, “land rights”, “property rights”, “title registration” and “property transactions”.

4.2.3 Screening and selecting appropriate research articles.

Google scholar was used to find appropriate research articles as it is connected to numerous databases with approximately 389 million entries, it the most extensive academic search engine available (Gusenbauer, 2019). Keywords were employed as the initial step in searching for relevant publications, followed by an evaluation of paper titles and abstracts to decide their inclusion in this study. The content of the articles' texts is reviewed once again. The articles' quality is evaluated using based on the number of citations on Google Scholar, as it is a comprehensive tool for social sciences where conference and academic articles are published online (Kousha and Thelwall, 2007).

Google Scholar's duplicate citation counts were mitigated through manual verification and cross-checking with databases like Scopus and ResearchGate. ResearchGate, though useful for tracking publicly available works, also has some duplicate metrics (Orduña-Malea, Martí-n-Martí-n and Delgado-López-Cózar, 2016; Copiello, 2019). Scopus, known for its extensive coverage and stringent inclusion criteria, was used to further validate citation counts due to its detailed metrics and broad journal indexing (Moed, Bar-Ilan and Halevi, 2016; Mongeon and Paul-Hus, 2016). The minimum number of citations to be included in the paper was 1. This study's initial inclusion criterion is research publications with a focus on land registration. The second criterion is the study's context: was the study conducted in relation to a developing nation or South Africa?

The preliminary review rejected papers that were deemed unsuitable for this study based on the research question. This resulted in the collection of 31 articles from Google Scholar. The context of the research articles was also used to screen for appropriate articles with contexts of non-developing nations not considered. Majority of the research selected focuses on Sub-Saharan African nations as well as selected perspectives from East Asia and Latin America. After reviewing the titles, abstracts, and content of the publications, 22 articles were deemed appropriate for the study. These comprise of 1 book, 1 book section, 2 thesis/dissertations, 3 conference papers, and 15 journal articles. Key land registration challenges were then extracted.

Figure 3: Word cloud of the existing land registration challenges in developing countries and South Africa

The retrieved data was compiled based on common themes emanating from passages within the research, a word cloud from the compilation of data reviewed can be seen in the figure above. This marked the beginning of the fourth stage of the meta-synthesis which was to combine and examine their findings.

4.2.4 Analysing and synthesizing the findings

The relevant citations from the text were then classified and grouped under themes in the NVIVO software, these themes were based on common research areas found in the selected texts. This resulted in the following themes being created, see table 9 below. These themes were then used to generate codes for the common land registration challenges between developing countries and South Africa. The data was then analysed again with the relevant citations classified based on the codes for land registration challenges generated. At this level, descriptive analysis is performed based on the closeness of data ideas. This procedure is done out using the NVIVO software.

4.2.5 Maintaining quality control

The quality of the papers included in this study was maintained by looking at their relevance to the research question and the number of citations from Google Scholar. Coding was utilised to improve data quality by evaluating the material again and categorising the data properly. In this procedure, coding, and classification of retrieved data from literature was consistent with the initial codes; hence, quality control is maintained in this study. Below is a table showing the selected research articles ranked by number of citations from Google Scholar, Scopus, ResearchGate or Other databases:

Table 8: Research articles selected.

No.	Authors	Year	Title of study	Paper type	No. of Citations	
					Google Scholar	Scopus, ResearchGate, Other
1.	Atwood, D.A.	1990	Land registration in Africa: The impact on agricultural production	Journal article	695	220 (Scopus)
2.	Toulmin, C.	2009	Securing land and property rights in sub-Saharan Africa: The role of local institutions	Journal article	563	236 (Scopus)
3.	Benjaminsen, T.A. et al.	2009	Formalisation of land rights: Some empirical evidence from Mali, Niger, and South Africa	Journal article	283	158 (Scopus)
4.	Adams, M., Sibanda, S. and Turner	1999	Land Tenure Reform and Rural Livelihoods in Southern Africa	Journal article	256	15 (ResearchGate)
5.	Cousins, B. et al.	2005	Will formalising property rights reduce poverty in South	Journal article	175	126 (ResearchGate)

			Africa's "second economy?			
6.	Boone, C.	2019	Legal Empowerment of the Poor through Property Rights Reform: Tensions and Trade-offs of Land Registration and Titling in Sub-Saharan Africa	Journal article	148	75 (The Journal of Development Studies - Taylor & Francis)
7.	Adams, M., Cousins, B. and Manona, S.	1999	Land tenure and economic development in rural South Africa: Constraints and opportunities.	Book	92	78 (Science Direct)
8.	Abdulai, R.T.	2006	Is land title registration the answer to insecure and uncertain property rights in sub-Saharan Africa'	Journal article	89	95 (ResearchGate)
9.	Domeher, D. and Abdulai, R.	2012	Access to Credit in the Developing World: does land registration matter?'	Journal article	85	39 (Third World Quarterly - Taylor & Francis)
10.	Barry, M. and Rüther, H.	2005	Data collection techniques for informal settlement upgrades in Cape Town, South Africa	Journal article	82	23 (Scopus)
11.	Dickerman, C.W. and Barnes, G.	1989	'Security of tenure and land registration in Africa: literature review and synthesis.	Journal article	72	24 (ResearchGate)
12.	Barry, M. and Roux, L	2016	Land ownership and land registration suitability theory in state-subsidised housing in two South African towns	Journal article	20	13 (Scopus)
13.	Tilbury, J.L., de la Rey, E. and van der Schyff, K.	2019	Business Process Models of Blockchain and South African Real Estate Transactions	Conference paper	20	12 (IEEE)
14.	Barry, M. and Roux, L.	2013	The Case Study Method in Examining Land Registration Usage	Journal article	16	12 (Scopus)
15.	Barry, M. and Whittal, J	2016	Land registration effectiveness in a state-subsidised housing project in Mbekweni, South Africa	Journal article	15	11 (Scopus)
16.	Barry, M. and Roux, L.	2014	Perceptions of land registration in a state-	Journal article	12	11 (Scopus)

			subsidised housing project in South Africa			
17.	Roux, L.M.	2013	Land Registration Use: Sales in a State-Subsidised Housing Estate in South Africa	Thesis/dissertation	10	14 (ResearchGate)
18.	Tembo, E., Nkwae, B. and Kampamba, J.	2014	Land registration in a digital environment	Conference paper	8	-
19.	Barry, M.	2020	Hybrid land tenure administration in Dunoon, South Africa	Journal article	5	3 (Scopus)
20.	Shange, M.B.	2010	A system-based approach to land registration analysis and improvements: a case study of the KwaZulu-Natal deeds registration system	Thesis/dissertation	5	-
21.	Barry and Roux, L.	2013	Land registration effectiveness in social housing in South Africa: a western cape case study	Conference paper	2	2 (ResearchGate)
22.	Green, J., Viruly, F. and Moghayedi, A.	2022	An Investigation into the Perceived Impact of Implementing Innovative Digital Technology in the Property Transaction Process in South Africa: Implications for African Property Markets	Book section	1	-

4.2.6 Present findings

After going through all the phases, the findings of the meta-synthesis technique are presented. Table 9 below exhibits a total of 6 themes relating to identifying the existing land registration challenges in developing countries and South Africa. The themes are listed in order of the number of citations attributed to each theme and its respective code.

Table 9: Number of citations per theme

Theme	Number of citations
Land Registration Challenges in South African Public Housing	120
Land Registration Challenges in Developing Countries	50
Land Registration Concept and Importance	31
Technological Innovations and Land Registration	16
Capacity Building and Public Awareness	11
Legal and Institutional Reforms for Effective Land Registration	5

After all the themes have been coded and classified, the data was analysed to group together common land registration challenges between developing nations and South Africa. From the above table we can see that the land registration challenges in South Africa and developing countries are the most cited themes. The codes used in the land registration challenges in developing countries' theme, provided a basis for classifying the land registration challenges identified in South Africa, see table 9 below. Some challenges were classified this way while others entailed the creation of additional codes to represent these challenges. The various codes ranked by number of citations for each theme can be seen in table 10 below.

Table 10: Themes and codes relating to land registration challenges in developing countries and South Africa

Theme	Code	Number of citations
Land Registration Challenges in South African Public Housing	Ongoing challenges related to urban land, informal settlements, and spatial planning	39
	Security of land tenure for vulnerable populations.	31
	Delays and inefficiencies in land restitution and redistribution programs.	18
	Transition to a democratic system and land reform initiatives.	12
	Contestation over communal land rights and traditional leadership roles.	11
	Historical context of land dispossession and apartheid policies.	9
Land Registration Challenges in Developing Countries	Informal land tenure systems and customary ownership practices.	14
	Conflict between statutory and customary land tenure systems.	11
	Weak legal frameworks and inadequate enforcement mechanisms.	8
	Limited access to land registration services, especially for marginalized communities	7
	Corruption and lack of transparency in land administration.	5
	Lack of reliable land records and documentation.	5
Land Registration Concept and Importance	Relationship between land registration and economic growth, social stability, and governance	20
	Definition of land registration and its significance in formalizing property ownership	11
Technological Innovations and Land Registration	Role of technology in addressing land registration challenges.	9
	Examples of successful digital land registration systems in developing countries.	3
	Potential benefits of blockchain and other distributed ledger technologies.	3
	Issues of data privacy, security, and digital divide in technological solutions.	1
Capacity Building and Public Awareness	Importance of educating citizens about land rights and registration processes.	7
	Community-based approaches to raise awareness and promote participation.	4
Legal and Institutional Reforms for Effective Land Registration	Land policy reforms to accommodate customary and informal tenure systems.	2
	Enhancing coordination between government agencies, local communities, and international organizations.	1
	Importance of legal frameworks in land administration.	1
	Strengthening institutional capacity for efficient land registration processes.	1

The meta-synthesis method necessitates the assignment of codes to each finding (descriptive analysis) obtained from research articles. The codes are used to classify or categorise the texts to address the research question. Considering this, pattern coding was used in NVIVO to categorise and

group comparable or related codes with shared content, as seen in the table below which answers the research question of, what are the existing land registration challenges in developing countries and South Africa? The following challenges were identified and are presented with the most cited challenges mentioned first. Each challenge is explained thereafter. A greater number of citations indicates greater importance of the challenge, however given South Africa's unique circumstances, challenges with a low number of citations may have greater importance over higher ranked challenges.

Table 11: Common land registration challenges faced by developing countries and South Africa for land registration.

Land registration challenge	**Number of citations**
Weak legal frameworks and enforcement mechanisms	18
Corruption and lack of transparency	13
Conflict between statutory and customary land tenure systems	12
Post-colonial property rights legacy	11
Deterioration of informal land tenure systems and customary ownership practices	9
Limited access to land registration services for marginalized communities	8
Lack of reliable land records and documentation	7
Investment factors relating to land redistribution and tenure reform	6

The first challenge is weak legal frameworks and enforcement mechanisms. These leave communal and private land rights vulnerable, especially in southern African nations where hybrid governance systems incorporating street committees, are sometimes unavoidable (Adams, Cousins and Manona, 1999; Cousins *et al.*, 2005; Benjaminsen *et al.*, 2009). Land registration does not eliminate the risk of being subject to the 'larger policy environment' of a particular nation. Additionally, land registration and titling do not offer protection for the destitute versus market forces (Boone, 2019). A specific legal challenge in South African state-subsidized housing initiatives are restrictive sales clauses, which are a reason to transact off-register, causing delays and exposing buyers to property reclamation and eviction risks (Barry and Roux, 2016).

South Africa has embarked on one of the biggest state-subsidized housing initiatives in the world, and consequently, land titling projects, on record. Since 1994, the nation has given individuals in

need approximately 4.3 million subsidized housing opportunities (Barry, 2020). To qualify for such housing, an applicant's household's income must not exceed R3,500 per month (Barry and Roux, 2014). Following the completion these housing projects, the original condition of land records is mostly uniform, with the intention of systematically transferring properties to beneficiaries within South African social housing projects (M. Barry and Roux, 2013). State-subsidized homes in South Africa are located on fully serviced individual plots, this is a distinctive feature of these initiatives (Barry and Roux, 2016).

Second is that, corruption and lack of transparency in land administration hinder property transactions and enable elite land grabs (Boone, 2019; Barry, 2020). Unofficial occupants who do not meet subsidized housing criteria pose legal transfer challenges, leading to land fraud cases (Barry, 2020).

The third challenge faced is the conflict between statutory and customary land tenure systems. This arises from the tension between individual titling and traditional regulations, sometimes manifesting in hybrid governance systems (Dickerman and Barnes, 1989; Toulmin, 2009; Boone, 2019; Barry, 2020). While the notion of formal property recognition transforming dormant capital into active capital is often discussed, it should not overshadow the reality that such a transformation can effectively transfer ownership from one party's dormant capital to another's active capital (Benjaminsen *et al.*, 2009).

Fourth is the post-colonial property rights legacy in South Africa and other developing countries which restricted property ownership for certain groups leading to tenure insecurity (Abdulai, 2006; Barry and Roux, 2014).

The fifth challenge faced is the deterioration of informal land tenure systems and customary ownership practices, especially in South Africa which have, lead to uncertainty, cloudy titles, political conflicts as well as reduced investment (Adams, Cousins and Manona, 1999; Adams, Sibanda and Turner, 1999). Some communities prefer communal land ownership to prevent conflicts and reduce individual title maintenance costs, highlighting contradictions between formal property requirements and the needs of community-based institutions (Cousins *et al.*, 2005). Additionally intervening in informal settlements is difficult due to problematic community leaders, internal conflicts, and confrontations with authorities (Barry and Rüther, 2005).

The sixth challenge is limited access to land registration services for marginalized communities. This results from low property values, high transaction costs (Toulmin, 2009; Green, Viruly, and Moghayedi, 2022), disputes triggered by registration announcements (Dickerman and Barnes, 1989) and increased off-register transactions due to affordability concerns (Barry and Roux, 2013, 2016). The term "off-register" rather than "informal" transactions is used, as many instances of off-register transactions involve formal social and local-level political processes, often manifesting as symbolic deliveries or private conveyancing (Barry and Roux, 2013). Off-register sales can be executed in various forms, including verbal agreements between parties, sometimes with a witness present, written private contracts between parties, the transfer of the municipal account to the buyer's name, and the delivery of the title deed as a form of private conveyance.

Seventh is a lack of reliable land records and documentation, as outdated information due to off register or unrecorded transactions occurring which complicates, ownership and legal issues, as well as the land market and city administration which require accurate data (Dickerman and Barnes, 1989; Adams, Cousins and Manona, 1999; Barry, 2020).

The final common challenge is that only when land registration is coupled with access to inputs, loans, extension services, and markets, as well as when the government takes further steps to encourage investment, can land redistribution and tenure reform have a favourable influence on output and investment (Adams, Cousins and Manona, 1999). These common land registration challenges between South Africa further inform the case study below and the discussion chapter. The appearance or lack of these land registration challenges allowed for insight into land registration within the state-subsidized housing market in South Africa.

These land registration challenges informed the empirical data collection as the existing land registration challenges relating to developing countries and South Africa have been identified. These challenges, together with the barriers and critical success factors identified in chapter 2, assisted in addressing the second and third research objectives. These challenges, barriers and factors form the basis for variables used in the empirical investigation. Which are to examine why blockchain technology has not been implemented in South Africa´s land registration system and, to determine factors that would contribute to the successful implementation of a blockchain based land registry.

The choice of a systematic literature review of land registration challenges adds value to the study for several reasons. The first is that the systematic literature review provided a comprehensive

overview of existing research and knowledge on the existing land registration challenges in developing nations and South Africa. They assisted in understanding the current state and context of knowledge by synthesising a wide range of studies (Tranfield, Denyer and Smart, 2003). Second is that the systematic literature review was used to identify research gaps in the current literature. These gaps reveal regions that require more investigation, allowing for recommendations for the direction of future works as elaborated on under section 5.4 (Grant and Booth, 2009). Third was that the review aided in the identification of high-quality, evidence-based investigations and insights. This allowed for informed decisions to be made based on strong empirical results when identifying the common land registration challenges (Petticrew and Roberts, 2008).

Fourth is that by combining and analysing current research, systematic literature reviews provide useful insights to policymakers and practitioners. They can help to shape the creation of standards and strategies, which is especially important in the context of blockchain-based land registration in South Africa (Petticrew *et al.*, 2013). Several legal and policy recommendation are made under section 5.4. Lastly, 14 out of 27 editors of real estate journals in 2018 regard an integrated literature review to be satisfactory as a research contribution. According to 25 of the 27 participants in the same survey, a grand synthesis would be a fairly sufficient contribution (Azasu and Simons, 2018). These reasons show that the systematic literature review aids to the contribution of useful knowledge.

The land registration challenges identified will have unique consequences for South Africa, given the transition to a democratic government and the overlap of new and apartheid-era legislation. This is highlighted by some of the apartheid-era legislation with regards to customary tenure where state ownership of land in the former homelands remains (Adams, Cousins and Manona, 1999), as well as the current land reform initiatives of providing state-subsidized housing (Barry, 2020). This also includes discussions regarding land expropriation without compensation (Home, 2022) and the introduction of an e-DRS system (Electronic Deeds Registration Systems Act 19, 2019). Digitization of land registration will directly affect all these issues.

4.3 Reasons why blockchain has not been implemented and potential success factors.

4.3.1 Introduction to qualitative case study and interview results

The property transaction process in South Africa remains a manual, paper-based process with blockchain technology not having made an inroad into the transaction process. This section begins addressing the second and third objectives, based on the pilot project investigated and described below, as well as semi-structured interviews conducted virtually with pilot project participants. The second objective is to examine why blockchain technology has not been implemented in South Africa´s land registration system. The third objective is to determine factors that would contribute to the successful implementation of a blockchain based land registry. This section outlines participant characteristics and the context of pilot project case study, trailed by the following sections, theme development, prestation of the themes, a contextual analysis, validation and trustworthiness, limitations, key findings then ending with a summary.

4.3.2 Participant characteristics and context of pilot project case study

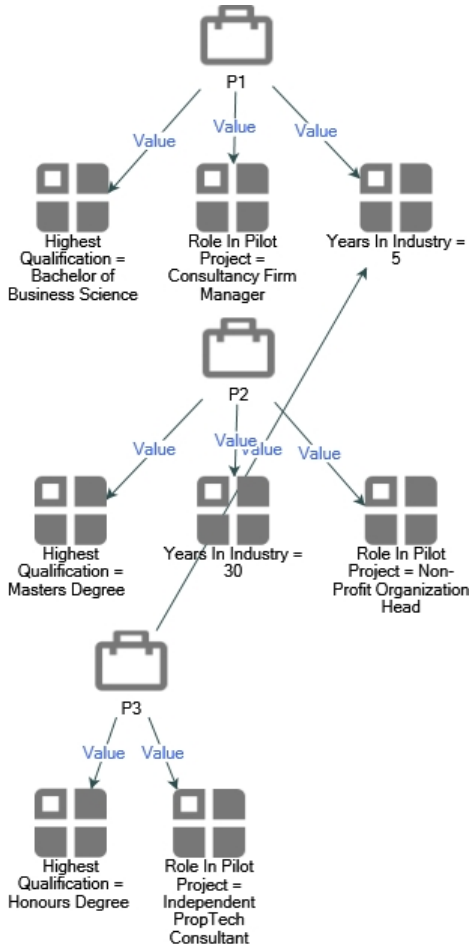
4.3.2.1 Participant characteristics

This section provides a brief summary of the participants' demographic information, such as years in the industry, highest qualification and role in the project to provide context for the information gathered (Maxwell, 2012).

The blockchain pilot described below is the only initiative of its kind in South Africa, this results in a very small sample of individuals relevant for questioning who were selected based on an expert sampling strategy. The pilot project launched consisting of 3 groups, a PropTech firm, a research consultancy firm and housing NPO. The project leads from each of these organizations form the population of the study. The sample included the heads of the research consultancy firm (Participant 1 – P1) and housing NPO (Participant 2 – P2) involved in the project as well as a prominent PropTech consultant and observer of the project (Participant 3 – P3). Some basic participant characteristics such as their highest qualification and years of experience in the industry are outlined in figure 10 below.

In addition to these interviews, secondary data in the form of documents and audio-visual/digital material relating to the pilot project were also collected and analysed. This secondary data was provided by the interviewees, they include secondary data sources 1 and 2 which are a podcast and YouTube video. The audio-visual/digital material included speakers such as the research consultancy firm head (P1), housing NPO head (P2), PropTech firm head involved in the project and PropTech consultant (P3).

Figure 4 – Interview participant characteristics



4.3.2.2 Context -Tenure Project X pilot project case study

4.3.2.2.1 Brief overview of the pilot project

A summary on the work done in South Africa on a blockchain pilot through the Tenure Project X (TPX) – a pseudonym for the pilot project investigated. The TPX is a walk-in office located in a state-subsidized housing development in Makhaza, Khayelitsha, a large township in the city of Cape

Town, see figure 3 below. This office was previously referred to as the "Transaction Project X", but this was later revised by in the head of the consultancy firm responsible for implementing the pilot project, states, "we should have called ourselves the Tenure Project X because that's really what we deal with". The main parties that initiated the project were a Housing NPO (Non-Profit Organization) which received funding for the project from a prominent NGO (Non-Governmental Organization), a research consultancy firm who are custodians of the project, and a PropTech firm with blockchain expertise. There are 5510 properties in Makhaza, Khayelitsha which have a collective value of approximately R1.3 billion (Breier, 2023). This overview is based on interview findings and secondary data in the form of documents and audio-visual/digital material relating to the pilot project.

4.3.2.2.1.1 Purpose and scope of the pilot project

This project focused on exploring how technology could be used to enable the process of transfer of a subsidized property from the city to the beneficiary. The TPX office was established in 2018 with the blockchain project commencing in 2019.

4.3.2.2.1.2 Project objectives

The project assisted individuals with distinct types of cases and several types of title deed problems, as well as municipalities with primary transfer cases which represents the handover of title deeds for government subsidised houses to beneficiaries.

Figure 5 – Makhaza, Khayelitsha

The project initially comprised of several components, the primary transfer cases piloted using blockchain based technology, a case management system which proposed to use smart contracts and an informal settlements pilot. The vision for the TPX's case management system was to create a one-stop shop. A highly effective but secure and inexpensive title shop where people would not need to go to the department of Home Affairs, the Master's office, city departments, or conveyancers. The system should have access to all the data to resolve cases and validate any kind of claim. The system sought to secure processes that coordinate seamlessly and sequentially across multiple parties to a transfer, various types of cases are described in the table below.

Table 12: Types of cases and title deed problems

Types of cases	**Title deed problems**
Title deed problems	Informal cash sale
House purchases	Deceased estate
Will	Primary transfer
Subsidy application	Other / administrative
House sale	
Other / legal problems	

4.3.2.2.2 Project Background

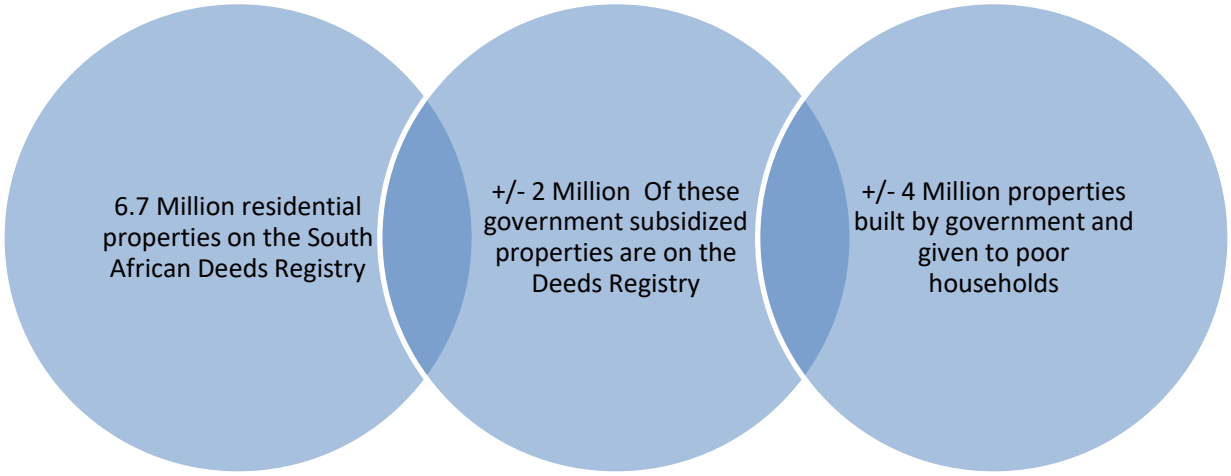
4.3.2.2.2.1 Historical context of property registries in the region

The government's housing subsidy programme is extensive, with approximately over three million houses built and handed over to beneficiaries. However, we have a massive backlog on the title deeds of those properties, so over a million of them have never been transferred from government to beneficiary.

4.3.2.2.2.2 Importance of the pilot project in modernizing property registration

It is important to note that property is the biggest asset beneficiaries own, these properties have massive potential and beneficiaries are unable to realise the full benefit of their housing assets. The below statistics outline the need for and importance of TPX type projects in addressing the titling challenge.

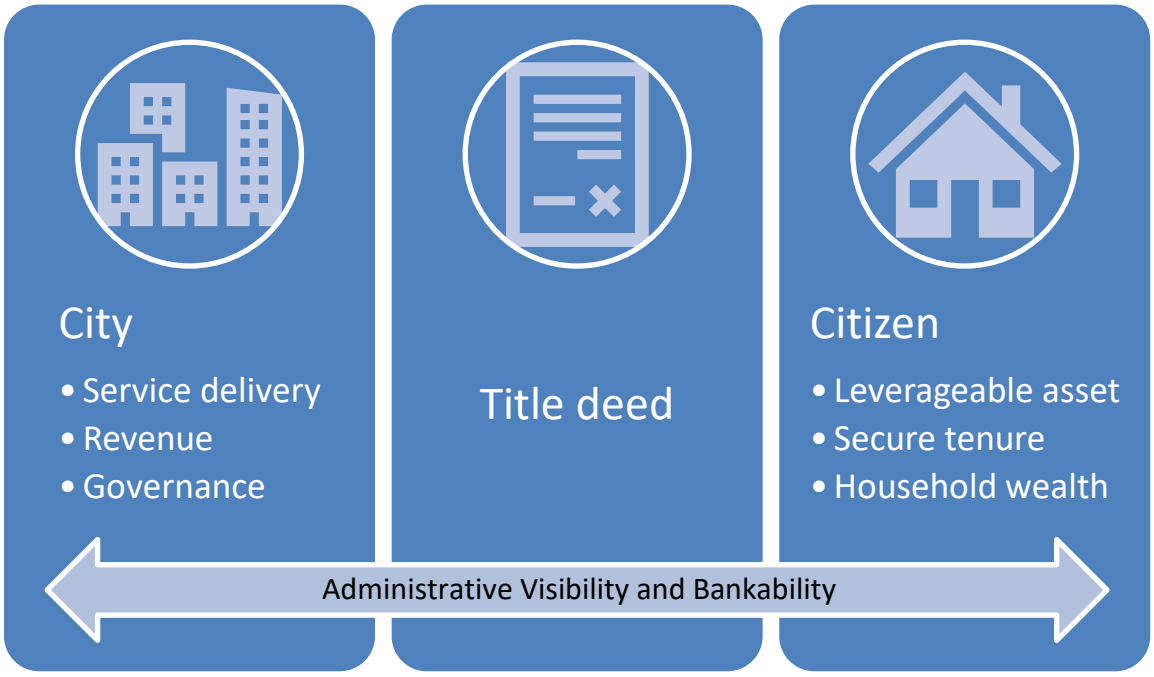
Figure 6 – Need for TPX.



The TPX is one of 6 initiatives attempting to tackle the titling challenge (Breier, 2023). The titling issue is significant as the title deed enables security of tenure, a leverageable asset and household wealth for the citizen. The city relies on property registration process to enable service delivery, governance, and revenue collection. The title deed permits administrative visibility and bankability, illustrated by the interplay between the title deeds, citizens, and the city in figure 5 below. The title deed represented in figure 5 could be stored on the blockchain in the form of the deed document itself or a combination of the various documents related to ownership.

The post-Apartheid government wanted to get people into houses as soon as possible, and some of the stages that take raw land to land that's registered in a general plan and that can be associated with the title deed, may have been missed. Now these errors need to be addressed. Gathering all the right certificates that are required from the city, establishing the township register, and then beginning to register the properties, can take many years.

Figure 7 – Title deed administrative visibility and bankability



4.3.2.2.3 Technical Implementation

4.3.2.2.3.1 Overview of the blockchain technology used.

The primary transfer issue and case management system employed blockchain technology. The distributed ledger technology allows for authenticated users to access a system, transacting in a permissible way, updating the records based on protocols with accurate data and valid authentication. There are other types of DLT other than blockchain, but they do not offer the same level of security as pointed out by the consultancy firm head, "Google sheets is a less secure solution". Blockchain can free administrators from spreadsheets in primary transfer, currently data management is weakened by a spreadsheet reliant system that lacks version control as data moves between the various parties involved in the housing development (the city, provincial authorities, the project team, and the conveyancer).

4.3.2.2.3.2 Technical architecture of the property registry system

The PropTech and research consultancy firms created an adaptable system which fits between the housing subsidy system and the current property registration system for primary transfer. This serves as a platform for individuals to transact once the TPX have authenticated their claim to a property,

and they are added onto the register. There is a process for keeping system records up to date, the supporting paperwork and official documents must be signed, and the registration procedure is completed swiftly on the system.

The case management system proposed to employ smart contracts. This is a system where you can see the processes and every participant to the transaction understands precisely what must happen since it's programmed. That code is also protected on the blockchain and cannot be tampered with, so you can have an update on the ledger that is authorised and validated clearly. The goal of using blockchain technology in the TPX's case management system is to increase administrative visibility and bankability, which may or may not be possible with the title deed.

4.3.2.2.3.3 Security measures and encryption protocols

When it comes to the property-based register, we are not dealing with a permissionless public blockchain, but rather a permissioned blockchain with validating entities in some cases that would govern it. Essentially, the system would integrate all these various departments, the province, the city, the national government, the revenue authority, banks, and the conveyances. The consultancy firm head also sees the opportunity to expand the system to validate identities, she states "as we get more and more involved in e-government we can validate identities off smart ID cards," this may affect the role of the conveyancer who is currently responsible for validating parties' identities.

4.3.2.2.4 Project Execution

4.3.2.2.4.1 Detailed chronology of the pilot project's execution

In 2019, the TPX collaborated with the City of Cape Town to undertake occupancy surveys, authenticate beneficiaries, and classify cases for transfer in three locations, Makhaza West 246 properties, Makhaza East 269 properties, and Makhaza Central 265 properties, totalling 780 residences with no title deeds. Property in this neighbourhood is worth roughly R200,000.00 a unit (based on the City of Cape Town Valuation Roll data subset) (Breier, 2023). The project had no direct agreement with the public sector in terms of an MOU (Memorandum of Understanding) signed either with the city, provincial or national government but they did have a working relationship with the city.

Approximately one-third of all properties are registered in the name of a deceased individual. As a result, the area's dead capital amounts to R290 million. There are 467 remedial transfers on

expropriated properties that have yet to materialise, due to residents either failing to or qualifying for the subsidy program. According to data from a 2014 occupancy study, an additional 732 houses were either unlawfully inhabited or sold informally. Undoubtedly, more informal transactions have occurred after 2014. At least 2 406 or 44% of the 5 510 properties in the case study have one or more title deed issues. This dead capital is worth R440 million (Breier, 2023).

As of November 2020, the project area consisted of 3 pilot sites for primary transfer which are housing developments from 2011-2014 of a high construction specification, Makhaza West, Makhaza East, and Makhaza Central. The TPX office is exceptionally central at most 1.8 kilometres away from each area. In initiating primary transfer, validated claims to a property at a point in time had to be recorded. This was done through an occupancy survey which is a slow, door to door process. Claims had to then be validated and any disputes resolved, then the claim was added to the register. TPX was signing sale agreements in the 3 areas, enabling complete process from onset to the deed's registry. Of the 664 properties surveyed in those areas, 484 properties were validated to sign sale agreements. Getting the sale agreements to be signed proved to be a large obstacle to overcome at the outset.

However, sometime between project initiation and project implementation a conflict between the organizations implementing the pilot project occurred. This conflict came in the form of a contractual dispute relating to the ownership of the blockchain registry intellectual property. As outlined by the first interview participant and head of the consultancy firm: "Who owns the technology? Who owns the register? Who owns who? Who collects fees? So, we had a parting of ways because we couldn't see eye to eye on the IP". The second interviewee who is also head of the NPO, substantiated this problem as she states: "We had to keep it a not-for-profit process, and our ability to do that was compromised by the contractual arrangements".

The contractual problem regarding Intellectual Property (IP) posed a serious limit on the advancement of blockchain technology in this pilot project as the PropTech firm eventually departed from the project. Due to these conflicts' representatives from the PropTech firm were not willing to participate in this investigation directly. Some of their perspectives were however available in secondary data. This represents a major limitation to the research and its findings.

4.3.2.2.4.2 Challenges faced during implementation.

Several challenges were faced, including the time consuming and difficult resolution of cases, inaccurate housing subsidy spreadsheet data, the changing of resident's circumstances over time, informal or off-register transactions, the current policy environment, title deed administrative issues and a lack of trust among between local leaders and the TPX. These are in addition to the contractual challenges relating to the ownership of intellectual property as mentioned above.

Blockchain does not eliminate the arduous and time-consuming process of gathering, confirming, and inputting data into the system at the outset. Cases require time and money to resolve and to build trust, going door to door is crucial.

In terms of primary transfer, there is no central authority who can pinpoint where any sale agreement is in the process or where any substantive beneficiary is at any given time. The housing subsidy administration system is large, slow and does not accurately record information. Additionally, when a spreadsheet is updated by one party the other parties are unaware, hence version control is a major problem, leading to inaccurate data. Parties involved in the primary transfer of state-subsidized houses are the city, provincial authorities, project team and the conveyancer.

Once a beneficiary occupies a property and until the time they receive a title deed, life happens, or their circumstances change. People get married, move away, some even die, divorces occur, and as a result, people sell or rent their properties. However, per the restrictive sale clauses on state-subsidized houses, beneficiaries are not allowed to sell properties until the time restriction has lapsed. If you are a beneficiary for eight years but you have not revived the title deed, you would not know about the restrictive clause. This has not stopped beneficiaries from transacting informally as explained by the consultancy firm head, "these are houses on the open market without a title deed at the moment for R250 000, there's a real incentive for people sometimes to be a little bit frugal with the truth".

Policy should support formalisation. Currently, the policy environment discourages people from wanting to formalise, as having a restriction on sale on the title deed does nothing to support formal processes. When people do need to sell, there are better ways for them to do so. The policy issue is significant, but policy changes may take many years.

The TPX has many cases that are closed or pending, and those are closed or pending because clients simply do not return to the TPX with the documents that they require. For instance, winding up a deceased estate is a very complex process that requires multiple documents from multiple departments. Once cases are resolved, trying to convince residents to sign additional sale agreements is a huge barrier. The inertia is substantial and makes the process protracted.

If a title deed is received it can have one of three common administrative problems, such as errors on the title deed (e.g., erroneous name, ID number, spouses not registered on deed), the original title deed being missing or damaged, and if primary transfer has occurred, but the beneficiary has not received title deed. The final challenge faced is that the TPX coming between leaders and officials increases distrust. Area leaders are wary, feel threatened, as they have some type of authority e.g., contact details of city officials who can affect transfer.

This context assisted in relating the case study and interview information with the literature to begin developing codes and themes to address the 2nd and 3rd research questions.

4.3.3 Coding and theme development

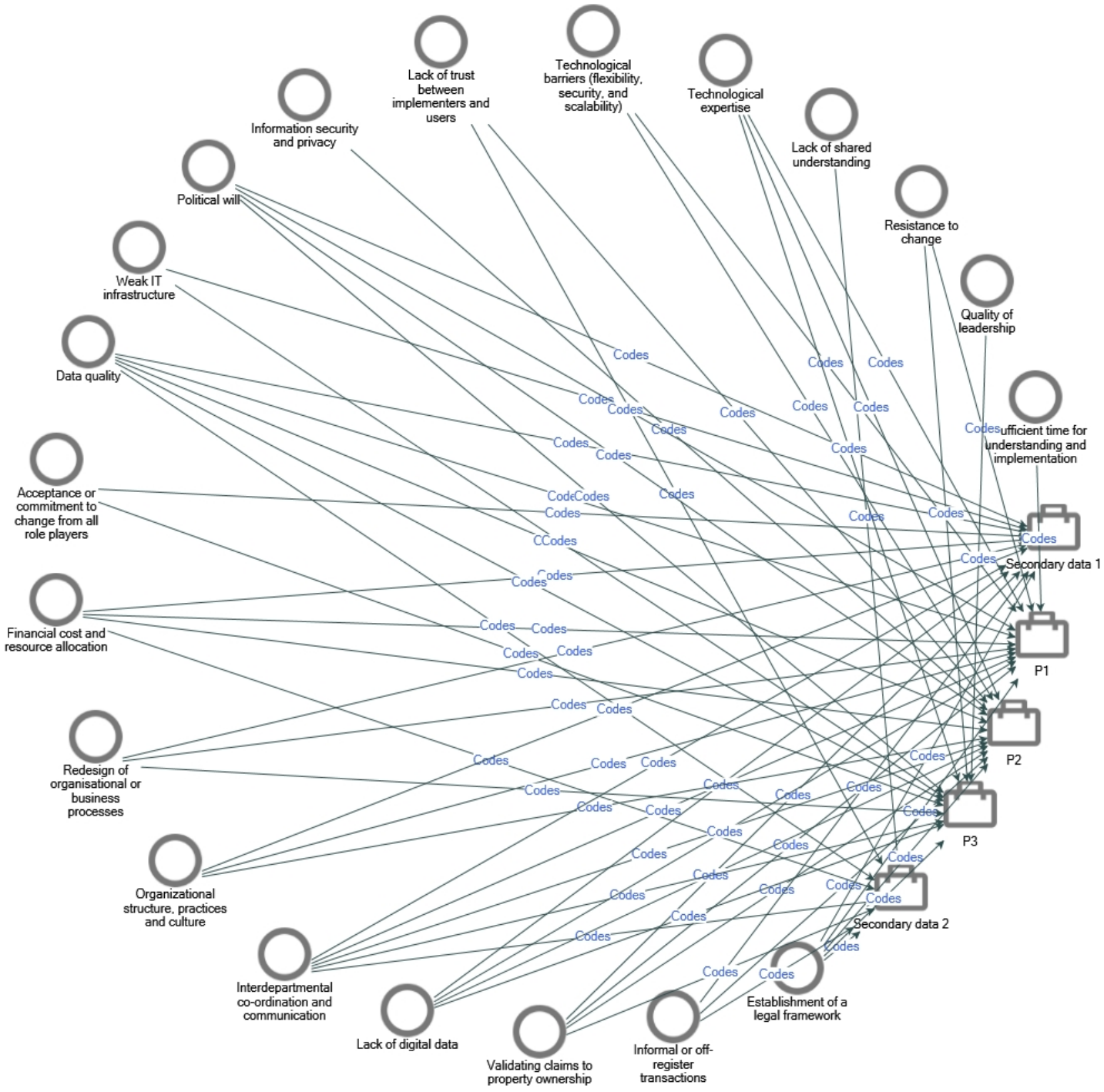
This section discusses the coding and theme creation process, including how interview data was analysed and themes were found themes, using the NVIVO software (Miles, Huberman and Saldana, 2014). The collection of data through semi-structured face to face interviews was conducted virtually through video conferencing software, secondary data was also collected from recommendations by the interview participants. These interviews and secondary data sources were then transcribed and reviewed to reduce errors and increase response accuracy. The largest issue faced in data collection was the unwillingness of the PropTech firm involved in the project to participate in the study, this can be attributed to the conflict explained in section 4.3.2.2.4 above.

To begin analysing the qualitative data, a content analysis was employed, this is when codes are generated before the data is analysed (Adu, 2019). Content analysis was chosen as the literature review in chapter 2 outlined specific barriers to public sector technology adoption worldwide, which could be used to represent majority of the codes. The remaining codes were generated from the addressing of research question 1, which showed land registration challenges from a systematic literature review. These codes characterise reasons as to why blockchain technology has not been implemented in South Africa´s land registration system, and factors that would contribute to the successful implementation of a blockchain based land registry. The codes were generated directly

from the literature reviews as each barrier to public sector technology adoption and the land registration challenge was made a code, for instance the barrier of “lack of trust between implementers and users” was made a code, and the land registration challenge of “informal or off-register transactions” was made a code. This resulted in the creation of 20 codes.

A description-focused coding strategy was used to review data and decide whether the information from participants was relevant to answering the research question in terms of the codes developed from the barriers to technology adoption identified in the literature review. Description based coding is focused on understanding the information from participants and deciding whether it is relevant to the code selected (Adu, 2019). For instance, the response from P1, “we would hope that government would trust a system that they don't necessarily have to build themselves”, represents significant information which can be attributed to the code “lack of trust between implementers and users”. This process was completed for each line of information collected through the interviews and secondary data transcriptions. The below figure 8 shows the link between each code and its origin.

Figure 8 – codes and their origin



Once all the data was coded, the codes were then clustered together by way of common relations they share with one another. Once all the codes were clustered together, the separate clusters were analysed, looking at the nature of the barriers (codes) as well as the corresponding direct quotations, to label the clusters with an appropriate title that encompasses the shared relationship between the

codes. For example, the codes of "lack of trust between implementers and users" and "acceptance or commitment to change from all role players", were clustered together because of the relationship between trust and acceptance. The cluster was then labelled based on this relationship as "trust and acceptance", which now represents a theme or barrier. This resulted in 6 clusters of codes which were translated into 6 themes.

4.3.4 Presentation of themes

Here the important findings from the data analysis are presented, with a short summary of each theme, as well as quotations from the interviews (Boyatzis, 1998). The 6 themes and their respective codes are represented in the table 13 below and explained thereafter. Each theme is presented in order of the number of references (or specific pieces of information) connected to that theme, starting with the greatest number of references going down to the least.

Theme 1 Regulatory and Legal Challenges

This theme encompasses the limits imposed by the current laws and policies in place relating to property ownership and the paper-based transfer process, contractual agreements between the organizations involved in the pilot project. It also includes the difficulty in formalisation of informal property transactions. Regulatory and legal challenges were referenced a total of 41 times from all participants and secondary data sources, making it the most dominant code in the study. Some codes connected to this theme include the establishment of a legal framework, informal or off-register transactions and validating claims to property ownership. This theme influences all the other themes as the laws and regulations influence all barriers to public sector technology implementation, for example the laws relating to the requirements for property transfer affect the cost of registration (resource and cost-related issues) and the potential of accepting electronic documents as part of the process (technological hurdles). The accepting of electronic signatures to execute deeds registry documents can be enabled through the Electronic Deeds Registry Act, but there is no indication of when or how this act will come into play. The following quote from P2 from secondary data source 1 encapsulates this problem.

> "Also, I think the technology piece is critical and we can only take it so for in the current South African context, the Electronic Deeds Registry act has been passed but for that to be implemented who knows, nobody is holding their breath and we do not know what that will do".

Table 13: Themes identified from clustering codes.

Themes	1) Regulatory and Legal Challenges	2) Organizational and Cultural Barriers	3) Technological Hurdles	4) Resource and Cost-Related Issues	5) Political and Social Factors	6) Trust and Acceptance
Codes	Establishment of a legal framework (Alshehri and Drew, 2012; Ismail, 2013; Batubara, Ubacht and Janssen, 2018; Cinar, Trott and Simms, 2019) Informal or off-register transactions (Barry and Roux, 2013, 2016). Lack of digital data (Shange, 2010; Tembo, Nkwae and Kampamba, 2014) Validating claims to property ownership (Toulmin, 2009; Domeher and Abdulai, 2012; Tembo, Nkwae and Kampamba, 2014)	Interdepartmental co-ordination and communication (Beaumaster, 1999; Allen, Kern and Havenhand, 2002; Ebrahim and Irani, 2005; Alshehri and Drew, 2012; Nwakanma *et al.*, 2013a; Cinar, Trott and Simms, 2019; Wang *et al.*, 2020) Organizational structure, practices, and culture (Cinar, Trott and Simms, 2019; Bjerke-Busch and Aspelund, 2021) Resistance to change (Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019; Bjerke-Busch and Aspelund, 2021) Redesign of organizational or business processes (Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019; Atique *et al.*, 2021; Bjerke-Busch and Aspelund, 2021; Beaumaster, 1999; Allen, Kern and Havenhand, 2002; Ebrahim and Irani, 2005; Nwakanma *et al.*, 2013a) Quality of leadership (Cinar, Trott and Simms, 2019; Bjerke-Busch and Aspelund, 2021)	Technological barriers (flexibility, security, and scalability) Weak IT infrastructure (Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019) Information security and privacy (Alshehri and Drew, 2012; Atique *et al.*, 2021) Technological expertise (Beaumaster, 1999; Ebrahim and Irani, 2005; Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019; Wang *et al.*, 2020; Atique *et al.*, 2021; Bjerke-Busch and Aspelund, 2021) Data quality (Dickerman and Barnes, 1989; Adams, Cousins and Manona, 1999; Barry, 2020).	Financial cost and resource allocation (Beaumaster, 1999; Allen, Kern and Havenhand, 2002; Ebrahim and Irani, 2005; Alshehri and Drew, 2012; Nwakanma *et al.*, 2013a; Cinar, Trott and Simms, 2019; Wang *et al.*, 2020; Bjerke-Busch and Aspelund, 2021). Insufficient time for understanding and implementation(Cinar, Trott and Simms, 2019; Wang *et al.*, 2020) Lack of shared understanding (Cinar, Trott and Simms, 2019; Bjerke-Busch and Aspelund, 2021)	Political will (Abdulai, 2006; Barry, 2020)	Lack of trust between implementers and users (Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019; Atique *et al.*, 2021; Bjerke-Busch and Aspelund, 2021; Beaumaster, 1999; Allen, Kern and Havenhand, 2002; Ebrahim and Irani, 2005; Nwakanma *et al.*, 2013a). Acceptance or commitment to change from all role players (Ismail, 2013; Batubara, Ubacht and Janssen, 2018).

Theme 2 Organizational and Cultural Barriers

Organizational barriers relate to firstly, the lack of adequate communication in the property transaction process between the government departments involved, the different deeds registry offices and the city. Secondly, a formalised understanding between the city and pilot project implementers is required, especially in a sometimes corrupt and overburdened public administration. Cultural barriers include the slow change expected when digitizing the deeds registry processes and the strong leadership required for such a huge task. Some codes relating to this theme include interdepartmental co-ordination and communication, organizational structure, practices, and culture as well as redesign of organisational or business processes. This theme can also influence other themes, for instance as stated by P2 the housing NPO head:

> "However, if a blockchain process tries to create at titling flow without a knowledge of the property system or the way in which people conduct their operations It's not going to work."

Here she explains that a blockchain based property transaction process will not work unless it is designed with knowledge on how the organizations, people and laws in place interact when transacting a property. This affects the laws and regulations related to transacting electronically as well as whether participants to the transaction will trust and accept a blockchain based property transaction system. Organizational and cultural barriers are the second most dominant theme with a total of 24 references coming from all data sources.

Theme 3 Technological Hurdles

Technological hurdles such as having accurate, validated, and up-to-date data loaded on the land registration system and the government departments not having accurate information on their housing projects, which compromise data quality. The choice of technology for land registration and how it is employed also represents a barrier as alternatives to blockchain technology exist. A further barrier technologically in the deed's registry, are the manual or paper-based components and lack of technological expertise. This theme is the third most dominant theme with a total of 20 references from all the data sources. The most referenced code under technological hurdles is that of data quality, its importance is emphasized by the custodian of the pilot project P1 as stated:

> "Rubbish on a blockchain register is very immutable rubbish".

This underscores the significance of having accurate data so that the outputs of the transaction process are legal and valid. This problem is commonly referred to as GIGO or Garbage In – Garbage Out.

Theme 4 Resource and Cost-Related Issues

Resources such as time and money represent a barrier to adoption as, the cost of registration for housing beneficiaries is too expensive, there is a lack of publicly available funds for new systems, and non-for-profit strategies are not in everyone's best interest. A time related barrier comes in the form of the delay in issuing of title deeds for housing project beneficiaries, while the physical resource of the technology employed must be secure and be trusted by users. Similarly, a gap between the vision of donors and the vision of the problem on the ground in the pilot project represent a barrier to adoption. This theme was referenced 10 times by all but one of the data sources. Resource and cost related issues are a barrier to the adoption of a technology in the public sector as governments are not the only organizations that require funding to build new systems, the pilot project implementers also require funds for their operations as described by the housing NPO head P2:

> "But in order to continue funding the process, we had to keep it a not-for-profit process".

Here the participant elaborates on the conditions the organization received their funding, they were required to keep the process without the incentive for profit. This may act against the interests of some parties as they require profit to fund their operations, as witnessed in the parting of the PropTech firm who sought to own parts of the blockchain based system. Some codes relating to this theme include financial cost and resource allocation, insufficient time for understanding and implementation and the lack of a shared understanding.

Theme 5 Political and Social Factors

This theme represents the will of government to participate in pilot projects as well as the will of leadership to support these projects and the resolution of ownership disputes. Political and social factors are a unique theme as it is only referenced 6 times by all but 2 of the data sources. Political will is summed up by P3 a prominent PropTech consultant:

> "You know housing is a very big political thing in its in its own", and "I guess you know it's probably a change in leadership and political will you know to carry these things out".

P3 is alluding to public or state-subsidized housing being a bone of political contention since the dawn of democracy in South Africa, this undoubtedly affects the willingness of politicians to deal with or even speak about title deed related issues in these initiatives.

Theme 6 Trust and Acceptance

Barriers such as a deficit of trust between government, beneficiaries and the blockchain technology will need to be overcome. While the acceptance of change from untrusting local leaders and residents also needs to be surmounted. The lack of trust is outlined by P2 the housing NPO head:

> "Then you need someone who can manage the blockchain registry and is trusted for that, and that's like a conveyancer type role".

P2 is describing that when a blockchain based registry is implemented, it will require a manager that parties to the transaction will trust. In literature the public entity responsible for the nation's property registry is mentioned as the organization that can be used for this role (Verheye, 2017b), as the public already trusts the entity and their data is regarded as mostly accurate. In South Africa the candidates to manage a blockchain based property register are the Deeds Registry or as explained in the case study, the city authorities as they are mostly recognized and trusted by citizens.

These themes provide a structured overview of the various factors and barriers associated with blockchain technology adoption in the public sector. They can help organizations and policymakers address these issues more effectively when considering blockchain implementation, with a specific focus on public or state-subsidized housing.

From the above-mentioned themes, their respective barriers to adoption, as outlined in chapter 2's literature review, are ranked in terms of number of references and sources of data/files (interview or secondary data) in the table 14 extracted from NVIVO below.

Table 14: Themes and barriers to adoption/codes ranked by number of references from NVIVO.

Codes

Name	Files	References
(RQ2) Barriers to adoption	5	107
(Theme) Regulatory and Legal Challenges	5	41
Establishment of a legal framework	5	18
Informal or off-register transactions	3	8
Lack of digital data	4	8
Validating claims to property ownership	4	7
(Theme) Organizational and Cultural Barriers	5	24
Interdepartmental co-ordination and communication	5	11
Organizational structure, practices and culture	3	5
Redesign of organisational or business processes	3	4
Resistance to change	2	3
Quality of leadership	1	1
(Theme) Technological Hurdles	5	20
Data quality	5	12
Technological barriers (flexibility, security, and scalabili	2	3
Technological expertise	3	3
Weak IT infrastructure	2	2
(Theme) Resource and Cost-Related Issues	4	10
Financial cost and resource allocation	4	7
Information security and privacy	1	1
Insufficient time for understanding and implementati	1	1
Lack of shared understanding	1	1
(Theme) Political and Social Factors	4	6
Political will	4	6
(Theme) Trust and Acceptance	4	6
Lack of trust between implementers and users	2	4
Acceptance or commitment to change from all role pl	2	2

The above table highlights the relative importance of each barrier to their respective theme and the pilot project. The most significant theme is regulatory and legal challenges with the establishment of a legal framework being the most referenced barrier, followed by informal or off-register transactions, a lack of digital data, and validating claims to property ownership. Organizational and cultural barriers are the second most significant theme, with the interdepartmental co-ordination and communication barrier most referenced, followed by organizational structure, practices, and culture and the redesign of organisational or business processes barriers. The third most significant theme is technological hurdles with the barrier of data quality being most significant, followed by technological expertise and weak IT infrastructure barriers. Resource and cost-related issues are the theme last in importance, with financial cost and resource allocation being the most significant barrier under this theme. The theme of political and social factors has the same number of references and hence importance as the trust and acceptance theme. Political and social factors only have one barrier being political will. Whereas the trust and acceptance theme comprise of the lack of trust between implementers and user's barrier, as well as the acceptance or commitment to change from all role players. The appearance of these significant barriers in the current South African context and the implementation of the pilot project will assist in addressing the 2nd and 3rd research questions.

4.3.5 Contextual analysis

This section discusses the context for each theme, it explains how the themes link to the research questions and gives a more in-depth knowledge of the study's findings (Yin, 2014).

Six main themes linked to barriers to adoption were identified from the analysis in response to research questions 2 and 3 along with several reasons for the lack of implementation based on the case study:

2. Why has blockchain technology not been implemented in South Africa's land registry?

3. What factors would contribute to the successful implementation of a blockchain based land registry?

In addressing both research questions, the above significant barriers represent reasons why has blockchain technology not been implemented and factors which would contribute to the successful implementation of a blockchain based land registry. The most significant barriers to adoption are the

establishment of a legal framework, followed by informal or off-register transactions, a lack of digital data, and validating claims to property ownership. The second most important barriers are interdepartmental co-ordination and communication, followed by organizational structure, practices, and cultural barriers and the redesign of organisational or business processes. The third most significant group of barriers to adoption are the barrier of data quality, followed by technological expertise and weak IT infrastructure barriers. The final important barriers are the financial cost and resource allocation barrier, political will, the lack of trust between implementers and user's barrier, as well as the acceptance or commitment to change from all role players.

To address research question 2, the following reasons why blockchain technology not been implemented in South Africa's land registry based on the case study and interviews were identified. First is misalignment of interests between the PropTech firm and NPO & research consultancy, this resulted in the subsequent loss of the PropTech firm and their blockchain expertise from the project. Second is that no MOU or PPP was signed with any public sector organisations, only a working relationship with the city was established. Lastly is a data issue relating to the manual door-to-door process of collecting data to verify claims as well as the unreliable versions of spreadsheet data emanating from the parties of the housing project team. These reasons can be further classified under themes developed from the interview analysis in the discussion chapter as they represent barriers to technology adoption. These reasons are classified under their relevant barriers in the discussion chapter below.

To address research question 3, the themes identified form the basis of factors which need to be addressed to successfully implement a blockchain based land registry. These factors can be compared to the land registration challenges found in addressing research question 1 based on shared characteristics, see table 15 below. For these factors to contribute to the successful implementation of a blockchain based land registry they need to be identified, investigated, and addressed in practice.

From table 15 below the first factor which would need to be addressed is regulatory and legal challenges which include the deterioration of informal land tenure systems and customary ownership practices, as well as weak legal frameworks and enforcement mechanisms. Organizational and cultural barriers include the challenges of corruption and lack of transparency, as well as the conflict between statutory and customary land tenure systems. The factor of technological hurdles includes the challenge of having reliable land records and documentation. Resource and cost-related factors

face the challenges of limited access to land registration services for marginalized communities, as well as insufficient investment factors relating to land redistribution and tenure reform. Political and social factors include the challenge of dismantling the post-colonial property rights legacy in former colonies. The trust and acceptance factor does not have a common linked land registration challenge but is a factor which must be addressed in the implementation of blockchain technology for land registration. Each theme and its respective barriers are substantiated by direct quotations from their source i.e., interview participants and secondary data sources (where interview participants P1, P2, and P3 were speakers).

Table 15: Themes and barriers to adoption/codes compared to common land registration challenges.

Theme	Barrier to adoption / code	Selected Quotation	Source of quotation	Related land registration challenges
Regulatory and Legal Challenges	Establishment of a legal framework	"We can't do that yet because we don't have legislation for that".	P2	• Deterioration of informal land tenure systems and customary ownership practices • Weak legal frameworks and enforcement mechanisms
	Informal or off-register transactions	"There's so much anecdotal evidence or commentary about informal transactions in about how the market isn't working".	Secondary data 1 – P2	
	Lack of digital data	"You know that the system that we use is very paper based and that's the formal system as well as the informal system".	P1	
	Validating claims to property ownership	"Blockchain does not resolve the tedious and time-consuming process of collecting verifying and bringing data into the system in the first place and that was certainly our experience".	Secondary data 2 – P1	
Organizational and Cultural Barriers	Interdepartmental co-ordination and communication	"Basically, the system that we're looking at would be to integrate all these various departments, the province, the city, national government, revenue authority, banks and of course we don't want to leave the conveyances out".	Secondary data 2 – P1	• Corruption and lack of transparency • Conflict between statutory and customary land tenure systems
	Organizational structure, practices, and culture	"So, it's again got nothing to do with the technology and all about the people and the processes".	P1	
	Redesign of organisational or business processes	"Notaries of conveyancers should be very upset to hear this but that process that conveyancer does, they verify that the person is who they say they are and that they own the property that they say that they own, those functions if you've digitised things properly can be automated to a large degree so there's enormous potential".	Secondary data 1 – P1	
	Resistance to change	"So yeah, I mean that that's my perspective that I wouldn't be focusing on the deed's office. There's going to be very, slow change there".	P2	
	Quality of leadership	"Yeah, I guess it gets very complicated, but there's all the politics and also, different leadership wanting to take credits etcetera".	P3	

Technological Hurdles	Data quality	"Blockchain is not the end-all solution, blockchain stores data securely but does not verify that data, so if you put bad data on the platform, you're going to have a not very useful platform".	Secondary data 2 - Head of PropTech firm	• Reliable land records and documentation
	Technological barriers (flexibility, security, and scalability)	"Whether it has to be blockchain, you know, there are many ways to maintain immutable records, doesn't have to be a blockchain, it can be anything as long as you cannot tamper with the evidence of a claim".	P1	
	Technological expertise	"And if your officials, can't imagine what a blockchain is, how are they supposed to deliver to it?"	P2	
	Weak IT infrastructure	"But you know one of the biggest challenges I think to kind of digitising you know the whole deeds registry and bringing in blockchain technologies, is just that there's such a huge legacy system".	P3	
Resource and Cost-Related Issues	Financial cost and resource allocation	"With low value properties the cost of the traditional mechanism for going through registration becomes a significant proportion of that property value and that's just it's not tenable actually".	Secondary data 1 – P2	• Limited access to land registration services for marginalized communities • Investment factors relating to land redistribution and tenure reform
	Information security and privacy	"But the issue of security and trustworthiness is critical".	P2	
	Insufficient time for understanding and implementation	"So, what's happened in these projects that government has built, they didn't issue the title deeds initially. It's ten years later they go to the property. They want to issue the title deed".	P1	
	Lack of shared understanding	"What we often find is I think there's a gap between the donors, of what their vision is of the problem and what it is on the ground".	Secondary data 2 – Head of PropTech firm	
Political and Social Factors	Political will	"We don't really know how to deal with disputes properly and it is actually not a gap in policy as much as it is a lack of willingness, I think it's lack of political leadership to really push this".	Secondary data 1 – P1	• Post-colonial property rights legacy in former colonies
Trust and Acceptance	Lack of trust between implementers and users	"When it comes to a blockchain based solution because the code is visible because everyone can see the steps and because everyone knows that those steps can't be tampered with, we would hope that government would trust a system that they don't necessarily have to build themselves".	Secondary data 2 – P1	
	Acceptance or commitment to change from all role players	"The local area leadership in place is not democratically elected but does have power, precisely because they are the only ones in the area who have the phone number of city officials, and no one has a title deed. So, anyone who wants a title deed needs to accord a little bit of respect to these community leaders because they're only guys engaging productively with the city".	Secondary data 1 – P1	

4.3.6 Validation and trustworthiness

This section discusses the procedures taken to guarantee the validity and reliability of your findings, such as member verification and triangulation (Lincoln and Guba, 1985). The first validity strategy this study employed was triangulation which is described as the comparison of multiple data sources to find common themes (Leedy and Ormrod, 2005; Noble and Smith, 2015). The interview findings were compared to what was found in the secondary data, which showed consistency.

Another strategy this study employed was the clarification of personal biases, this entails the researcher describing the manner in which their understanding of the findings is influenced by their personal history, such as gender, culture, history, and socioeconomic origin (Leedy and Ormrod, 2005; Noble and Smith, 2015; Creswell and Creswell, 2018). Personal biases included a negative outlook in the public sector and public housing initiatives.

The final strategy this study employed was respondent validation, this required the researcher to take outcomes back to the partakers and establishing if they feel the findings were correct (Leedy and Ormrod, 2005; Noble and Smith, 2015; Creswell and Creswell, 2018). This was done by reflecting upon the responses from the first interviewee when interviewing the other participants and vice versa, the respondent validation was also possible through the probing of findings from the secondary data with participants as majority of the participants were speakers in the secondary data sources.

4.3.7 Key findings of qualitative case study results

This section sums up the major findings and their significance to the research questions. The findings are then related to the overarching study goals (Maxwell, 2012). In addressing both research questions 2 and 3 the following significant barriers represent reasons why has blockchain technology not been implemented and factors which would contribute to the successful implementation of a blockchain based land registry. They begin with the establishment of a legal framework, followed by informal or off-register transactions, a lack of digital data, and validating claims to property ownership. Second are interdepartmental co-ordination and communication barriers, followed by organizational structure, practices, and cultural barriers and the redesign of organisational or business processes. Third are the barrier of data quality, followed by technological expertise and weak IT infrastructure barriers. Lastly there are the financial cost and resource allocation barrier, political will, the lack of trust between implementers and user's barrier, as well as the acceptance or commitment to change from all role players involved.

The following are reasons why blockchain technology not been implemented in South Africa's land registry based on the case study and interviews were identified. First is misalignment of interests between the PropTech firm and NPO & research consultancy, this resulted in the subsequent loss of the PropTech firm and their blockchain expertise from the project. Second is that no MOU or PPP was signed with any public sector organisations, only a working relationship with the city was established. Lastly is a data issue relating to the manual door-to-door process of collecting data to verify claims as well as the unreliable versions of spreadsheet data emanating from the parties of the housing project team.

Factors which would need to be addressed for the successful implementation of blockchain technology begin with regulatory and legal challenges which include the deterioration of informal land tenure systems and customary ownership practices, as well as weak legal frameworks and enforcement mechanisms. Second is organizational and cultural factors which include the challenges of corruption and lack of transparency, as well as the conflict between statutory and customary land tenure systems. Third is the factor of technological hurdles, which includes the challenge of having reliable land records and documentation. The fourth factor is resource and cost-related issues, which face the challenges of limited access to land registration services for marginalized communities, as well as insufficient investment factors relating to land redistribution and tenure reform. The final factor which would contribute to successful implementation is political and social factors, which include the challenge of dismantling the post-colonial property rights legacy in former colonies.

4.3.7.1 Outcomes and results of pilot project implementation

4.3.7.1.1 Analysis of data collected during the pilot project.

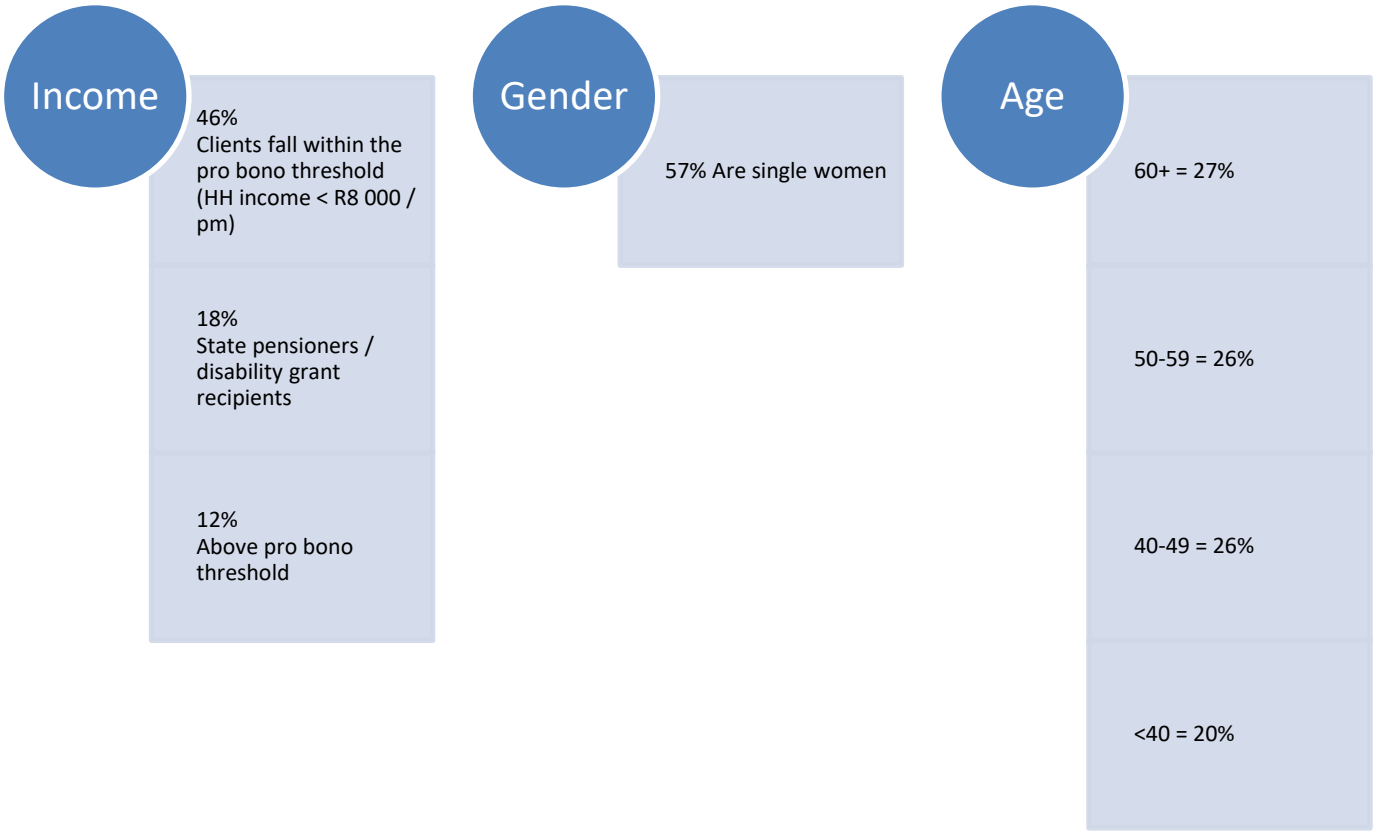
In terms of walk-in clients to the TPX, the following is reported (Breier, 2023):

Title deed issues:

Title deed issues are reported by 72% of the 1 027 walk-in clients. A single case may have many title deed issues. The most prevalent issues by number of cases are, where the registered owner has passed away (313), informal sale (253), primary transfer (234), administrative (94) donation (28), divorce (22), and a single case may have more than one of these problems.

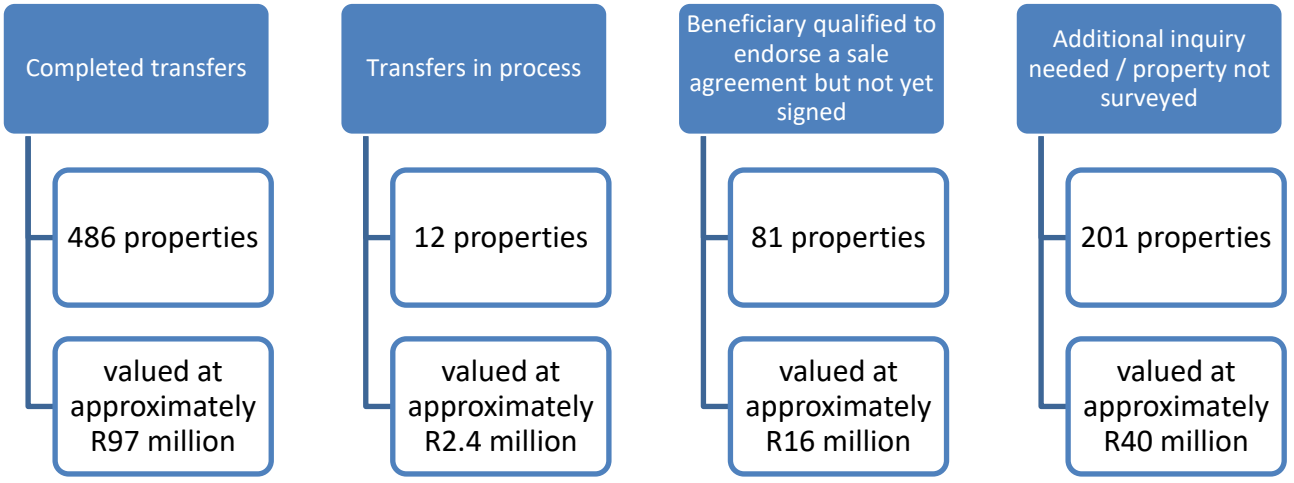
Walk in client demographics:

Figure 9 – TPX walk in client demographics.



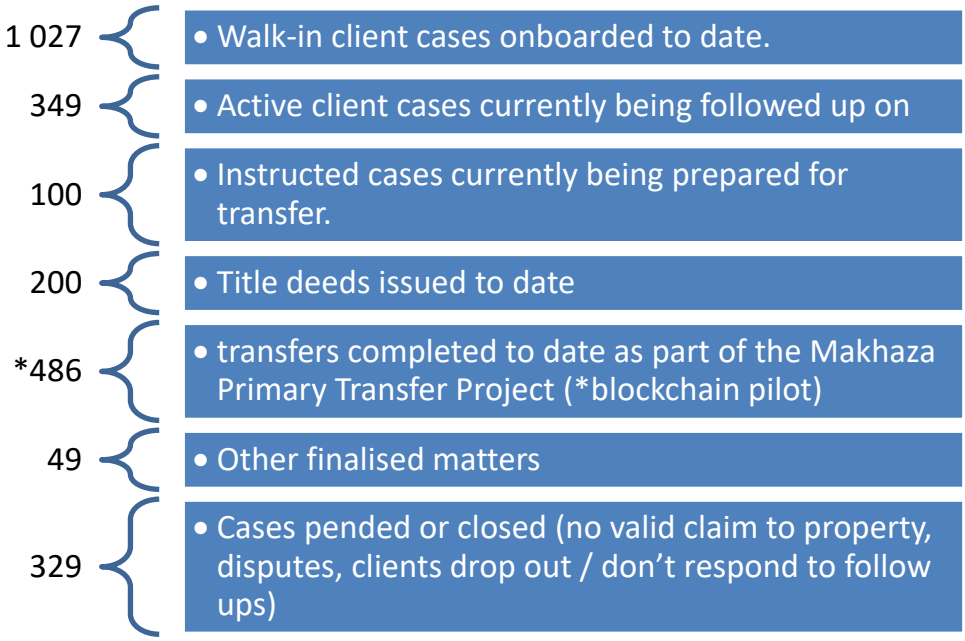
In terms of the primary transfer pilot in Makhaza numbering 780 properties (Breier, 2023):

Figure 10 – Primary transfer pilot



The TPX's team on the ground was able to achieve substantial progress when dealing with the most difficult title deed cases. Of the office walk-in clients (Breier, 2023):

Figure 11 – TPX office walk in clients plus primary transfer pilot.



4.3.7.1.2 Impact on property registration processes and efficiency

Some areas were willing to participate in the pilot project while others were not. Those with higher participation percentages were attributed to the TPX being established working in the area for a year prior. The physical presence in the neighbourhood of the TPX office is crucial to achieving its purpose and goals, as clients can be assisted in person. The pilot project has created something that is akin to a title deed and in some ways better when the documents are stored on the blockchain. The pilot has satisfied the burden of demonstrating an administratively visible and bankable record can be built and be shared with the city. As stated by the research consultancy firm head, "the pilot works very well with primary registration so to handle the title the backlog that we can scale up."

Additionally, for a property worth R250,000.00 the costs of transfer are as follows. Normal charges include conveyancing fee – R8,440 and disbursement costs – R1,344 (Rates clearance certificate – R630, deeds office fee – R642, deeds search – R72), giving a total of R9,784. At the TPX: indigent and pensioners receive these services for free. If your household income is less than R8,000 per month the conveyancing fee is free and disbursement costs are the only charge resulting in a total of

between R1,300 and R1,800. If your household income is greater than R8,000 per month the conveyancing fee and disbursement costs together amount to R6,000. This shows that the TPX provides a cheaper service when compared to normal charges to access the formal property transfer system.

The TPX's property register would essentially have manifold entities contributing in a blockchain-based platform that can permit this effectiveness, low-cost, and security. This is where the "trust machine" can be framed, so long as the parties using the system trust it, the solution can be scaled up.

4.3.7.2 *Lessons Learned from pilot project implementation.*

This section assists in answering research sub questions 2 and 3 by listing the key take-aways from the implementation of the pilot project. The second question asks why blockchain technology has not been implemented in South Africa´s land registration system. The third question asks what factors would contribute to the successful implementation of a blockchain based land registry.

This pilot project was not connected directly to the deeds registry, as the property register and "pseudo title deed" fill the gap between the housing subsidy system and the formal property registration system. The most important value add of the blockchain is a secure place to store property transaction documents and the title deed. The TPX believes that passing the information back to the city system. This would enable them to recognise a validated, verified participant who they themselves as a validating entity in the system have validated, with this is an attainable goal for the case management system.

<u>Key lessons from primary transfer (Breier, 2023)</u>

- Walk-in customers
    - Difficult to locate the property transfer project data, the project manager, and the conveyancer involved in the initial project.
    - In other situations, developments have not yet begun; there are no clear timetables for when this will occur or how long it will take for title documents to be granted.
    - Subsidy applications are effective, although it is not always apparent what to do with non-qualifiers.

- Pilot
    - Numerous lessons so a toolkit was created to assist municipalities with primary transfer.

Key lessons from the regularization of informal sales (Breier, 2023)

- Informal sales in the past
    - Extremely disorganised, but some issues can and should be fixed.
    - The cost of legal registration is a reason for why the property was never transferred initially.
    - Need to establish legal precedent in circumstances where there are disagreements or sellers cannot be found. The TPX is currently testing an application to the magistrate court (a comparable case was fruitfully tried in the High Court of late).
    - The Land Titles Adjustment Act is not seen as a realistic option for stalled informal sale instances (as there are many administrative hurdles, only makes sense if a group of cases is presented to a commissioner, with at least two missing connections in the transaction).
- Current sales
    - Buyers are becoming more aware of the dangers, yet money is still changing hands prior to transfer owing to sellers' liquidity concerns.
    - The pre-emptive or restrictive sales clause is a serious impediment to regularisation in the setting of a massive main transfer backlog.
    - The Western Cape waiver mechanism works (for municipal services arrears), but it adds administrative complication and postponements.
    - Transaction proof is essential. While waiting for the other procedures to play out, there is a need to build a framework which allows individuals to record proof of past transactions and keep evidence of present activities.
- The time taken to resolve informal sales cases:
    - Shortest – 2 to 3 months
    - Longest – more than 3 years (46 months)
    - Average – 17 months

Key lessons from deceased property owners (Breier, 2023)

- Deceased property owners
    - This is an enormous concern that low-income households across the country require support with.
    - The operation of the Master's Office is vital, but presently the process is extremely lengthy, inefficient, and opaque (the lone avenue to track a case is to visit their premises during the imposed hours - 3 days a week between 9 a.m. - 12:30 p.m.).
    - There is a tremendous prospect for increased efficiency in the Master's Office through digitization.
    - The TPX has closed huge estates at a cheaper cost to the customer (the 3.5% estate charge is waived for clients). However, without the TPX, prices would be too expensive for low-income households. This situation will worsen as property values increase and more estates surpass the small estate threshold.
    - No means for resolving estate disagreements (a minority of TPX cases)
    - Due to the risk of family feuds, many customers choose donation transfers over wills.
- Time to resolve cases for deceased estates:
    - Shortest – 5 – 7 months
    - Longest – 4+ years (52 months)
    - Average – 20 months

The second question asks why blockchain technology has not been implemented in South Africa´s land registration system. From primary transfer, there is difficult in locating the property transfer project data, the project manager, and the conveyancer involved in the initial project. Regularization of informal sales, the volume of past sales and lack of transaction proof are reasons why the technology has not been implemented. Regarding deceased property owners, a reason for non-implementation is the lack of digitization within the Master's Office.

The third question asks what factors would contribute to the successful implementation of a blockchain based land registry. From primary transfer the sharing of accurate beneficiary information with all relevant parties would contribute to successful implementation. Regularization of informal sales will require government intervention for dispute resolution as well as the recording of transaction information electronically (must also be legally permissible to do so), would contribute

to successful implementation. With regards to deceased property owners, the digitisation of the Masters Office and appropriate dispute resolution would contribute to successful implementation.

4.3.7.3 Pilot project key findings, implications, and future research

4.3.7.3.1 Summary of pilot project key findings and their significance

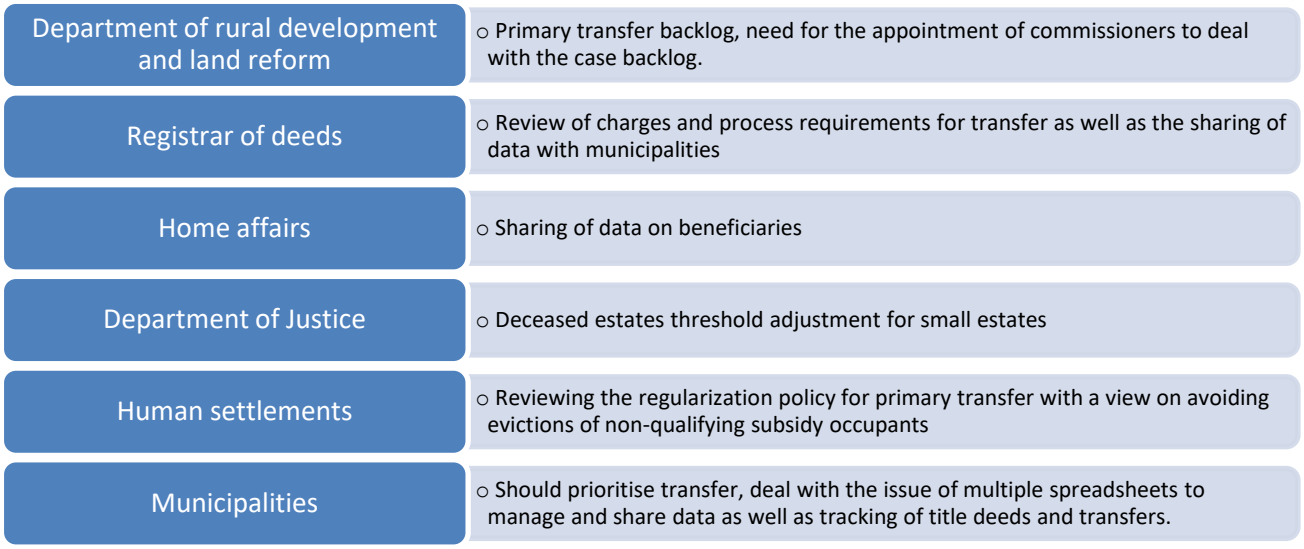
The blockchain pilot sought to explore how technology could be used to enable the process of transfer from the city to the beneficiary, and it has successfully been able to resolve cases and initiate primary transfer. However, the parting of ways of the PropTech firm means that the blockchain registry cannot be developed any further which represents a failure in terms of championing blockchain DLT for the functioning of a property or land registry. Despite this clear problem, the project did manage to create a "pseudo title deed" which can be shared with the city and is an administratively visible and bankable record which has the potential to resurrect the previously dead capital. The most important value add of the blockchain is a secure place to store property transaction documents and the title deed. The TPX's remedy of cases, ability to initiate primary transfer and thus capacity to assist clients in securing their tenure indicate that, with proper contractual agreements between the PropTech firm, NPO and research consultancy, a blockchain based solution can be scaled up.

The issuing of title deeds has aided the city in recognizing growing property values in the area and allowed beneficiaries to defend their tenure. In terms of factors which would contribute to the unsuccessful implementation or why blockchain technology was not implemented, the following reasons are identified when compared to literature. First is misalignment of interests between the PropTech firm and NPO & research consultancy, this resulted in the subsequent loss of the PropTech firm and their blockchain expertise from the project. Second is that no MOU or PPP was signed with any public sector organisations, only a working relationship with the city was established. Lastly is a data issue relating to the manual door-to-door process of collecting data to verify claims as well as the unreliable versions of spreadsheet data emanating from the parties of the housing project team.

4.3.7.3.2 Implications for the broader adoption of blockchain in property registries from pilot project

Government's function is crucial in enabling scalability of the pilot project. Critical aspects for government in scaling up per their departments are outlined in the figure below.

Figure 12 – critical aspects for government departments to scale up a blockchain based land registry.



Another implication for future blockchain initiatives is the issue of trust. How will various entities in the system come to trust the technology? Will government have to build the system themselves to trust it? The pilot project forecasts that because the code is visible in a blockchain system, the steps are visible and cannot be altered, then it is hoped government should have no issue trusting the system.

4.3.7.3.3 Future research directions and policy recommendations from pilot project

More projects are needed, specifically using blockchain technology to test its applicability to the South African context, be that in the formal property market or the subsidized housing market. The case study also highlights that blockchain does not necessarily need to be the technology to achieve property titling at scale. Policy recommendations include reviewing, the restrictive sale clauses, the regularization policy for non-qualifying subsidy occupants without evictions and the appointment of commissioners to expedite resolution of ownership disputes in the Land Titles Adjustment Act. Further, the laws, regulations and requirements relating to the property transfer process need to be revised to allow for cheaper, quicker, and electronic transactions.

4.4 Summary

This section addressed the objective to determine why has blockchain technology not been implemented in South Africa's land registry, and what factors would contribute to the successful

implementation of a blockchain based land registry. The sample consisted of 3 participants to a unique blockchain property registry pilot project. Secondary data in the form of form of documents and audio-visual/digital material relating to the project was also collected and analysed, these materials had input from all 3 participants as well as the PropTech firm previously part of the project.

Content analysis and description-based coding were employed in analysing the interview data. This resulted in the development of 6 themes from the literature review-based codes which a ranked based on their number of references or significance. Therefore, the barriers to adoption of blockchain technology in South Africa's public sector are regulatory and legal challenges, organizational and cultural barriers, technological hurdles, resource and cost-related issues, political and social factors as well as trust and acceptance.

The case study revealed the following reasons why blockchain technology has not been implemented. First is misalignment of interests between the PropTech firm and NPO & research consultancy which resulted in the subsequent loss of the PropTech firm and their blockchain expertise from the project. Third is that no MOU or PPP was signed with any public sector organisations, only a working relationship with the city was established, preventing the project from being scaled up. The last factor is a data issue relating to the manual door-to-door process of collecting data to verify claims as well as the unreliable versions of spreadsheet data emanating from the parties of the housing project team.

Factors which would need to be addressed for the successful implementation of blockchain technology begin with regulatory and legal challenges which include the deterioration of informal land tenure systems and customary ownership practices, as well as weak legal frameworks and enforcement mechanisms. Second is organizational and cultural factors which include the challenges of corruption and lack of transparency, as well as the conflict between statutory and customary land tenure systems. Third is the factor of technological hurdles, which includes the challenge of having reliable land records and documentation. The fourth factor is resource and cost-related issues, which face the challenges of limited access to land registration services for marginalized communities, as well as insufficient investment factors relating to land redistribution and tenure reform. The final factor which would contribute to successful implementation is political and social factors, which include the challenge of dismantling the post-colonial property rights legacy in former colonies.

5 Discussion and conclusion

5.1 Overview and summary of findings

5.1.1 Overview

Several nations have recently deployed blockchain-based land management system projects for activities such as land registration and/or titling, land recordation, and land information management (Ameyaw and de Vries, 2021). When applied in land management systems and land transactions blockchain provides more transparency, trust, data security, as well as increased data quality, and immutability through the consensus process (Ameyaw and de Vries, 2021; Shuaib, Alam and Daud, 2021).

This provides for simpler access and tracking of land records, which lowers fraud, corruption, record manipulation, and multiple sales of property. Further efficiency is obtained by lowering land transaction costs (Ameyaw and de Vries, 2021; Shuaib, Alam and Daud, 2021). These benefits provided by blockchain technology to land registration, transactions, and management seek to address the following market deficiencies. In contrast, the quality of land records in poor countries is seen as inefficient and untrustworthy (Kaczorowska, 2019).

According to the world bank South Africa ranks low down on registering property with a ranking of 108 out of 190, while the blockchain adopters Sweden and Georgia rank at 9 and 5, respectively. South Africa can be characterized by a high number of procedures – 7, long transaction time – 23 days and high costs which make up – 8% of the property's value (The World Bank Group, 2019).

Despite these inefficiencies the technology has not yet made an inroad into the land registration or transaction process. The purpose of this research is to investigate the potential use of blockchain technology to digitize land registration in South Africa. In addressing the purpose of this research, three objectives were identified. Firstly, to identify the existing land registration challenges in developing countries and South Africa. Secondly to examine why blockchain technology has not been implemented in South Africa´s land registration system and lastly, to determine factors that would contribute to the successful implementation of a blockchain based land registry. This section covers a summary of the findings, interpretation of the findings, comparing the findings and existing

literature connections, the implications of the study, recommendations, the conclusion and lastly contributions of the study.

5.1.2 Summary of the findings

The following eight key themes were identified as the common existing land registration challenges in developing countries and South Africa to fulfil the first research objective. They are reliable land records and documentation, the deterioration of informal land tenure systems and customary ownership practices, limited access to land registration services for marginalized communities, corruption and lack of transparency, weak legal frameworks and enforcement mechanisms, conflict between statutory and customary land tenure systems, post-colonial property rights legacy in former colonies, as well as investment factors relating to land redistribution and tenure reform.

The fulfilment of the second and third research objectives resulted in the following six factors and their respective barriers to technology adoption being identified. The most significant factor is regulatory and legal challenges with the establishment of a legal framework being the most significant barrier, followed by informal or off-register transactions, a lack of digital data, and validating claims to property ownership. Organizational and cultural barriers are the second most significant factor, with the interdepartmental co-ordination and communication barrier most referenced, followed by organizational structure, practices, and culture and the redesign of organisational or business processes barriers. The third most significant factor is technological hurdles with the barrier of data quality being most significant, followed by technological expertise and weak IT infrastructure barriers. Resource and cost-related factors are fourth in importance, with financial cost and resource allocation being the most significant barrier under this theme. Lastly, the political and social factors are equally as important as the trust and acceptance factor. Political and social factors only have one barrier being political will. Whereas the trust and acceptance factor comprise of the lack of trust between implementers and user’s barrier, as well as the acceptance or commitment to change from all role players. These factors point to why blockchain technology has not been adopted in South Africa's land registry, and what would contribute to the successful implementation of a blockchain based land registry.

The common existing land registration challenges in developing countries and South Africa can be classified under the same six factors. The first factor which would need to be addressed is regulatory and legal challenges which include the deterioration of informal land tenure systems and customary

ownership practices, as well as weak legal frameworks and enforcement mechanisms. Organizational and cultural factors include the challenges of corruption and lack of transparency, as well as the conflict between statutory and customary land tenure systems. The factor of technological hurdles includes the challenge of having reliable land records and documentation. Resource and cost-related factors face the challenges of limited access to land registration services for marginalized communities, as well as insufficient investment factors relating to land redistribution and tenure reform. Political and social factors include the challenge of dismantling the post-colonial property rights legacy in former colonies. The trust and acceptance factor does not have a common linked land registration challenge but is a factor which must be addressed in the implementation of blockchain technology for land registration.

The case study revealed the following reasons which contributed to the unsuccessful implementation of the technology in South Africa. First is misalignment of interests between the PropTech firm and NPO & research consultancy, resulting in the subsequent loss of the PropTech firm and their blockchain expertise from the project due. Second is that no MOU or PPP was signed with any public sector organisations, only a working relationship with the city was established, preventing the project from being scaled up. The last factor is a data issue relating to the manual door-to-door process of collecting data to verify claims as well as the unreliable versions of spreadsheet data emanating from the parties of the housing project team.

5.2 Discussion - a comparison of the findings with previous research

To make sense of the findings, the results of each research objective are explained, compared to the literature reviewed and contrasted with the theoretical framework outlined in chapter 3 and illustrated under Annexure A. Importantly a wholistic interpretation can be made on the findings as the land registration challenges and barriers to technology implementation found in literature can be viewed in terms of the case study evidence. This allows the main research problem to be addressed based on speculation and explanation of the research findings.

5.2.1 Existing land registration challenges in developing countries and South Africa

The common land registration challenges found in developing countries and South Africa begin with the need for reliable land records and documentation. Outdated information due to off-register or unrecorded transactions occurring complicates ownership and legal issues, as well as the land market

and city administration, which require accurate data (Dickerman and Barnes, 1989; Adams, Cousins and Manona, 1999; Barry, 2020). Following the theoretical framework developed by (Peled, 2001), reliable land records and documentation represent a technological and administrative variable. Technological in that accurate data is required and administrative as this information needs to be constantly updated and maintained to ensure data quality.

An administrative variable influenced by organisational politics is represented by the deterioration of informal land tenure systems and customary ownership practices. Customary and informal land tenure systems and practices have become weaker over time, affecting the relative strength of this type of land tenure in South Africa (Adams, Cousins and Manona, 1999; Adams, Sibanda and Turner, 1999). Strength here refers to how well tenure can be defended and enjoyed. Some communities prefer communal land ownership, highlighting contradictions between formal property requirements and the needs of community-based institutions (Cousins *et al.*, 2005). Additionally intervening in informal settlements is difficult due to problematic community leaders, internal conflicts, and confrontations with authorities (Barry and Rüther, 2005).

Also affecting South Africans is limited access to land registration services for marginalized communities. Citizens are unable to access land registration services as the costs are too high and their property may not be valuable enough (Toulmin, 2009; Green, Viruly, and Moghayedi, 2022), resulting in increased off-register transactions due to affordability issues (Barry and Roux, 2013, 2016). When looked at through the lens of the theoretical framework, limited access to land registration services represents an administrative variable which is influenced by organisational politics.

Another land registration challenge influenced by organisational politics is, corruption and lack of transparency, which are classified as technological and administrative variables. This challenge hinders property transactions and enables elite land grabs (Boone, 2019; Barry, 2020), it also allows for ineligible occupants to be in possession of state-subsidized houses (Barry, 2020), for instance those earning above the income threshold.

The above-mentioned problem is also a consequence of weak legal frameworks and enforcement mechanisms. These leave communal and private land rights vulnerable, especially in southern African nations where hybrid governance systems incorporating street committees, are sometimes unavoidable (Adams, Cousins and Manona, 1999; Cousins *et al.*, 2005; Benjaminsen *et al.*, 2009).

Land registration does also not eliminate the risk of being subject to the 'larger policy environment', which can work against the objectives of government and individual property owners (Boone, 2019). An example of this can be found in South African state-subsidized housing initiatives in the form of restrictive sales clauses, which are a reason to transact off-register, causing delays and exposing buyers to property reclamation and eviction risks (Barry and Roux, 2016). This challenge is classified as administrative variable influenced by organizational politics under the theoretical farmwork.

Also influenced by organizational politics and represented as an administrative variable is the conflict between statutory and customary land tenure systems. This arises from the tension between individual titling and traditional regulations, sometimes manifesting in hybrid governance systems which incorporate both government and non-government entities (Dickerman and Barnes, 1989; Toulmin, 2009; Boone, 2019; Barry, 2020). Additionally, the formalisation process of informal land can effectively transfer ownership from one party's dormant capital to another's active capital (Benjaminsen *et al.*, 2009).

This conflict can be attributed to the post-colonial property rights legacy in former colonies. These restricted property ownership for certain population groups leading to tenure insecurity (Abdulai, 2006; Barry and Roux, 2014). The dual system of land rights that existed throughout the colonial and apartheid eras is still in force today. Despite the abolition of legislation that created artificial racial categories, state ownership of land in the former homelands remains. Apartheid-era legislation that granted chiefs and tribal groups significant control over not just land management, but also judicial and governance concerns must yet be removed. The trustee system, which established the state as both the owner and the supervisor of property, resulted in current legislation governing former homeland territory to include both ownership and governance authority (Adams, Cousins and Manona, 1999). As per the theoretical framework, this challenge can be classified as an administrative variable influenced by organisational politics.

The final land registration challenge developing countries and South Africa share also influenced by organisational politics are the investment factors relating to land redistribution and tenure reform. These represent both administrative and technological variables. Investment factors relating to land redistribution and tenure reform, are associated with the various steps a government can take to encourage investment, such as inputs, loans, extension services, and fostering functioning markets (Adams, Cousins and Manona, 1999).

5.2.2 Why has blockchain technology not been implemented in South Africa's land registry?

To address this research question, the findings from case study and interviews were analysed and grouped based on shared characteristics and their relationship to theoretical framework. This process revealed the following common reasons which are represented in the figure below.

Figure 13: Why has blockchain technology not been implemented in South Africa's land registry.

From figure 12 above, blockchain technology has not been implemented in South Africa's land registry due to technological and data related issues, government not fully fulfilling its responsibility as an administrator for land registration, and due to limited access and resources available. These reasons are technological hurdles, regulatory and legal challenges, organizational and cultural barriers, as well as limited access to land registration services for marginalized communities.

Technological hurdles include having accurate, validated, and up-to-date data loaded on the land registration system, the government departments not having accurate information on their housing projects, which all compromise data quality. The choice of technology for land registration and how it is employed also represents a barrier as alternatives to blockchain technology exist. A further barrier technologically in the deed's registry, are the manual or paper-based components and lack of technological expertise.

However, the primary reason why the technology has not been implemented is a legal barrier. Electronic transactions are not yet recognized, and courts only recognize transactions involving a conveyancer, with a valid sale agreement and title deed. An analysis of the land registration procedure, on the other hand, gives evidence of potential impediments. The Deeds Registries Act 1937 (Act No. 47 of 1937), the Sectional Titles Act 1986 (Act No. 95 of 1986), and the Alienation of Land Act (Act 68 of 1981) govern land registration in South Africa. Our land registration system, with its clearly defined obligations and duties of the many role-players, may be considered to effectively assure title security - to the point that title insurance (the standard in the United States) is unknown in South Africa (Shange, 2010).

Conveyancing is described as the legal transfer of property from one owner to another (Amadi-Echendu, 2013). According to Section 15 of the Deeds Registry Act. "Except in so far as may be otherwise provided in any other law, no deed of transfer, mortgage bond or certificate of title or any certificate of registration of whatever nature, mentioned in the Act, shall be attested, executed or registered by a registrar unless it has been prepared by a conveyancer." Regulatory and legal challenges encompass the limits imposed by the current laws and policies in place relating to property ownership and the paper-based transfer process, the contractual agreements between the organizations involved in the pilot project as well as the difficulty in formalisation of informal property transactions.

The use of the Deed's Registry is expensive, time consuming and requires access to conveyancers as well as paper-based documents which limits access to land registration services for marginalized communities i.e., state-subsidized housing beneficiaries. In addition to these costs the organization implementing a blockchain based land registry will require funds to build and maintain such a system. These reasons represent resource or cost related issues.

Organizational barriers represent the lack of adequate communication in the property transaction process between the government departments involved, the different deeds registry offices and the city. Further, a formalised understanding between the city and pilot project implementers is required, especially in an oftentimes corrupt and overburdened public administration. Cultural barriers include the slow change expected when digitizing the deeds registry processes and the strong leadership required for such a huge task.

To further understand why blockchain technology has not been implemented, the pilot project in its totality must be viewed through the lens of the theoretical framework by (Peled, 2001). In doing so, the pilot project appears to fall between the network and coalition phases. An issue network was formed as the housing NPO, Research Consultancy and PropTech firm came together to address the titling and land registration issue in state-subsidized housing developments, specifically in Makhaza, Khayelitsha. The coalescence between these organizations resulted in the primary transfer blockchain pilot. In this phase the PropTech firm protected their interest of wanting to earn a profit and subsequently exited the project. The pilot project presents itself as being trapped between the network and coalition phases, this signals a failure of innovation, see figure 12 below.

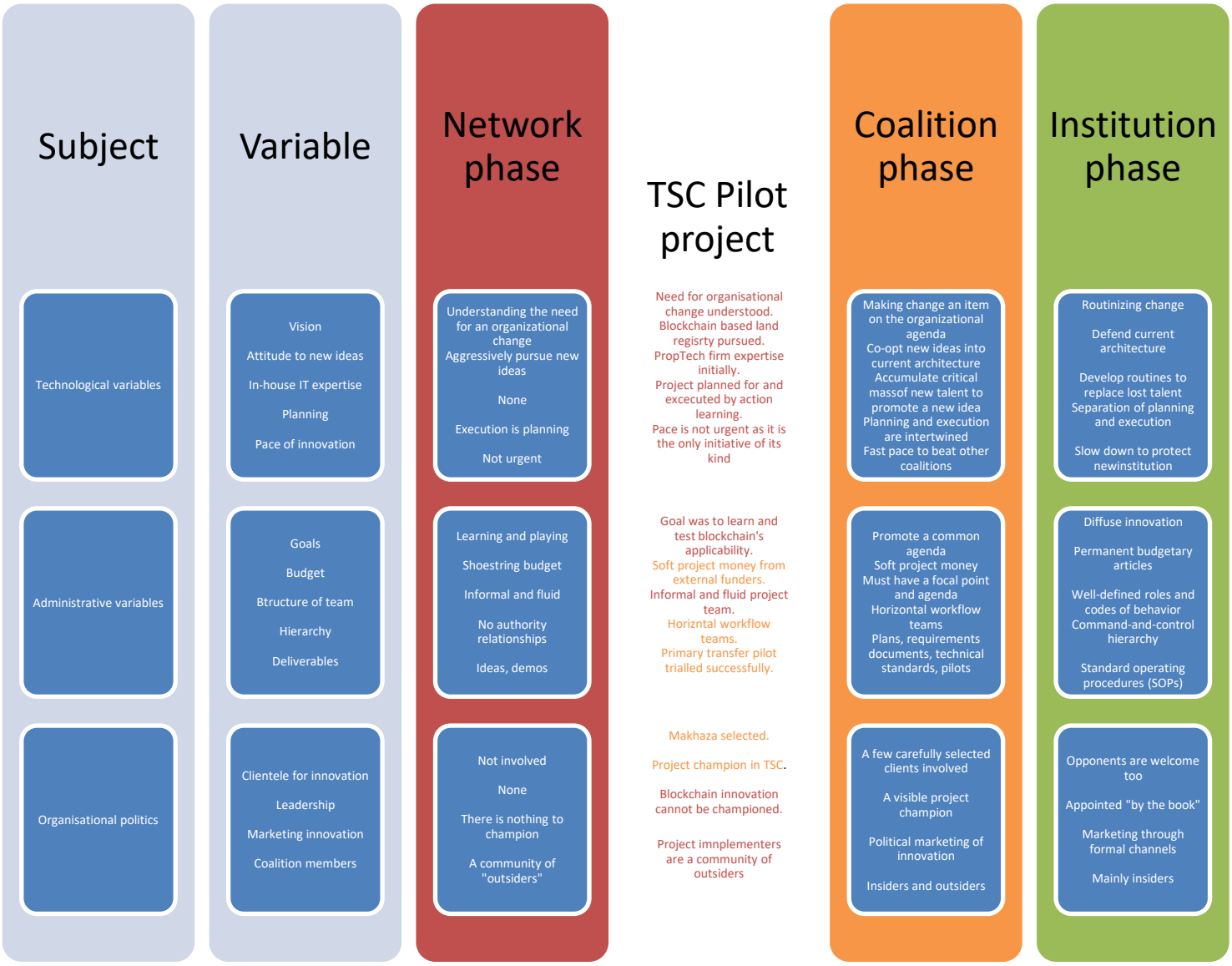
A PPP could not be established as the project did not work directly with the Deed's registry, rather it worked with the city, and even here no formal MOU was signed. This signals the lack of a contractual agreement between the pilot project organisations and the public sector. The case study had a similar issue to the Honduran blockchain project, where the PPP could not be established successfully due to the misalignment of interest between the Honduran government, who wanted to keep the project under wraps, and the private partner who sought to advertise the project (Benbunan-Fich and Castellanos, 2018). The pilot project saw the PropTech firm seeking a profit while the other organisations wanted to keep the project a non-for-profit process. The absence of formal agreements such as MOUs and PPPs are an administrative variable which can be influenced by organisational politics. The contractual agreement would outline the structure of the team, its hierarchy, and project deliverables.

A mechanism for dealing with the misalignment of interests and resistance from the PropTech firm due to the conflict was needed to prevent the PropTech from exiting and retaining blockchain expertise. The misalignment of interests forms part of organisational politics as a coalition member was lost. Additionally, digital data was mostly available for the primary transfer pilot, which was successful, whereas walk-in clients to the TPX had paper-based documentation which needed to be verified. This is a time-consuming process and required data gathering on the ground of the housing development by going door-to-door. The digital data from the primary transfer project, however, was not reliable as version control on the various spreadsheets emanating from the organisations involved (the city, provincial authorities, the project team, and the conveyancer), remained a problem. This is similar to the Honduran project where lack of digitized paper records to move onto the blockchain contributed to this project's failure (Benbunan-Fich and Castellanos, 2018). Data quality is

emphasised as a key success factor contributing to the Georgian project (Shang and Price, 2019). This is a technological and administrative variable as paper-based land registration data will need to be digitized, and once digitized it will have to be maintained and kept up to date.

As per figure 12 below, the pilot project was analysed in terms of the theoretical framework. The pilot project shares parts of the network and coalition phases, with the network phase related explanations in red and the coalition related explanations in orange. These reasons for the lack of implementation also represent factors that would contribute to the successful implementation of a blockchain based land registry if they were addressed.

Figure 14 – Pilot project and theoretical framework.



5.2.3 Factors that would contribute to the successful implementation of a blockchain based land registry.

The following issues contributed to the unsuccessful implementation of the blockchain technology in the case study. First was the misalignment of interests between the PropTech firm and NPO & research consultancy which resulted in the loss of the PropTech firm and their blockchain expertise from the project due to this conflict. This can be classified firstly under resource and cost related issues as it represents the lack of a shared understanding barrier, and secondly as a technological hurdle with the loss of blockchain expertise a barrier. Second is that no MOU or PPP was signed with any public sector organisations, only a working relationship with the city was established, preventing the project from being scaled up. This is classified as a regulatory and legal challenges as legal framework could not be established. The third issue is a data problem relating to the manual door-to-door process of collecting data to verify claims as well as the unreliable versions of spreadsheet data emanating from the parties of the housing project team. This represents a technological hurdle due to the data quality barrier. These issues manifest themselves in the barriers to blockchain technology adoption, which were outlined in literature review and used to code the interview data into themes. These themes represent the factors which need to be addressed in the successful digitization of the land registry and property transactions. Below is a table outlining the factors, barriers they include, how these barriers manifest themselves and their classification in terms of the theoretical framework, the table is explained thereafter:

Table 16: Factors contributing to the successful implementation of a blockchain based land registry.

Factor	Barrier to adoption	How barriers manifest themselves	Peled's theoretical framework classification
Regulatory and Legal Challenges	Establishment of a legal framework Informal or off-register transactions Lack of digital data Validating claims to property ownership	These include the limits imposed by the current laws and policies in place relating to property ownership and the paper-based transfer process, contractual agreements between the organizations involved in the pilot project, as well as the difficulty in formalisation of informal property transactions	Administrative and technological variable influenced by organizational politics
Organizational and Cultural Barriers	Interdepartmental co-ordination and communication Organizational structure, practices, and culture Redesign of organisational or business processes Resistance to change Quality of leadership	Relates to the lack of adequate communication in the property transaction process between the government departments involved, the different deeds registry offices and the city. A formalised understanding between the city and pilot project implementers is required. Cultural barriers include the slow change expected when digitizing the deeds registry processes and the strong leadership required	Organizational politics
Technological Hurdles	Data quality Technological barriers (flexibility, security, and scalability) Technological expertise Weak IT infrastructure	Having accurate, validated, and up-to-date data loaded on the land registration system. Government departments not having accurate information on their housing projects compromise data quality. The choice of technology for land registration and how it is employed as alternatives to blockchain technology exist. In the deed's registry, are the manual or paper-based components and a lack of blockchain expertise	Technological variable
Resource and Cost-Related Issues	Financial cost and resource allocation Information security and privacy Insufficient time for understanding and implementation Lack of shared understanding	The cost of registration for housing beneficiaries is too expensive. There is a lack of publicly available funds for new systems (and their maintenance). Non-for-profit strategies are not in everyone's best interest. A time related barrier comes in the form of the delay in issuing of title deeds for housing project beneficiaries. A gap between the vision of donors and the vision of the problem on the ground in the pilot project represent a barrier.	Administrative variables influenced by organisational politics
Political and Social Factors	Political will	The will of government to participate in pilot projects as well as the will of leadership to support these projects and the resolution of ownership disputes.	Organisational politics
Trust and Acceptance	Lack of trust between implementers and users Acceptance or commitment to change from all role players	A deficit of trust between government, beneficiaries and the blockchain technology itself, will need to be overcome. The acceptance of change from untrusting local leaders and residents also needs to be surmounted	Organisational politics

The most significant factor to adoption for South Africa's land registry are regulatory and legal challenges. This encompasses the limits imposed by the current laws and policies in place relating to property ownership and the paper-based transfer process, contractual agreements between the organizations involved in the pilot project, as well as the difficulty in formalisation of informal property transactions. This barrier is substantiated in literature, as the absence or lack of a legal or policy framework and regulations for technology adoption, which hinders effective governance and implementation of a chosen technology (Alshehri and Drew, 2012; Ismail, 2013; Batubara, Ubacht and Janssen, 2018; Cinar, Trott and Simms, 2019).

The contractual dispute regarding ownership of IP between the NPO, research consultancy and PropTech firm represents a legal challenge, which resulted in the parting of ways between the other pilot project entities and the PropTech firm. A PPP was never signed as the project was unable to reach that stage due to the exit of the PropTech firm from the project. Legal, policy and regulatory challenges include the legality of electronic property transactions, restrictive sales clauses, current transaction requirements (signed deed of sale, multiple documents and need for a conveyancer), when the Electronic Deeds Registration Systems Act 19 will be implemented, as well as informal or off-register transactional disputes. This barrier can be represented as an administrative and technological variable which is influenced by organizational politics when viewed through the theoretical framework.

Organizational and cultural barriers are the second most significant factor, also represented under organizational politics. This barrier relates to firstly, the lack of adequate communication in the property transaction process between the government departments involved, the different deeds registry offices and the city. Secondly, a formalised understanding between the city and pilot project implementers is required, especially in a sometimes corrupt and often overburdened public administration. Cultural barriers include the slow change expected when digitizing the deeds registry processes and the strong leadership required for such a huge task.

The pilot project had no Memorandum of Understanding (MOU) signed with City of Cape town, only a working relationship was established. The pilot is also not connected directly to the Deed's registry, it only facilitates registration for TPX clients. A formal working relationship and cooperation between all parties involved is crucial, from the city to the PropTech firm and Deed's registry.

Literature shows us that poor communication, coordination and information sharing between departments or organizations are a barrier to technology adoption organizations (Beaumaster, 1999; Allen, Kern and Havenhand, 2002; Ebrahim and Irani, 2005; Alshehri and Drew, 2012; Nwakanma *et al.*, 2013a; Cinar, Trott and Simms, 2019; Wang *et al.*, 2020). Additionally, redesigning organizational/business processes poses a challenge to technology adopters (Beaumaster, 1999; Allen, Kern and Havenhand, 2002; Ebrahim and Irani, 2005; Nwakanma *et al.*, 2013a), as would be the case in a fully digital property transaction process and registry. Some entities may resist new technology due to professional culture or potential changes in roles (Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019; Bjerke-Busch and Aspelund, 2021), this is a risk especially for conveyancers. The quality of leadership in organizations involved, a lack of a shared understanding of goals and strategy, as well as organizational structures and practices, all influence technology adoption (Cinar, Trott and Simms, 2019; Bjerke-Busch and Aspelund, 2021).

Technological hurdles are the third most significant factor, which also needs to be overcome for successful adoption. Hurdles such as having accurate, validated, and up-to-date data loaded on the land registration system, and the government departments not having accurate information on their housing projects, compromise data quality. The choice of technology for land registration and how it is employed also represents a factor as alternatives to blockchain technology exist. A further barrier technologically in the deed's registry, are the manual or paper-based components and lack of blockchain expertise. The lack of technological skills or expertise at various levels are a barrier to technology adoption (Beaumaster, 1999; Ebrahim and Irani, 2005; Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019; Wang *et al.*, 2020; Atique *et al.*, 2021; Bjerke-Busch and Aspelund, 2021). Weak IT infrastructure is another technological barrier identified in literature which is relevant to the findings (Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019).

When viewed through the theoretical framework, this factor is classified as a technological variable. The lack of blockchain expertise, lack of digital data and current paper-based processes at the Deed's registry indicate that IS readiness is low. It will be easier to enter new data onto blockchain system as seen in the primary transfer pilot, this is quicker than converting existing titles from walk-in clients at the TPX. Major parts of South Africa have a formal and developed property market with much information being paper-based and some data already digitized in major cities by the city administration and private companies e.g., Windeed or Lexis Convey. Paper-based title deeds will need to be digitized. IS readiness in these "first economy" property markets are much better as

information is already digitized. Here all the titles could be moved onto the blockchain in two processes, one where existing title deeds are added to the blockchain for properties with already digitized information and another process where titles currently forming part of a transaction are placed on the blockchain as that transaction is completed.

Digitization by two processes could strain resource and cost-related issues, which are the fourth most significant factor to blockchain adoption. Resources such as time and money represent a barrier to adoption, as the cost of registration for housing beneficiaries is too expensive, there is a lack of publicly available funds for new systems (and their maintenance), and non-for-profit strategies are not in everyone's best interest. A time related barrier comes in the form of the delay in issuing of title deeds for housing project beneficiaries, while the physical resource of the technology employed must be secure and be trusted by users. Also, a gap between the vision of donors and the vision of the problem on the ground in the pilot project represent a barrier to adoption.

From literature we find that insufficient funding and a lack of available resources for are a barrier to technology adoption (Beaumaster, 1999; Allen, Kern and Havenhand, 2002; Ebrahim and Irani, 2005; Alshehri and Drew, 2012; Nwakanma *et al.*, 2013a; Cinar, Trott and Simms, 2019; Wang *et al.*, 2020; Bjerke-Busch and Aspelund, 2021). Insufficient time to understand and implement a new technology are a further barrier (Cinar, Trott and Simms, 2019; Wang *et al.*, 2020) along with the lack of a shared understanding of goals and strategy (Cinar, Trott and Simms, 2019; Bjerke-Busch and Aspelund, 2021).

Resource and cost-related issues are classified as administrative variables influenced by organisational politics when viewed through the theoretical framework. The pilot project was funded from private sector donors, not the government. The non-profit strategy or conditions of funding to the NPO in direct opposition to the PropTech firm’s goal of making a profit. A mechanism for dealing with a contractual and strategic conflict was needed, to prevent the PropTech firm from exiting and to retain blockchain expertise.

The will of government to participate in pilot projects as well as the will of leadership to support these projects and the resolution of ownership disputes form part of the second to last significant factor. This is represented by political and social barriers. From literature it is noted that, due to the complexities of tenure issues and an emphasis on land redistribution, several governments in Southern Africa have neglected tenure reform (Adams, Sibanda and Turner, 1999), this represents a

lack of will from governments regarding these initiatives. Land tenure reform should be based on a detailed understanding of the intended beneficiaries' livelihood plans.

This barrier is classified under organisational politics when analysed through the theoretical framework. According to the Centre for Housing Finance (CAHF), the South African government has built approximately 3 million RDP (Reconstruction and Development Programme) houses, of which only 1.9 million houses have been registered formally, while The national Department of Human Settlements, Water and Sanitation (NDHSWS) approximates the title deed backlog for RDP houses constructed preceding 2014 is 511,752 (Green, Viruly, and Moghayedi, 2022). State-subsidized housing was a major political bone of contention, however now that these houses have been built in South Africa, delivering title deeds to housing beneficiaries does not seem to have the same significance. The title deed backlog is a major cause of off-register transactions. The pilot project requires political will to be scaled up. This title deed backlog for state-subsidized houses is a unique problem to South Africa as it shows that this problem is worse in South Africa when compared to similar land registration systems elsewhere.

Similarly, for the project to be scaled up there is a need for trust and acceptance. This final significant factor includes issues such as a deficit of trust between government, beneficiaries and the blockchain technology itself, that will need to be overcome. The acceptance of change from untrusting local leaders and residents also needs to be surmounted. Literature has shown that trust issues existing between users and the public sector and among decision-makers within organizations represent a barrier to technology adoption (Alshehri and Drew, 2012; Cinar, Trott and Simms, 2019; Atique *et al.*, 2021; Bjerke-Busch and Aspelund, 2021). While the successful adoption of a technology requires commitment and acceptance from all involved in the land registration process (Ismail, 2013; Batubara, Ubacht and Janssen, 2018).

This factor can be classified under organisational politics in terms of the theoretical framework utilized. Implementers and users must trust the system. In the project, the blockchain technology was trusted, but the implementers (PropTech firm) did not trust the NPO and research consultancy to champion their interest of turning a profit. Users or clients did trust the technology, as through the primary transfer project all the title deeds were delivered, and walk-in clients continue to receive their title deeds. Blockchain technology and its advantages were not marketed to the beneficiaries, instead the TPX’s focus was on formalising transactions and delivering clients their title deeds so

they are able to defend their tenure over time. Just as the pilot project had limiting factors, this study similarly confronted several limitations explained below.

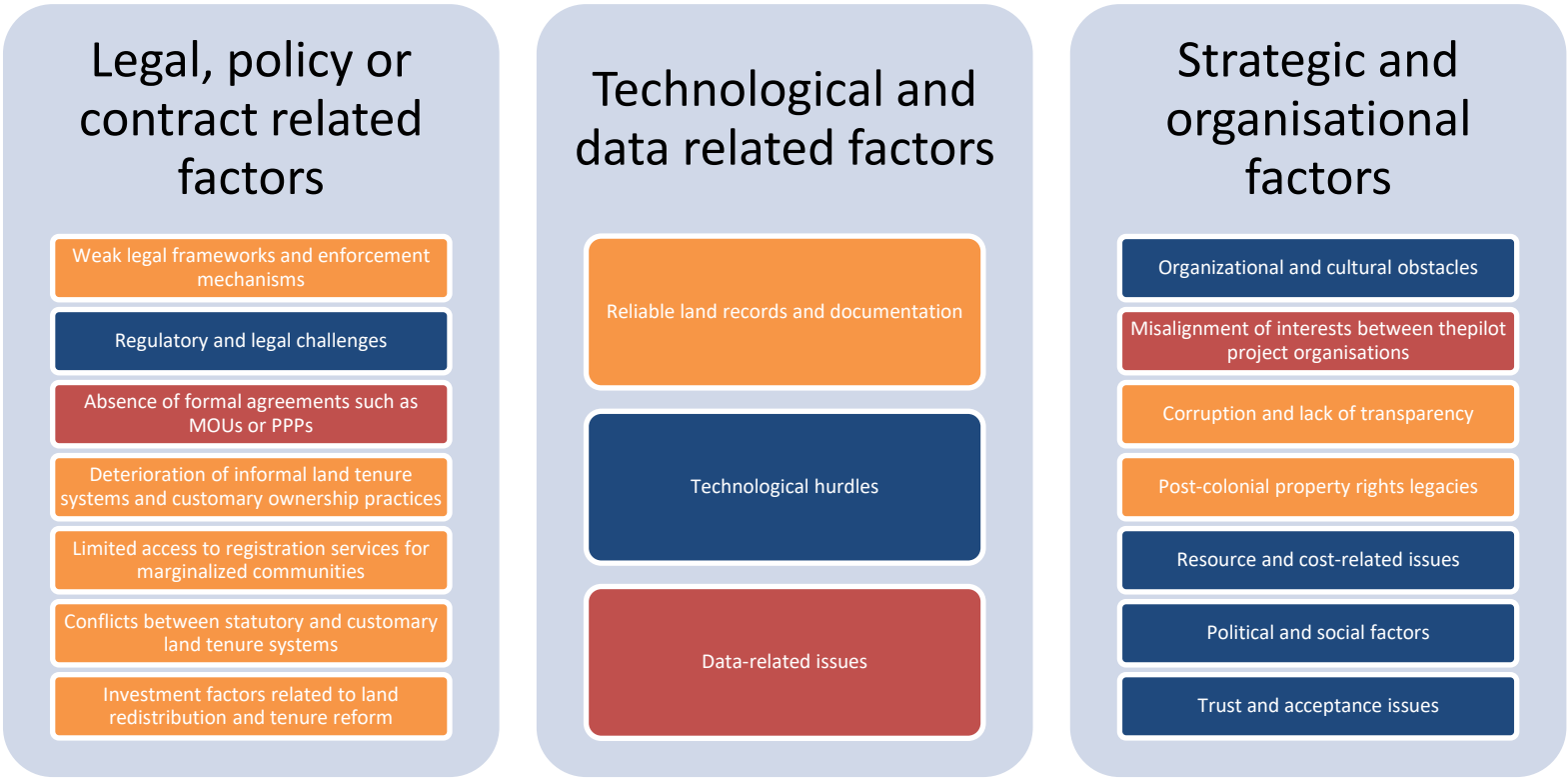
5.3 Implications and recommendations of the study

In addressing the implications and recommendations of the study, the findings from both the systematic literature review, the interviews and case study were analysed together. The factors identified and challenges found in literature were grouped together based on shared characteristics and their relationship to theoretical framework. This resulted in three key areas relating to the aim of the study or investigating the potential use of blockchain technology to digitize land registration in South Africa. In investigating the potential use of the technology, the findings that were grouped together, form factors which indicate readiness for blockchain technology, these were derived based on their shared characteristics.

5.3.1 Implications

From the figure 13 below, these readiness indicating factors (legal, policy or contract related factors, technological and data related factors, as well as strategic and organisational factors) can be monitored individually based on the barrier to adoption (in dark blue boxes), land registration challenge (in orange boxes) or factors contributing to unsuccessful implementation (in red boxes), to assess South Africa's readiness ready to use blockchain technology to digitize its land registry.

Figure 15 Factors that can be used to evaluate the readiness of South Africa being ready to use blockchain technology to digitize its land registry.



Legal, policy or contract related factors.

This factor begins with regulatory and legal challenges. The lack of adequate policy and laws in South Africa to enable affordable, accessible, and electronic land registration results in residential property market failure for state-subsidized housing. It also results in paper-based processes and off-register or informal transactions. These challenges are worsened by weak legal frameworks and enforcement mechanisms. Communal and private land rights become nothing more than words on a document when their legal standing is not recognized or enforced. The lack of adequate enforcement from government has resulted in hybrid governance systems assuming the responsibility of recognizing and enforcing property rights. The lack of clarity with regards to the policies and laws applicable, further deepen misunderstandings and distrust of the government, resulting in another reason for beneficiaries or citizens to transact informally. In relation to the case study, the pilot project showed that the absence of formal contractual agreements such as MOUs or PPPs limits the working relationship and scalability of the blockchain property registry initiative.

Limited access to registration services for marginalized communities also form part of this factor. Citizens who are unable to access formal land registration services are at risk of their tenure being challenged without formal recourse. Lack of affordability also increases the risk of informal or off-register transactions. Law and policy influence investment factors related to land redistribution and tenure reform. These relate to the various steps a government can take to encourage investment, such as inputs, loans, extension services, and functioning markets. The combination and performance of these factors together allow for land reform, redistribution, and registration/titling initiatives to fully achieve their goals. As numerous studies conducted in South Africa and globally have demonstrated, the case investigations do not endorse the straightforward notion that private property and titling initiatives alone result in economic advantages for impoverished populations (Barry and Whittal, 2016).

The deterioration of informal land tenure systems and customary ownership practices is an issue of policy and law. This results in uncertainty, cloudy titles, political conflicts as well as reduced investment. Not all citizens prefer individual ownership, however. Some prefer communal ownership to prevent conflicts and reduce title maintenance costs. The weakening of informal land practices also means that formalising informal settlements into state-subsidized housing projects risks conflicts and confrontations between local leaders, amongst themselves, and with authorities. This change in tenure causes conflicts between statutory and customary land tenure systems. The implication of this conflict is that hybrid governance systems may be unavoidable in certain circumstances e.g., formalising an informal settlement into a housing project. As land titles may be allocated individually the hybrid governance system previously present in the informal settlement may manifest itself in the housing development. Formalisation of land rights may result in a trade-off, as it takes one individual's dead asset and transforms it into another's active asset.

Technological and data related factors.

A lack of technological expertise especially when implementing new systems represent a huge limitation for government. Blockchain is one type of DLT, and alternatives do exist, the appropriate choice of technology will depend on what the systems requirements are. Regardless of the system, it is only as good as the data that it processes. Hence having accurate and digital data (validated claims of ownership) is even more important than they type of technology employed. Validation of ownership claims also comes with the need for dispute resolution. These hurdles may also lead to

partial or unsuccessful adoption. The implication of data related issues from the case study show that significant amounts of time and resources are spent verifying land registration data, and that data quickly becomes unreliable as people's circumstances change and transactions occur. Without reliable land records and documentation further informal or invalid transaction can take place. Resulting in tenure insecurity for owners. Further the city needs accurate information to correctly bill, plan and provide adequate bulk services to those properties.

Strategic and organisational factors

This factor begins with resource and cost-related issues. Insufficient funds and the proper allocation of existing funds from government influence their different department's ability to build and implement new systems for land registration. Funds are also required to maintain any new systems that are implemented for property transactions. For citizens or beneficiaries of state-subsidized housing the monetary cost of registration is currently a barrier to formalized transactions, see the various charges outlined in section 4.3.8.1. Profit is a significant motivator for PropTech firms and third-party providers to government, and the lack of a profit-making strategy or goal works against their interests. This misalignment of interests resulted in the loss of the blockchain expertise as the PropTech firm exited from the pilot project.

Related to organisations, the lack of communication and working together of different government departments directly affects individuals wanting to transfer property. This is because these departments all share information and workflows, to the property transaction. When some entities processing the transaction have inaccurate information or follow different processes, then the buyer, beneficiary and/or seller is at risk of an invalid transaction. A further implication is that these public sector entities may resist innovations as they may have their work tasks or roles being changed. Failure to address organizational and cultural barriers can lead to delayed adoption and inefficiencies. Resistance to change can result in missed opportunities for improving land registry systems and hinder the realization of benefits associated with blockchain adoption.

The acceptance of change from all role players in a property transaction is crucial as without it blockchain technology cannot be adopted wholistically. Some factions may work against its implementation if it is not in their best interest. State subsidized housing beneficiaries must trust the government to be able to deliver on their promises, a deficit of trust can be worsened when state-subsidized housing initiative processes are corrupt or do not lead to the desired outcome for

applicants. Local area leaders must also trust the formalization process, as without trust, violence and intimidation may be unavoidable. Blockchain technology must also be trusted by its implementers, the PropTech firm might trust the technology, but the decision makers within government and the deed's registry might not.

A lack of political will to support land titling initiatives and the resolution of ownership disputes will further widen the gap between the "first-economy" or formalized property markets and the "second economy" or informal property markets. This results in insecure tenure and eventually market failure for the less developed markets. Ignoring political and social factors can lead to resistance from stakeholders, regulatory hurdles, and public mistrust, which can hinder the adoption of blockchain in land registration.

Another issue for organizations is corruption and lack of transparency, the implications of this in land registration are legal transfer issues and land fraud. A large enabler of corruption and lack of transparency is the legacy of post-colonial customary property rights. Customary ownership, its related institutions, policy, and laws are outdated, with some a legacy of the apartheid administration. These laws, policies and institutions need to be reviewed and upgraded based on today's circumstances and needs.

5.3.2 Recommendations

Legal, policy or contract related factors.

The laws and policies relating to land registration and property transactions need to be revised to increase access, make the process less costly, burdensome, and time-consuming. The types and formats of documentation required by law could also be revised. Additionally specific clauses such as the restrictive sales clause need to be repealed as they increase informal transactions. The Electronic Deeds Registration Systems Act outlines a foundation for an Electronic Deeds Registration System (e-DRS) which paves the way for property transactions to be executed electronically. However, the reasons why this act has not been implemented should also be an urgent research priority.

Similarly, the absence of formal agreements such as MOUs, PPPs or comparable contractual agreements between the case study organisations and public sector prevent the scaling up of the blockchain based land registry. A proper formalised working relationship needs to be established

either with the city or the Deeds registry. The study conducted by (Ameyaw and de Vries, 2021) recommends that a legal foundation for PPP be established to ensure blockchain experts of a permanent position in the land market.

Limited access to registration services for marginalized communities is a result of the current laws and policies in place. Regarding state subsidized housing projects in South Africa, the following suggestions are made. Simply reducing transaction costs, altering tenure forms, or changing record-keeping methods would be exceedingly crude responses. Possible ways to enhance current circumstances involve prolonging and replicating educational programs, providing support in drafting wills, offering support for local-level land tenure administration, and aiding in estate management and property rights conveyancing (Barry and Whittal, 2016).

Also, a product of the current laws and policies in place are investment factors related to land redistribution and tenure reform. It is recommended that governments view land registration as one of several significant tools to achieve land reform or redistribution initiatives. Greater priority should be given to addressing the needs of local investors. This approach should also ultimately attract foreign investment since foreign direct investment is more likely to be drawn to evidence of a robust domestic economic activity (Toulmin, 2009).

The deterioration of informal land tenure systems and customary ownership practices is also legal and policy factor. Customary land tenure laws, policy, regulation, and systems need to be urgently revised so that these institutions are not weakened further. Strong customary tenure institutions could then attract investment and protect citizens who reside on communal land. Support and oversight of informal and customary institutions is a necessity to ensure people are treated fairly and the systems are not abused by powerful actors for personal gain. Blockchain technology may aid this process as a single block (representing land information) can be split into multiple parts, allowing for funds to be raised or shares to be distributed, like the issuing of cryptocurrencies through an ICO (Initial Coin Offering), where a bitcoin block is split between numerous buyers at differing prices.

Conflicts between statutory and customary land tenure systems sometimes result in hybrid governance systems which include street committees or other civic organisations. According to (Barry, 2020), if the involvement of non-state entities in tenure administration is unavoidable, it would be ideal for the state to find ways to cooperate with them, potentially through intermediaries. Hybrid governance systems could be formalized into rate-payers associations in state-subsidized

housing projects to properly recognize residents' issues. This research recommends that the responsibility of creating and maintaining the registry itself could be decentralized away from the Deeds registry to the city/municipality or even further. This is possible so long as the citizens trust the entity administrating the system and it is legally permissible. Blockchain technology is applicable here as one of its key principles is decentralization.

With regards to informal or customary land it is more effective to focus on bolstering current social practises that have widespread legitimacy, rather than on costly alternatives that aim to replace them (Cousins *et al.*, 2005). The policy suggestion here is that African governments ought to prioritize strengthening traditional landholding institutions through support and empowerment, instead of attempting to replace them. This hinges on good governance and demands political commitment from governments (Abdulai, 2006). A practical approach should also be taken when formalising customary land or informal settlements to firstly evaluate if individual tenure is the best option and secondly if it is, to deal with the trade-off between transforming one individual's dead asset into another's active asset. While tenure reform remains needed and significant, it should be recognized that the intricacy of multiple informal tenures within the "extra-legal" sector differs fundamentally from Western capitalism's individualized, exclusive private property systems (Toulmin, 2009).

Technological and data related factors.

In the early stages of land registration projects, affordable methods are still relatively new, so it is advisable to adopt a pilot approach, coupled with thorough observation and impact assessments, prior to considering expansion (Benjaminsen *et al.*, 2009). While a single unified system might be a sensible long-term objective, it could be more practical to establish locally customized processes that can be progressively improved (Toulmin, 2009). Once more, blockchain's attribute of decentralization is applicable in this recommendation. The existing paper-based land registration system in South Africa will need to coexist with an electronic system, as an immediate transition to a fully electronic system would be impractical (Shange, 2010). The reorganization of the land transfer system in an age dominated by information and communication technology entails the harmonization of strategic goals with operational processes (Tembo, Nkwae and Kampamba, 2014).

Governments must compensate for a lack of blockchain or technological expertise by partnering with PropTech firms, possible through a PPP. For an innovation to have the desired impact, the remaining paper-based systems or information need to be digitized. This information must also be validated,

especially when dealing with informal or off-register transactions in state-subsidized housing. Once validated the information needs to be kept up to date on the system employed. It is recommended that this validation happens as soon as possible. This is due to people's circumstances are constantly changing, resulting in additional layers to the informal transaction that have already taken place. The need for accurate, recorded claims to ownership starting at a particular time point in time is crucial to scaling up any digital property registry. Once verified, this information must be shared with the city and other government departments who are reliant on this information for their functioning and verification procedures. What is necessary is that the parties keep their affairs up to date. If alternative registration systems are under consideration as a policy option, a critical question is how much uncertainty or fraud would be tolerable and how these issues would be addressed (Barry and Roux, 2013).

Ownership disputes and the title deed backlog need to be a priority for government with regards to state-subsidized housing to get accurate, recorded claims to ownership starting at a particular time point in time. The necessary provisions and resources must be made available by government through the Land Titles Adjustment Act 111 of 1993. This involves a commissioner facilitating the regularization of the title and its registration under the names of the de facto owners. Nevertheless, this approach is characterized by inefficiencies and substantial costs (Barry and Roux, 2013; Barry, 2020). Land tenure security performs a critical role in many development strategies as it provides the necessary stability for these strategies to thrive. Consequently, a substantial portion of data collection and information management efforts should be directed towards ensuring security and fairness within the land tenure system (Barry and Rüther, 2005).

Blockchain technology is able to ensure immutability and security of information but it cannot be a replacement for the established infrastructure and institutions which are crucial for guaranteeing data quality (Shang and Price, 2019). To ensure that management information remains accurate and up-to-date, initial settlement censuses and mapping should be followed by frequent, cost-effective, and rapid data collection in both formal and informal housing settlements (Barry and Rüther, 2005), data should be collected electronically where it is possible and legally permissible.

Strategic and organisational factors

This factor begins with resource and cost-related recommendations. More funds should be allocated to the deeds registry to implement a blockchain based land registry, alternatively the funds can be

allocated to municipalities who can then create their own property registries akin to the pilot project. The costs of land registration and conveyancers' fees need to be lowered (via subsidy or changes in law or policy) to enable low-income or unemployed beneficiaries to access formal property transaction services. Relating to time, the gap between beneficiaries taking occupation and them receiving a title deed (primary transfer) needs to be eliminated completely. This can help reduce further layers of informal transactions and enable an accurate recording of ownership at the time of occupation. To address resource and cost-related issues, organizations should conduct thorough cost-benefit analyses, explore cost-sharing models, and seek funding opportunities. Collaboration with government agencies or international organizations can also help alleviate financial burdens.

From the misalignment of interests between the pilot project organisations, the following recommendations are made. The interests of each party to the pilot project must align so that they share common goals and strategies. The parties must come together and make their interests known to each other when deliberating the way forward, as a misalignment of interests can result in the loss of critical blockchain technological skills. One of the key success factors contributed to the Georgian project was blockchain education. For successful implementation it is essential that every stakeholder be knowledgeable in blockchain technology (Shang and Price, 2019).

To address organizational and cultural barriers, organizations should invest in change management strategies, employee training, and education programs. Encouraging a culture of innovation and openness to new technologies can facilitate the adoption process. The public and private sector entities that deal with land registration and property transactions must come together to set national standards relating to the data and processes for property transfer. This would include the departments responsible for supplying state-subsidized housing not just the traditional entities (deeds registry, municipalities, conveyancers). This is so that primary transfer happens at the same time beneficiaries are given occupation of the house.

The post-apartheid government has undertaken the colossal task of providing indigent citizens with homes for free. While this is a notable achievement, the government has failed to prioritize the formalization of this home into an asset for the beneficiary. It is recommended that the government prioritizes the delivering of title deeds to beneficiaries so that their ownership can be formalized. This formalization will enable cities to plan and manage service delivery better, grow their tax base, allow for a functioning residential property market and, beneficiaries can then properly pass down

their assets as well as protect their tenure. The results of formalisation from the case study point to an increase in property values once title deeds are received by beneficiaries.

Recommendations relating to trust and acceptance are as follows. To increase trust between government and beneficiaries it is important that engagement on formalization of titling happens transparently, and on the ground, where the trust is built by going door-to-door. For governments to trust the technology they must educate themselves on the technology and its capabilities to make sound judgement on the type of technology and PropTech firms selected to engage with. Broad discussion within government and the numerous departments involved in primary transfer of state-subsidized housing and general property transactions, must take place before systems are implemented or upgraded. This is to ensure that all departments involved agree on the new processes and requirements for transfer and any conflicts or disputes are identified and dealt with.

In relation to corruption and lack of transparency, proper oversight and visible communication and decision making from public sector entities is required. This is so fraud is reduced, and qualifying beneficiaries are allocated houses. The management of registered ownership is critical as part of a poverty reduction strategy. Transparent administration has played an important role in housing complexes with few off-register transactions (Barry, 2020). Post-colonial property rights legacies have left customary tenure vulnerable to corruption. Customary ownership, its related institutions, policy, and laws need to be reviewed and modified to induce a more favourable environment that will allow the assets potential to be realized.

5.4 Conclusion, contribution of study and further research

5.4.1 Conclusion

Land registration is complex with common land registration challenges existing between developing countries and South Africa. The following eight key challenges were identified as part of the first research objective. They are, reliable land records and documentation, the deterioration of informal land tenure systems and customary ownership practices, limited access to land registration services for marginalized communities, corruption and lack of transparency, weak legal frameworks and enforcement mechanisms, conflict between statutory and customary land tenure systems, post-colonial property rights legacy in former colonies, as well as investment factors relating to land redistribution and tenure reform. Even though these challenges may be similar to that of many

developing countries, the consequences for South Africa are distinctive because of the enduring legacy of Apartheid on land ownership. Hence these challenges have unique consequences for South Africa given the multiple tenure forms (statutory and customary tenure – where state ownership of land in the former homelands remains a legacy of apartheid era legislation), the legacy of ownership disparities based on race. This also includes the possible introduction of an e-DRS system, current land reform initiatives involving state-subsidized housing, and current debates surrounding land reform through expropriation without compensation.

The colonial and apartheid legal systems have methodically excluded Black Africans from owning land, have a broad legacy affecting the land ownership, security, and tenure of South Africans. In addition to these property ownership related inequalities South Africans must deal with an inefficient real estate transaction process. This is underscored by the South African government having built approximately 3 million state-subsidized houses, of which only 1.9 million have been registered formally, this is a distinctive challenge to the South African system when compared to other developing nations systems.

South Africa's current real estate purchasing process can be defined as inefficient, costly, long transaction times and susceptible to fraud. Blockchain technology presents a potential tool to overhaul South Africa's traditional land registry, improve other outdated real estate transaction systems and possibly enable wealth creation for its citizens. Blockchain is also identified as Distributed Ledger Technology (DLT) and can be described as a distributed, communal, encrypted database that serves as a permanent and incorruptible store of transactions or digital events among participating parties, blockchain can enable the transfer of assets or anything of value. The South African real estate economy, its assets and the transaction process could benefit from blockchain technology to address these inefficiencies.

Registering property in South Africa can be characterized by a high number of procedures – 7, long transaction time – 23 days and high costs which make up – 8% of the property's value. Despite these inefficiencies blockchain technology has not yet made an inroad into the land registration or transaction process. This raises the question as to why has blockchain technology not been implemented in South Africa's land registry? This question is raised with the aim of investigating the potential use of blockchain technology to digitize land registration in South Africa. Based on this analysis, the study concludes that South Africa cannot use blockchain technology to digitize its entire

land registry currently, due to the following factors. First is the effectiveness of laws, policies and contractual relationships between governments and third-party entities. Second is technological and data related factors, which relate to data quality and maintenance as well as blockchain education, expertise and overall IS readiness of entities involved in property transactions. Lastly strategic and organisational factors. These relate to interdepartmental communication, formalised contractual working agreements, the redesign of organisational or business processes, alignment of interests and strategies of parties involved, as well as levels of corruption and transparency. Centred on these factors, we can conclude that South Africa's land registry is not ready to implement blockchain technology for land registration purposes currently.

The fulfilment of the second and third research objectives through the qualitative case study interviews resulted in the following six factors being identified. These factors represent reasons why blockchain technology has not been adopted in South Africa's land registry, and what aspects would contribute to the successful implementation of a blockchain based land registry. They begin with regulatory and legal challenges, followed by organizational and cultural barriers, technological hurdles, resource and cost-related issues, political and social factors, and finally, trust and acceptance. Each of these factors represent several barriers to blockchain technology adoption. The most significant barriers to adoption are the establishment of a legal framework, followed by informal or off-register transactions, a lack of digital data, and validating claims to property ownership. The second most important barriers are interdepartmental co-ordination and communication, followed by organizational structure, practices, and cultural barriers and the redesign of organisational or business processes. The third most significant group of barriers to adoption are the barrier of data quality, followed by technological expertise and weak IT infrastructure barriers. The final important barriers are the financial cost and resource allocation barrier, political will, the lack of trust between implementers and user's barrier, as well as the acceptance or commitment to change from all role players.

Based on these findings several reasons why the blockchain technology was not adopted in the case study were identified. First is misalignment of interests between the PropTech firm and NPO & research consultancy which resulted in the loss of the PropTech firm and their blockchain expertise from the project due to this conflict. This can be classified firstly, under resource and cost related issues as it represents the lack of a shared understanding barrier, and secondly as a technological hurdle with the loss of blockchain expertise a barrier. Second is that no MOU or PPP was signed

with any public sector organisations, only a working relationship with the city was established, preventing the project from being scaled up. This is classified as a regulatory and legal challenges as legal framework could not be established.

The third reasons why the blockchain technology was not adopted in the case study is a data problem, relating to the manual door-to-door process of collecting data to verify claims as well as the unreliable versions of spreadsheet data emanating from the parties of the housing project team. This represents a technological hurdle due to the data quality barrier. Last and most important, is a legal barrier as electronic transactions are not yet recognized and courts only recognize transactions involving a conveyancer, a valid sale agreement and title deed. These impediments encountered are the factors and barriers which need to be overcome in contributing to the successful implementation of a blockchain based land registry in South Africa if the case study was scaled up.

Based on the case study, every change in business processes in the public sector needs a mix of technological expertise, infrastructure that is ready, and resistance-overcoming procedures. The innovation can only work if the primary records of data and infrastructure are prepared for change, and if all participants cooperate, including ways to counteract pushback from entrenched interests. All these elements form part of technological variables, administrative variables, and organisational politics per Peled's theoretical framework utilized in analysing the findings. Together these elements are required to function cohesively for the effective transition of the pilot project from the network phase to the coalition phase and constitute a technological innovation in the public sector.

The primary research question asks, how can blockchain technology be used to digitize the land registry? The blockchain pilot case study sought to explore how technology could be used to enable the process of transfer from the city to the beneficiary, and it has successfully been able to resolve cases and initiate primary transfer. However, exit of the PropTech firm from the case study means that the blockchain registry cannot be developed any further. This represents a failure of innovation in terms of championing blockchain DLT for the functioning of a property or land registry according to Peled's theoretical framework.

Despite this clear problem, the project did manage to create a "pseudo title deed" which can be shared with the city and is an administratively visible and bankable record which has the potential to resurrect the previously dead capital. The most important value add of the blockchain is a secure place to store property transaction documents and the title deed. Thus, South Africa's deeds registry

could utilize blockchain technology as a secure data store in state-subsidized housing developments, as this asset class is uniform and already has a need for primary registration. The Deed's registry could use state-subsidized housing developments to pilot the use of blockchain technology for the e-DRS system proposed by the Electronic Deeds Registration Systems Act to enable electronic or digital land transactions.

A key limitation to this study was the unwillingness of a key stakeholder to participate in the interview process nevertheless, some of their perspectives were uncovered in secondary data. However, this study outlines several implications and recommendations relating to blockchain technology adoption for land registration in South Africa for, legal, policy or contract related factors, technological and data related factors, as well as strategic and organisational factors. This study is important as land registration through land registries documents property rights and exalt internal confidence among individuals, businesses, and the government, by undertaking this responsibility, they assist countries in preserving stability inside their borders and their economic expansion into the rest of the world. Therefore, the study finds that for South Africa to adopt blockchain technology in its land registry system, the common land registration challenges need to be surmounted, barriers to blockchain implementation overcome, and factors contributing to previous unsuccessful attempts mitigated.

5.4.2 Contribution and further research

This research contributes to knowledge by being the first study investigating the reasons why blockchain technology has not been adopted for land registration in South Africa. The study also identifies factors that are critical to the implementation and scaling up of a blockchain based property registry. This research complements existing literature by producing research founded on practical experiences which implemented blockchain technology for land registration to the existing body of knowledge in the land registration and blockchain technology fields. Second, the knowledge gathered from this study may aid in the design and implementation of land registration systems to better serve the people who would benefit from land titling programmes. Third, it improves the government's understanding of property transfers in state-subsidized housing developments.

In general, the study adds to the understanding of land tenure in the developing world, with various implications and recommendations made, which provide insight for legislation and policy development. This research also outlines a way for South Africa's Deeds Registry to implement

blockchain technology in state-subsidized housing developments. More blockchain land registry pilot projects must be started and monitored, to see if blockchain technology represents an actual innovation as not all real estate market participants will accept blockchain technology (Veuger, 2020). Further research in other developing nations is required in creating a framework to evaluate the preparedness of land management and land administration systems for blockchain consideration in developing land markets (Ameyaw and de Vries, 2021). Future research is also required when blockchain is applied to nations that have multiple land tenure systems (Ameyaw and de Vries, 2021).

Future research must analyse blockchain initiatives for land registration in other countries to view which barriers to adoption were overcome and how they were overcome. How the technology was implemented, what problems it was able to address successfully, with the context of these issues must also be investigated. More blockchain pilot projects must be initiated as the primary transfer pilot shows promise to address the state-subsidized housing title deed backlog in South Africa.

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Annexure A: Differences between network, coalition, and institution

Subject	Variable	Network phase	Coalition phase	Institution phase
Technological variables	Vision	Understanding the need for an organizational change	Making change an item on the organizational agenda	Routinizing change
	Attitude to new ideas	Aggressively pursue new ideas	Co-opt new ideas into current architecture	Defend current architecture
	In-house IT expertise	None	Accumulate critical mass of new talent to promote a new idea	Develop routines to replace lost talent
	Planning	Execution is planning	Planning and execution are intertwined	Separation of planning and execution
	Pace of innovation	Not urgent	Fast pace to beat other coalitions	Slow down to protect new institution
Administrative variables	Goals	Learning and playing	Promote a common agenda	Diffuse innovation
	Budget	Shoestring budget	Soft project money	Permanent budgetary articles
	Structure of team	Informal and fluid	Must have a focal point and agenda	Well-defined roles and codes of behavior
	Hierarchy	No authority relationships	Horizontal workflow teams	Command-and-control hierarchy
	Deliverables	Ideas, demos	Plans, requirements documents, technical standards, pilots	Standard operating procedures (SOPs)
Organizational politics	Clientele for innovation	Not involved	A few carefully selected clients involved	Opponents are welcome too
	Leadership	None	A visible project champion	Appointed "by the book"
	Marketing innovation	There is nothing to champion	Political marketing of innovation	Marketing through formal channels
	Coalition members	A community of "outsiders"	Insiders and outsiders	Mainly insiders

(Peled, 2001)

Annexure B: Ethics clearance certificate

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SCHOOL OF CONSTRUCTION ECONOMICS AND MANAGEMENT RESEARCH ETHICS COMMITTEE

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER CEM-EC/02/23/DJ- 1113285**
PROJECT TITLE	An assessment of successful implementation of a blockchain based land registry in South Africa.
INVESTIGATOR	Deelan Jeram
SCHOOL/DEPARTMENT	**SCHOOL OF CONSTRUCTION ECONOMICS AND MANAGEMENT**
DATE CONSIDERED	March 17, 2023
DECISION OF THE COMMITTEE	Approved conditionally with respect to the declaration and attached feedback sheet
EXPIRY DATE	March 16, 2024
DATE	
CHAIRPERSON	Prof. Nthatisi Khatleli
cc: Supervisor:	Prof. Ehsan Saghatforoush

DECLARATION OF INVESTIGATOR (S)

To be completed in duplicate and **ONE COPY** emailed to the Postgraduate officer, Mrs K Alexander at katharine.alexander@wits.ac.za.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

Signature **Date** 22 / 03 / 2023

Annexure C: Participant information sheet, consent form, information sheet and interview protocol

Participant Information Sheet

This research is being strictly conducted under the University of the Witwatersrand, as per the School of Construction Economics and Management (MSc (BLG & QS) Dissertation)

Researchers: Deelan Jeram
Supervisors: Prof. Samuel Azasu and Prof Ehsan Saghatforoush

Ethics reference number
CEM-EC/02/23/DJ- 1113285

Study Title
An assessment of the necessity of implementing a blockchain based land registry in South Africa

You are invited to partake in a research study primarily focused on a blockchain based land registry in South Africa for the completion of the abovementioned researchers. As such your expertise in the field is regarded to complete the study. Please take your time in reading the full requirements of yourself and feel free to contact us with any queries. Your participation in this study will be highly appreciated.

What is the purpose of the study?
The primary purpose of this study is to fulfil the requirements of the BUQS8000A MSc (BLG & QS) Dissertation. This study aims to evaluate what factors are indicatory of South Africa being ready to use blockchain. It will contribute to research not being conducted in a South African context by developing frameworks and key findings.

What will happen to me if I take part?
Upon agreement to the study, you will be required to sign the accompanying consent form. You will then be interviewed based on a selected few questions pertaining to your area. The interview will be audio recorded so that responses can be collected, analysed, and interpreted. The research aims to evaluate what factors are indicatory of South Africa being ready to use blockchain technology to digitize its land registry through the following objectives:

1. To identify the existing land registration challenges in developing countries and South Africa
2. To examine why blockchain technology has not been implemented in South Africa´s land registration system.
3. To determine factors that would contribute to the successful implementation of a blockchain based land registry.

All interview data can be made strictly confidential and responses, disclosure of persons involved, and personal nature will remain undisclosed should the participant wish. Each interview will not exceed an hour

in time and the length is dependent on the response of the interviewee. To ensure validity and reliability of interview data, recorded notes will be physically taken as well as use of an audio recorder to allow for re-analysis of the data. The research will span over 10 months and a final report will be compiled with the interviewed data recorded.

What are the possible benefits of participating?

1. Findings of this research may further suggest if blockchain technology is a disruptive modernization or a significant technological evolution and if the market's complete value chain will adopt this.
2. Another reason to embark on this research is to help create a framework to evaluate the preparedness of land management and land administration systems for blockchain consideration in developing markets.
3. South Africa has two forms of land tenure known as are statutory and customary tenure, this unique quality provides for a rationale to assess blockchain's implementation to the country's registration system.

What is the confidentiality guarantee of this study?

Your confidentiality will be completely safeguarded should you choose as the final report is supervised and thoroughly analysed by expert and highly academic supervisors of a prestigious institution. The results will only be made available to the researchers, the supervisors and course coordinator.

What will happen to the results of the research study?

The results of the study will be analysed by the researchers and processed into the final report. If all requirements are met, the research will be published as an article in a journal.

Further information and contact details.

If you have any query related issues or questions to this study, you may contact any of the below mentioned members or contributors of this research. Please ensure you include our supervisors, Professor Ehsan Saghatforoush or Professor Samuel Azasu in any communication.

Deelan Jeram	1113285@students.wits.ac.za
Ehsan Saghatforoush	ehsan.saghatforoush@wits.ac.za
Samuel Azasu	sazasu@unav.es

Thank you for your time.

Consent Form

An assessment of the necessity of implementing a blockchain based land registry in South Africa

Deelan Jeram student no. 1113285

I _____, acknowledge that I have read and fully understand the participant information sheet, that my name and that of the company I represent will remain anonymous should I choose, and that I am over 18 years old. I also recognize that the research I am participating is under the School of Construction and Economics Management at the University of Witwatersrand where the results of my interview will be used in the research report titled above.

I agree to the following:

(Please circle the relevant options below)

The research study was explained to me. I understand what this study is about.	YES NO
I understand that I can volunteer to take part in the study	YES NO
I agree that the interview may be audio and/or video recorded (if interviewed virtually)	YES NO
I agree that direct quotations from my interview may be used by the researcher in their research report	YES NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report	YES NO
I agree that other researchers may use the information I provide in my interview (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES NO

…… (signature)

…… (name of participant)

…… (date)

…… (signature)

…… (name of researcher/person seeking consent)

…… (date)

Information document

Study title: ***An assessment of the necessity of implementing a blockchain based land registry in South Africa***

Dear Sir/Madam

Introduction:

I, Deelan Jeram am doing research on *an assessment of the necessity of implementing a blockchain based land registry in South Africa.* This study aims to evaluate what factors are indicatory of South Africa being ready to use blockchain. It will contribute to research not being conducted in a South African context by developing frameworks and key findings. The following are the objectives of our research: 1. To identify the existing land registration challenges in developing countries and South Africa 2. To examine why blockchain technology has not been implemented in South Africa´s land registration system 3. To determine factors that would contribute to the successful implementation of a blockchain based land registry. The primary purpose of this study is to fulfil the requirements of the BUQS8000A MSc (BLG & QS) Dissertation.

Invitation to participate: We are asking / inviting you to take part in our research study as a property/blockchain professional so that we may increase our understanding and knowledge of property transactions on the blockchain.

What is involved in the study: Our study will be led through an interview which should take around 60 minutes to complete. The interview questions will be posed by a student to the interviewee with the meeting being recorded and taking handwritten notes of the responses being taken. The interview questions will be directly related to answering the abovementioned objectives.

The study aims to interview between 5 and 10 participants from the private and public sectors involved in the use case project i.e., politicians, bureaucrats, technologists, and other persons in the issue-network, with a focus on real estate practitioners, blockchain technology and use case experts in the implementation of the e-DRS system in South Africa. The interviews are preferred to be done through a direct meeting with the interviewee but where this is not possible skype or conference calls may be used where a direct meeting is not possible (if consented to by all parties).

Risks: we anticipate that there is no risk in participation of this study. All interviews will be conducted at the interviewee's location/workplace during working hours at an agreed upon time by both parties. Again, where a meeting is not possible a skype or conference call may be used. The identity of the interviewee and the organization that they represent may be kept anonymous throughout the study should the participants choose in the interest of not naming individuals or organizations to competitors.

Benefits: This study is being conducted for academic purposes; it is also hoped that the study will begin to open the discussion around 1. Suggesting if blockchain technology is a disruptive modernization or a significant technological evolution and if the market's complete value chain will adopt this 2. Another reason to embark on this research is to help create a framework to evaluate the preparedness of land management and land administration systems for blockchain consideration in developing markets 3. South Africa has two forms of land tenure known as are statutory and customary tenure, this unique quality provides for a rationale to assess blockchain's implementation to the country's registration system.

Participation is voluntary: Refusal to participate will involve no penalty or loss of benefits to which the participant is otherwise entitled, and that the subject may discontinue participation at any time without penalty loss of benefits to which the participant is otherwise entitled.

Reimbursements: The study will not require any monetary expenditure from the interviewees. The only expenditure from the side of interviewees will be the 60 min of time required for the interview.

Confidentiality: Efforts will be made to keep personal and company/institution information confidential should the participant choose. Absolute confidentiality cannot be guaranteed. Personal information may be disclosed if required by law. Organizations that may inspect and/or copy your research records for quality assurance and data analysis include the Research Ethics Committee.

Contact details of researcher/s – for further information / reporting of study related adverse events. Below are the researcher's names, email addresses and mobile numbers:

- Deelan Jeram, 1113285@students.wits.ac.za, 0742629418

Contact details of REC administrator and chair – for reporting of complaints / problems. Below are the supervisors name, email, and mobile number.

- Prof. Ehsan Saghatforoush ehsan.saghatforoush@wits.ac.za
- Prof. Samuel Azasu sazasu@unav.es

Research Instrument- Questions to be asked in interviews:

1. Who were the counterparts —blockchain company and government representatives? Was there an MOU (Memorandum of Understanding) signed?
2. When did the initiative/conversations start?
3. How was the land-registry process going to work in the Blockchain? How does the technology overcome some of the challenges of the manual/digital process?
4. How do you transition from a current manual system to a blockchain-based system if there is no origin (land title)?
5. What are the parties that need to be involved for these initiatives to work?
6. What role does government/politics play in making these initiatives happen?
7. What do you think went wrong?
8. Do you think there is a future for this project in the future?

9. What is your highest qualification?
10. Where did you complete your studies?
11. How long have you been in the blockchain/PropTech space?
12. What is your current position in terms of the Blockchain property registry?