A Business Process Model for Blockchain-based South African Real Estate Transactions

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A Dissertation Submitted in Fulfilment
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Master of Commerce in Information Systems
of
Rhodes University

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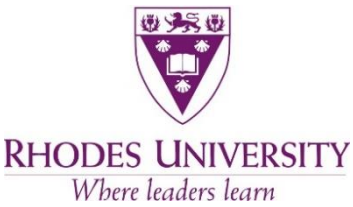

Declaration

I, Jack Laurie Tilbury, declare that the dissertation entitled “A Business Process Model for Blockchain-based South African Real Estate Transactions”, which I hereby submit for the degree of a Master of Commerce at Rhodes University, is my own work. I also declare that this dissertation has not previously been submitted by me for a degree at this or any other tertiary institution and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

Acknowledgements

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Lastly, to my Lord and Saviour Jesus Christ. For God has plans for each one of us, for us to prosper and not be harmed, plans that give hope and a future. I give thanks for this chance I was given, and just like Simon Peter and the Disciples, I wouldn't know who else to turn to: *John 6:64-68:"'Yet there are some of you who do not believe.' For Jesus had known from the beginning which of them did not believe and who would betray him. He went on to say, 'This is why I told you that no one can come to me unless the Father has enabled them.' From this time many of his disciples turned back and no longer followed him. 'You do not want to leave too, do you?' Jesus asked the Twelve. Simon Peter answered him, 'Lord, to whom shall we go? You have the words of eternal life.'"*

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List of Terms

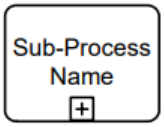
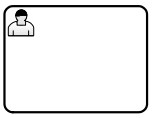
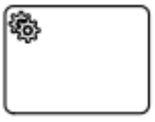
Terms	Definitions
51% Network Attack	An attack on a blockchain network whereby a group of miners gain a 51% control of the network, enabling them to determine the outcome of transactions.
Addendum	Document attached to the purchase agreement, adhering to issues not covered in regular purchase agreements.
Asymmetric Information	A situation whereby one party in an economic transaction has greater knowledge than the other party.
Bitcoin	The first cryptocurrency to be invented. Bitcoin represents a digital, distributed, cryptographic currency that was developed by an open-source community using peer-to-peer technology.
Business Process	A set of tasks or activities which involves inputs and a defined single output whereby a product or service is delivered to a client.
Cryptocurrency	A digital and virtual currency that uses encryption techniques for its creation and verification of transfer of funds.
Cryptography	A method of writing and solving codes and formulas so as to protect communication channels. Cryptography is used to ensure that intended recipients receive intended communication.
Decentralised Application	A computer application that runs on a peer-to-peer network of computers rather than a single computer, designed to avoid a single point of failure.
Digital Scarcity	The process of not being able to simply duplicate digital documents or information that is found online. Blockchain keeps digital assets and digital documents scarce.
Digital Signatures	Signatures used to uphold the integrity of information on the blockchain by providing verification that parties are who they say they are. These signatures are used to digitally verify an individual's identity.
Disintermediation	A situation where there is reduced involvement from middlemen in conducting and controlling transactions, with the goal being increased efficiency and lower transaction costs.
Disclosure Document	A legal document issued by a seller stating relevant information about the property to the buyer.
Distributed Ledger Technology	A ledger that acts as a database for transactions using peer-to-peer technology to allow for value exchange between parties without the need for an intermediary. The ledger is decentralised, meaning there is no single point of authority or control.
Double-Spending	The double-spending problem represents a situation whereby digital money is spent more than once. This is because digital files can be duplicated and/or falsified.
E-Conveyancing	A more efficient and accurate way of conducting traditional conveyancing transactions aimed to replace the paper and manual processes typically involved in property transactions. It involves taking property transactions online which permits the automatic completion of real estate transactions through online transaction platforms.
Ethereum	An open-source public blockchain which uses the programming language Solidity to write smart contracts. The official token of the Ethereum network is Ether (ETH).
Escrow	The situation whereby a third-party possesses property title documents on behalf of two independent parties who are in the process of conducting a transaction.
Fiat Currency	Fiat currency is traditional currency that is currently used today. This form of currency comes in physical form through notes and coins and is backed by the government which issued it.

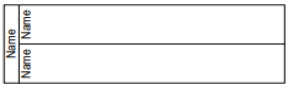
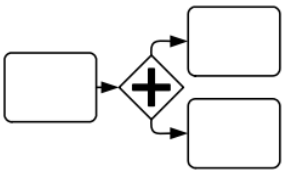
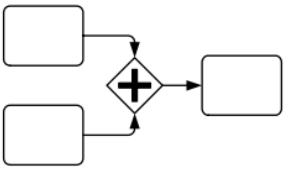
FinTech	The act of incorporating technology, such as computer programs and software, into financial services. Online banking is an example of FinTech.
Financial Guarantee	A document issued by a financial institution which guarantees the payment of funds when certain events occur.
Fourth Industrial Revolution	A technological revolution characterised by new technologies. It refers to disruptive technologies that will change the way humans live and work.
Genesis Block	The starting or beginning block of transactions in a specific blockchain network. Genesis represents the origin.
Hashing	The process of generating a fixed length value from a given input (regardless of the length) This generated value is known as the hash value and is useful in ensuring blockchain information is not tampered with.
Homeowners Association Fee	An amount of money paid monthly, by owners of certain residential property, for community expenses such as maintenance.
Immutability	Immutability refers to the inability to change, alter, or manipulate something. Transactions on blockchain are secure as their information cannot be tampered with.
Low Trust Society	A society in which interpersonal trust is low, as people share different ethical values, resulting in low trust amongst fellow community members.
Mining	The process whereby transactions and entries are verified and added to the blockchain by miners (also known as nodes). Miners are then usually rewarded depending on the network on which they operate.
Money Laundering	The concealment of illegally obtained funds in a process of legitimising assets that were acquired illegally.
Multiple Listing Service	A database of real estate listings in a local area allowing real estate brokers to share property information with one another.
Private Blockchain	A blockchain network which requires an invitation to join and which has a validation process before an individual can join the network.
Public Blockchain	A blockchain network that is open to the public, meaning anyone can join and participate in the network.
PropTech	The integration of technology in property and real estate practices.
Secure Hash Algorithm 256	This is the hash function mostly used in Bitcoin. A hash function takes an input and returns a fixed hash function.
Servitude	A servitude on a title deed, refers to the right to amend property or use a person's land for specific purposes.
Stakeholder Buy-In	The acceptance and commitment to a new business process by all stakeholders involved in its execution.
Tokenisation	The process of representing assets (physical, intangible, and intellectual) on the blockchain. Tokenisation involves the process of converting rights to an asset into a digital token, which can be represented and traded on a blockchain network.

List of Abbreviations

Acronyms	Definitions
BCA	Bond Cancellation Attorney
BCCA	Blockchain Certified Agent
BPMN	Business Process Model and Notation
BRA	Bond Registration Attorney
DLT	Distributed Ledger Technology
DVP	Delivery vs. Payment
ECC	Electrical Compliance Certificate
ESC	Escrow Smart Contract
ETH	Ether
FICA	Financial Intelligence Centre Act
IoT	Internet of Things
MLS	Multiple Listing Service
OTP	Offer to Purchase
PRP	Propy Registry Platform
RCC	Rates and Clearance Certificate
SA	South Africa
SABLES	South African Blockchain Land Exchange System
SHA	Secure Hash Algorithm
SPLUMA	The Spatial Planning and Land Use Management Act
SSIDM	Self-sovereign Identification Management System
TA	Transfer Attorney
TD	Transfer Duty
TLR	Traditional Land Registry

Business Process Modelling and Notation Symbols

Element	Notation	Description
Start Event		Signals the first step of a process.
Intermediate Event		Represents any event that occurs between a start and end event.
End Event		Signals the final step in a process.
Activity/Task		The most basic level of an activity that cannot be broken down further. A task is an activity that is included in a process.
Collapsed Sub-Process		A sub-process is the situation for grouping a group of tasks fit together well. Collapsed means that the details of the sub-process are not visible in the main diagram.
Group		A collection of activities and sub-processes that fall within the same category. A group can be described as a visual container for specific elements within a business process diagram.
User Task		A workflow task whereby a human performs the task with the assistance of software application or through a system such as a website.
Script Task		This is executed by a business process engine. The implementer defines the script in a language the engine can understand. Script tasks are used to represent smart contracts in this dissertation.
Manual Task		A workflow task where the activity is performed without the aid of a business process engine or any assisting application.
Service Task		A task that makes use of a service such as a web service or an automated application. A service task will make use of other services in completing the task at hand.
Message	 	A message that depicts the content of communication between two participants. Messages (and other symbols) can be added into the event circles. Such events (with shapes now in them) are called triggers. These events can be 'catching' (unfilled) or 'throwing' (filled) events. ***Catching events***: These will react to a trigger as a message is arriving. When catching, the next step will be to act on information caught and conduct the process. ***Throwing events***: These will process triggers. When throwing a message, you are throwing a result and send a message out and in doing so provide the process with a notification.

Connecting Object: Normal Sequence Flow		Connects flow objects in proper sequential order.
Connecting Object: Message Flow		Represents messages from one process participant to another.
Connecting Object: Association Flow		Shows relationship between artefacts and flow objects
Swim lane		A representation of a participant in a process.
Pool		Consists of multiple swim lanes each with a sub-partition within a process.
Gateway: Exclusive		A decision will be made based on conditions, and the flow will break into different paths according to the decision made or question answered.
Gateway: Parallel		This allows for multiple processes to occur at the same time. The parallel gateway is not dependent on conditions or events or questions being answered. It is used to represent tasks that can happen concurrently in a business process.
Fork of Parallel Tasks		Divides a path into two or more parallel paths. It represents a place in the process where activities can be performed concurrently.
Join of Parallel Tasks		The combining of two or more parallel paths into one path again.

Abstract

The real estate transaction process has been described as inefficient and technologically outdated due to numerous stakeholders and predominantly paper-based operations. Despite the apparent bottlenecks in the current process, the implementation of new technology into the real estate sector has lagged. Several attempts have been made to modernise and digitise the business process but committed integration of assisting technology has lacked attention. This study examined the applicability and potential integration of blockchain technology into the business process of South African real estate transactions. Blockchain's novelty means that research in this space, especially within South Africa, is limited. Of the research that has been conducted, no models of the business processes for South African or blockchain-based real estate transactions have been constructed. This study provides two business process models, illustrating the two different processes. The main contribution of this paper was an integrated business process model, illustrating how the various processes and stakeholder interactions for South African blockchain-based real estate transactions are conducted on one transaction platform, common to all participating stakeholders. This platform was named the South African Blockchain Land Exchange System (*SABLES*), which manages and facilitates these transactions in their entirety from start to finish. This model depicts an enhanced business process that provides increased security, transparency, and speed. These benefits will be realised by those who register, adopt, and transact on the platform. Through in-depth interviews, the integrated business process model was assessed. The findings produced a final and combined thematic map, representing the main themes of the analysed interview data, namely blockchain implementation strategies, business process applicability, information technology assimilation, current transaction context, and PropTech 3.0 success factors. The discussion revealed that the current transaction process lacks technological innovation, which increases pressure on the conveyancing role. It was also revealed that there is not only a need within the industry, but a desire, for newer technologies to assist the transaction process. In order to streamline and improve efficiency, business processes should leverage digital records and data, and strive for a solution beyond digitisation, achieving digitalisation. Digitalisation recognises digital documents as official and legal documents as opposed to simply being digital back-ups. This, coupled with the business process models, represent theoretical contributions.

KEYWORDS: *Blockchain Technology; Distributed Ledger Technology; Smart Contracts; Real Estate Transactions; Conveyancing; South Africa; Business Process Modelling*

Chapter 1: Introduction

1.1 Background Information

The real estate sector is currently fraught with inefficient practices, resulting in an array of problems when it comes to real estate transactions. Some inefficiencies stem from antiquated processes such as paper-based operations which can result in fraudulent activities relating to transaction documents, as well as a lack of transparency throughout the process (Baum, 2017). In addition, the vast number of stakeholders involved means that transaction costs are high and transaction times can be lengthy. According to Chas Everitt (2018) a buyer should take into account that the total costs associated with purchasing a property will be between 8 to 10 percent of the purchase price. These costs range from transfer costs, bond initiation fees, bond registration fees, and conveyancer's fees (SAHomeLoans, 2016). Moreover, the entire transaction can take between two to three months to complete (SAHomeLoans, 2016; Picken, 2017). The processes involved in a South African real estate transaction can be summarised as five stages. The process begins with an 'Offer to Purchase' contract, which is arranged by a transfer attorney and signed by the buyer and the seller. Secondly, the financial elements of the transaction need to be settled. This involves the seller cancelling and arranging pay-outs of any existing bonds on the property and the buyer obtaining finance through a financial institution or declaring a cash payment. Following this, the transfer attorney will need to ensure that there is municipal clearance on the property by obtaining various approved certificates. The fourth stage requires the buyer to pay transfer tax and this is achieved through the buyer paying a 'Transfer Duty' fee and receiving a 'Transfer Duty' receipt. Lastly, the transaction will be validated and finalised through a series of procedures that occur at the respective Deeds Office (Amadi-Echendu, 2013; Amadi-Echendu, 2016). These stages, each with their contracts, certificates, and documents, are integral to all real estate transactions that occur in South Africa.

The stages described above require the services of many stakeholders including banks and lawyers. At minimum there are 12 stakeholders (including the buyer and seller) involved in a single real estate transaction in South Africa, and this number has the potential to rise to 17 depending on the nature of the transaction (Neil Esterhuysen and Associates Inc, 2015; SAHomeLoans, 2016; Chas Everitt, 2018). Not only does this incur additional costs and lengthen the process, it also results in duplicated information being stored by each stakeholder across various systems. Currently, all of these stakeholders conduct their transaction process with the aid of bespoke systems which exist in isolation from one another, which results in an

unwieldy process of asymmetric information where the same information must be recaptured multiple times. The lengthy duration of real estate transactions makes property one of the least liquid assets in the economy. Additionally, the volume of financial and legal paper-based documentation that is required in real estate transactions not only opens the door for fraudulent activities but also results in siloed information that can further be lost or misplaced, complicating these transactions even more. In combination, the issues in South African real estate transactions of multiple stakeholders, bespoke systems with duplicated information, paper-based operations, fraudulent activities, and lengthy transaction time, make up a series of inefficient business processes across real estate transactions and land registry systems.

A move towards a more efficient real estate sector and its associated transactions begun taking place worldwide in 2017 (Malviya, 2017; Picken, 2017; Spielman, 2017). In October 2017, blockchain technology facilitated a real estate transaction for the first time when an apartment in the Ukraine was bought and sold using smart contracts running off the Etheruem[1] blockchain platform. This transaction was executed by an American-based start-up company called Propy[2]. Propy is a decentralised property application platform that utilises blockchain technology and smart contracts to allow for a collaborative transaction platform amongst all stakeholders (Cuthbertson, 2017; Baum, 2019). Various start-ups around the world are attempting to follow this model with projects being executed in Sweden, the Netherlands, and Kenya, among others. The goal of this model is to leverage blockchain technology to provide more efficient services for real estate transactions and the land registry systems which manage transaction data and documentation. The integration of technology and property is known as 'PropTech' and it is now in its third phase, 'PropTech 3.0', which combines technologies such as blockchain with real estate practices and transactions (Baum, 2017; Baum, 2019).

In its most simplistic form, the blockchain is a decentralised and distributed digital ledger (Narayanan, et al., 2016; Veuger, 2017). This ledger acts as a database for transactions. The technology is built around open data and on a 'peer-to-peer' transaction network, meaning that all transactions and entries are publicly available to the participants in the network (Veldhuizen, 2017; Veuger, 2017). The ledger is 'distributed' since all computers within the network have a complete and up-to-date copy of the ledger. The information and data of recorded transactions is stored across multiple computers (known as nodes) which can exist all over the world (Narayanan, et al., 2016). The term decentralised implies that there is no single

[1] https://www.ethereum.org/

[2] https://propy.com/

point of authority, and therefore, no single point of failure. This, however, is only true for a public blockchain (Narayanan, et al., 2016; Szabo, 2016). There are various techniques within the architecture of a blockchain which can allow for a public, private, or hybrid approach to be adopted.

The ledger described above is continuously updated and validated by the nodes in the network as new transactions are added. In addition, transactions in the blockchain ledger are timestamped, which allows for a complete audit trail of activity. These transactions are stored in 'blocks' which are 'chained' together, which gives rise to the term, the blockchain. The decentralised and distributed characteristics of the technology assist in preventing manipulation and ateration of data and fraudulent activities, which provides transparency and security (Spielman, 2016; Malviya, 2017; Veldhuizen, 2017). The blockchain ledger is also immutable, meaning that records and documentation contained within cannot be amended. Blockchain technology makes it safe to be used in a trust-less environment, as cryptographic proof permits two stakeholders to directly transact with one another, reducing reliance on middlemen to confirm transactions.

Blockchain technology represents a window of opportunity for real estate transactions and land registry record-keeping systems. The technology has the potential to bring about more efficient processes in the real estate sector (Spielman, 2016; Szabo, 2016; Spielman, 2017). Over and above its role in bitcoin and other cryptocurrencies, this nascent technology has become increasingly applicable in a variety of use cases. Several advantages include disintermediation, which can result in cost-saving processes, real-time transactions with complete transparency, and the opportunity for a comprehensive audit trail of records. Furthermore, cryptography and immutability allow for increased security of transactions. The immutability of data stored in the blockchain ledger means that fraudulent activities can be prevented, if not eradicated. In addition, the technology gives rise to innovative ways of executing contractual transactions in real estate through the use of programmed self-executing smart contracts, significantly enhancing security when it comes to the transfer of property ownership versus the transfer of funds (Szabo, 2016; Picken, 2017; Veuger, 2017).

1.2 Problem Statement

South African real estate transactions exemplify a cumbersome business process. This is because these transactions are currently plagued by manual and paper-based processes which are heavily dependent on various stakeholders. In light of this, this study developed the following problem statement:

1.2 Problem Statement

> *The process of purchasing property in South Africa's current real estate sector can be described as inefficient due to the lack of digitisation and a significant reliance on various stakeholders. Additionally, the extensive manual review, verification, and storage of financial and legal documents in the current land registry system (and throughout the transaction process) are prone to error and fraudulent activities. This results in high transaction costs and a prolonging of the time in which property transactions are completed.*

To address the problem statement and real estate transaction concerns above, this study intended to answer to this main research question:

> ***How can blockchain technology be integrated into the process of real estate transactions in South Africa?***

Blockchain technology has significant potential beyond the use of cryptocurrencies. This technology is being applied in numerous sectors with the real estate sector representing a prime scenario for its adoption. Answering this question could assist South African real estate transactions and the stakeholders within as it could reveal a more efficient mechanism for conducting current processes. The answer to this question could provide valuable insight into a more secure method of record-keeping for real estate transaction documentation and data. This research aimed to show where blockchain technology is most applicable in the transaction process and the challenges to its application. Note, in this project the term 'real estate transaction(s)' accounts for both the transactional processes involved between all of the stakeholders as well as the consequent recording of the property title deed in the land registration system, in this case, the South African deeds office system. As a result, when the research refers to the inefficiencies of real estate transactions, it is referring to both of the aforementioned aspects.

In answering the main research question, this study needed to address various factors. This allowed for a holistic approach when addressing the identified problem statement and putting forward a comprehensive answer to the main research question.

1.2 Problem Statement

1. ***Why should South African real estate transactions make use of blockchain technology?*** The purpose of this question was to investigate why blockchain technology represents a viable alternative for conducting real estate transactions. The information gathered and presented here discuss the opportunities that blockchain technology can provide and how these opportunities can aid the transaction process. This question was primarily answered through a literature review (*Chapter Four*), however, questions were also posed to interview participants which supplemented the data found in literature.
2. ***What are the existing business processes in South African real estate transactions?*** The project posed this question to gain an understanding of how real estate transactions are currently executed and how the subsequent title deeds are managed and stored in the South African Deeds Office land registry system. This provided the study the processes currently involved, which processes and data are key to South African real estate transactions regardless of the mechanisms used to carry them out, as well as the stakeholders currently involved. When designing new solutions for a current business process, it is vital to obtain a holistic understanding of how processes are currently structured. This allowed the study to identify problematic areas and issues of concern and focus the proposed solutions on addressing these concerns.
3. ***What are the existing business processes for blockchain-based real estate transactions?*** While the previous research question intended to uncover the processes involved with current South African real estate transactions, this research question was focused on describing current blockchain-based transactions. As mentioned in *Section 1.1,* blockchain-based real estate transactions have already been executed. There are numerous start-ups attempting to illustrate these capabilities. This study focused on the Propy platform which has overseen and managed various blockchain-based real estate transactions. Although all these transactions have occurred internationally none have yet been conducted in Africa. The study investigated and examined how these transactions occurred and how the technology was utilised. Answering this question provided the research with a comprehensive understanding of the technicalities involved, assisting the discussion of how this can be employed at a local level.
4. ***How would the business processes for real estate transactions and recording property titles in South Africa change if blockchain technology was integrated into the current transaction process?*** The purpose of this question was to explore, discuss, and visualise an alternative approach for conducting South African real estate transactions. The

answer to this question involved a technical discussion on where and how the technology can improve the process. Further, it identified the stakeholders who are involved and the roles that they would play. This question aimed to understand how the interview participants viewed the integrated model which illustrated the incorporation of blockchain technology into South African real estate transactions. In answering this question, the research developed an integrated business process model, illustrating an enhanced business process through a transaction platform that could cater for such transactions. The construction of this model will be discussed in *Section 1.3*.

1.3 Goals of the Research

The main objective of this study was to produce an integrated business process model, illustrating how the various processes and stakeholder interactions for South African blockchain-based real estate transactions are conducted on one platform, common to all participating stakeholders. The integrated business process model depicts a transaction platform which manages and facilitates these transactions in their entirety from start to finish. To achieve this objective, an understanding of the relevant factors that contribute to this was needed. Thus, the research consisted of four sub-goals:

1. To conduct an analysis of the current nature of South African real estate transactions and the processes involved.
2. To conduct an analysis of the nature of blockchain-based real estate transactions and the processes involved.
3. To produce two business process models illustrating *sub-goal 1* and *2* above.
4. To examine these business process models and determine how integration could occur. From this, to consider key elements to be included in the integrated business process model, illustrating how blockchain technology could be incorporated into the processes involved in South African real estate transactions.

This integrated business process model aimed to demonstrate how blockchain technology could not only facilitate but enhance real estate transactions, through increased efficiency and security. This integrated business process model was produced before the data collection process began and was provided to interview participants prior to the interview. The study then aimed to gain an in-depth understanding from interview participants on their views towards the integrated model. Additionally, the interviews were intended to provide further insight into the

factors that need to be considered and when constructing such a business process model, represents a transaction platform of this nature. Ultimately, the purpose of the interviews was to collect data on blockchain technology in real estate transactions and cross examine these findings with the proposed integrated business process model. Following the interviews, the research planned to put forward a thematic alignment discussion which examined the analysed data and how it either aligned or differed with the integrated model.

1.4 Methodological Approach

The goals of this study were met by outlining and following a clear methodological approach. This research was conducted within the interpretivist research paradigm. This research involves examining existing events and processes by employing an inductive approach throughout, whereby the research anticipates meaning and understanding to emerge from the collected data. As Davis (1995) mentions, an interpretative approach allows for the discovery of themes and patterns within activities and processes, and assigns meaning to these events. Further, it aims to understand the world from an individual's perspective, taking into account their environment and particular social setting. An interpretive approach allowed the study to collect and gain insight from interview participants and draw conclusions from the gathered data. This approach led the research to conclude that multiple realities exist and therefore reality is a social construct. This is reinforced by Walsham (1995) who posits that any data beyond arithmetic and numerical data are constructions and developments of the human mind. Contrary to this is a positivist approach whereby the focus is on quantitative data and factual findings. The interpretive approach chosen allowed the study to obtain results and understand and interpret their meaning. Case study methodology is an ever-growing research strategy for qualitative work and was chosen for this study (Yin, 2011; Hyett, Kenny and Dickson-Swift, 2014). Yin (2003) as well as Baxter and Jack (2008), state that qualitative case studies allow the research to gain a comprehensive understanding of complex phenomena within their situational contexts. Additionally, case studies are applicable when exploring new processes, such as blockchain technology in real estate transactions, which are yet to be thoroughly studied (Benedichte Meyer, 2001; Yin, 2003).

1.4.1 Research Methods

In line with the interpretive model, this study employed qualitative research methods when collecting and analysing data. Qualitative methods in interpretive studies employ the principle investigator as a key instrument throughout the study. Creswell (1994) states that constructs

produced in qualitative work can be defined as 'pattern theories', as explanations and patterns emerge during the research process. Creswell (1994) goes on to mention that qualitative studies will use inductive approaches to theory and construct development.

1.4.2 Data Collection

Data gathered for this study consisted of a two-phase approach, namely document analysis and in-depth interviews. First, document analysis was conducted by collecting information on current South African and blockchain-based real estate transaction processes. This involved the collection of secondary data through documents, reports, or publications detailing the respective transactional processes. The purpose of this was to gain an understanding of how these two differing processes are conducted in isolation. This resulted in two individual business process models illustrating these types of transactions in isolation (*Figure 3.9:* South African Real Estate Transaction Process: Business Process Model *and Figure 5.3:* Blockchain-based Real Estate Transaction Process: Business Process Model). These two models acted as inputs for the integrated business process model (*Figure 6.3:* South African Blockchain Real Estate Transaction (*SABLES*): Integrated Business Process Model).

Second, and once the integrated business process model had been constructed and produced, in-depth interviews were carried out with interview participants who specialise in the study's respective areas. This qualitative approach allowed the research to uncover the views and opinions of the integrated business process model from the interview participants. The purpose of the in-depth interviews was to obtain an in-depth knowledge of and understanding of the relevant aspects that need to be considered for the integrated business process model (Benedichte Meyer, 2001; Hyett, Kenny and Dickson-Swift, 2014). Further, these interviews assisted in evaluating the integrated model. The in-depth interviews culminated in a discussion exploring these opinions in relation to the proposed integrated business process model.

1.4.3 Sources of Data

This study covered a topic that has not yet been well mapped, documented, or implemented in South Africa, blockchain-based real estate transactions. Further, as stated in *Section 1.1* blockchain-based real estate transactions only first occurred in 2017. It was important that the interview participants should consist of personnel with specialities either in one of the respective areas (blockchain or real estate) or both (PropTech 3.0). The interview participants included participants from four areas. First, conveyancing participants were selected and interviewed. These professionals possess valuable insight into the current nature of South

African real estate transactions and their inefficiencies. Second, blockchain technology specialists were interviewed. This aided in identifying the capabilities and specific technicalities of blockchain as well as its applicability to real estate transactions. Third, and perhaps most importantly, the research drew on the views and opinions of PropTech 3.0 professionals, who possess expertise regarding blockchain technology and its application in the real estate sector. These participants offered invaluable interpretations of how the two can successfully integrate with one another. Lastly, the study also included an Information and Communications Technology (ICT) legal participant group, although this was not a key focus. Given that real estate transactions and their processes are heavily regulated, the application of digital technology must take current legislation into consideration. These specific groups of participants were selected because the integration of blockchain technology into South African real estate transactions depends on the joint insights and opinions from these people. The combination of these four groups, and the data that they yielded, permitted the research to put forward a holistic discussion in *Chapter Eight*.

1.4.4 Data Analysis

This study employed the thematic analysis technique. Specifically, this research made use of a six-phase approach outlined by Braun and Clarke (2006). *Chapter Two* narrates the theory of this technique and lists the steps involved. *Chapter Seven* shows the practical application of each of these steps to the transcribed interview data. The thematic analysis yielded a final and combined thematic map (*Figure 8.1:* Final and Combined Thematic Map). The concepts from this map were aligned and discussed in relation to the integrated business process model.

1.5 Dissertation Structure

- ***Chapter Two*:** This chapter addresses the methodological approach that was followed when conducting the research. This chapter presents detailed discussions on the processes involved in data collection and data analysis. The chapter concludes with a set of interview questions which were asked to the interview participants. The purpose of these questions is also presented.
- ***Chapter Three*:** This chapter provides an overview regarding the current state of South African real estate transactions. The chapter is a literature review as well as a discussion on the data collected through document analysis, outlining South African real estate transactions. The goal is to describe and illustrate the complete process of South African real estate transactions, delineating who and what is involved. This chapter produces a

business process model (*Figure 3.9*), illustrating how the various processes and stakeholder interactions for South African real estate transactions are conducted across multiple siloed platforms (each operated by respective stakeholders) which manage and facilitate a specific part of the transaction.

- ***Chapter Four*:** This chapter discusses how blockchain technology is applicable to the real estate sector its transactions. This is done through a literature review. The discussion begins with an overview of what blockchain technology is, providing a technical definition of its key components. This is followed by a review of how technology has played a role in the real estate sector over the years. The chapter then presents and discusses both the opportunities and challenges pertaining to blockchain technology in real estate transactions (*Sections 4.5 and 4.6*).
- ***Chapter Five*:** Similar to *Chapter Three*, this chapter provides an overview regarding an alternative mechanism for real estate transactions, blockchain-based real estate transactions. This chapter focuses on four international examples where real estate transactions have been facilitated using blockchain technology. This chapter produces a business process model (*Figure 5.3*), illustrating how the various processes and stakeholder interactions for blockchain-based real estate transactions are conducted on one platform (common to all participating stakeholders) which manages and facilitates these transactions in their entirety from start to finish.
- ***Chapter Six*:** This chapter discusses how blockchain technology can be integrated into the South African real estate transaction process. It incorporates a combination of aspects from *Chapters Three*, *Four*, and *Five*. The main contribution of this chapter is an integrated business process model, illustrating how the various processes and stakeholder interactions for South African blockchain-based real estate transactions are conducted on one transaction platform, common to all stakeholders. This platform has been named the South African Blockchain Land Exchange System (*SABLES*), which manages and facilitates these transactions in their entirety from start to finish. The integrated business process model, *SABLES* (*Figure 6.3*), concludes the chapter. Furthermore, this integrated business process model represents the main focus and contribution of the study.
- ***Chapter Seven*:** This chapter provides the findings that emerged from the data collected during the in-depth interviews. It elaborates on the contextual background of the interview participants to justify their inclusion as well as describe the knowledge which they possess. This is followed by the thematic analysis process, illustrating how the

research arrived at the main themes. This chapter concludes with four thematic maps, one for each participant group (*Section 7.5*).

- ***Chapter Eight*:** This chapter consists of two key elements of the study, the final and integrated thematic map (*Figure 8.1*) and the discussion of this map. This chapter begins with the final and integrated thematic map, which is a combination of all four maps which were presented at the end of *Chapter Seven*. From this, an interpreted narrative on each of the themes in relation to the integrated business process model, *SABLES,* is presented. A summary and reflection on the integrated business process model, based on the findings and views coming from the interview participants, concludes *Chapter Eight.*
- ***Chapter Nine*:** Here, the research is summarised. This is done by revisiting the research questions and stating how they were addressed. This is followed by the study's contributions, limitations, and areas of future research. The chapter finishes with a summary of the dissertation.

Chapter 2: Methodology

2.1 Introduction

In *Chapter One*, the problem statement and the research questions of this study were delineated. *Chapter One* highlighted the goals of this study which entailed four key steps needed to be carried out in order to achieve these goals. The information presented in the previous chapter provided a brief description of the methodological approach which would guide this study. This chapter provides a detailed methodological motivation for how this study was conducted. *Chapter Two* illustrates how this study was carried out, detailing the research design together with the specific methods adopted. This study leveraged off the eight-phase approach specified by Creswell (1994) and Yin (2003) which starts from the philosophical assumptions (the research paradigm) through to the more intricate details of how the findings are collected and presented. In between these aspects the chapter discusses the type of design (case study methodology) as well as the role that the principle investigator played throughout the study. Data collection, recording, and analysis techniques are discussed. The concepts mentioned in this approach provided the study with a strong methodological foundation. This chapter concludes with a discussion on the approach to theory and model development and discusses how the business process models were created, outlining the Business Process Modelling and Notation[3] (BPMN) that was utilised. It will also mention how the integrated business process model was evaluated and how the outcomes and findings were presented.

2.2 Research Design

When conducting a research study, one of the first tasks is to determine what the problem is that the study is attempting to research and examine and offer potential solutions as to how the problem can be addressed. *Chapter One* outlined the problem statement, namely South African real estate transactions represent an inefficient business process. This study was based on the premise that the integration of blockchain technology into the current process of South African real estate transactions and land registry systems could enhance and make these transactions more efficient. The process of getting from the problem statement to the precise conclusions which answer the research questions is academically known as the research design (Hofstee, 2006). According to Hofstee (2006), the research design represents the overall approach that is

[3] http://www.bpmn.org

adopted when conducting research, providing the reader with a road map of what study is carried out and in what manner, in order to arrive at the conclusions that they did. Yin (2003) states that the research design is an action plan for getting from questions to answers, through the collection, storage, analysis, and interpretation of data. This study made use of the research design specified by Creswell (1994) and Yin (2003) which posited that there are eight aspects to consider when orchestrating the research design for a qualitative study.

1. ***The philosophical assumptions of the design***

This study was conducted within the interpretivist research paradigm. Through an interpretive approach, the research drew conclusions from the views and opinions of key stakeholders, resulting in a scenario whereby reality was socially constructed based on individuals' experiences of phenomenon within a specific setting. The research paradigm is described in detail in *Section 2.2.1*. A research paradigm – also termed as a theoretical lens – is underpinned by certain philosophical assumptions made by the principle investigator (Yin, 2003). The philosophical assumptions of this interpretive study were:

- Knowledge of the world, and events within, is derived from human background, experience and specific context.
- Interpretivist research discovers the realities of individual participants and how they perceive and understand phenomena. As a result, every individual possesses their own version of the truth and reality. As stated by Schwandt (1998, p.221–222):

> *"…particular actors, in particular places, at particular times, fashion meaning out of events and phenomena through prolonged, complex processes of social interaction involving history, language, and action."*

- Consequently, a study collects data on the views of an information system from various stakeholders and as a result, reality is socially constructed.
- Knowledge and the context in which it is acquired go hand-in-hand. This applies to the interview participants as well as the principal investigator during the phase of data collection. Thus, an interpretive approach adopts a two-phase interpretation based on the perception, views, and formed realities of participants as well as the principal investigator.

2. ***The type of design***

2.2 Research Design

This study adopted a case study methodological approach. The cases of South African real estate transactions and blockchain-based real estate transactions were studied. This will be further discussed in *Section 2.2.2.*

3. The role of the researcher

Conducting research within an interpretivist paradigm made the principal investigator a key figure in the collection and analysis of data. The principal investigator collected, conducted and transcribed the information gathered throughout the study, becoming the prime research instrument for the duration of the study. According to Smith and Osborn (2015), interpretive interviews conducted through qualitative methods can be slightly biased towards the principal investigator's objectives. Interpretive research affords the principle investigator the opportunity to obtain first-hand insight into real-world phenomenon from a participant's subjective experience. However, the study must distinguish between the subjective views obtained and facts, and present objective findings from the gathered data (Creswell, 1994; Schwandt, 1998). However, to reduce the potential of research bias, Yin (2011) mentions two approaches. Firstly, it is important to talk about what will be discussed during the interview, prior to the interview, in order to set a planned procedure. Secondly, a strong sample should be interviewed, both in quantity and knowledge. The research abided by both of these approaches. The nature of the interviews and the samples used will be further discussed in *Sections 2.2.3.1.* and *2.2.3.2*.

4. The data collection techniques

This study employed qualitative data collection methods. The data collection involved a two-phase process whereby document analysis and in-depth semi-structured interviews were used. The data collection methods will be outlined in detail in *Section 2.2.3.1*.

5. The data recording procedures

The interviews occurred through telephone calls or video calls, depending on participant preference. All of the interviews were voice recorded through a recording device which was placed on the desk where the interview occurred. The participant's participation as well as the voice recording was all made clear to each participant and consent forms were signed prior to the interview. The interviews and the interview instrument will be detailed in *Sections 2.2.3.1* and *2.2.3.3* respectively.

6. The data analysis techniques

This study followed an inductive approach, which moves from the specific to the general and generates new knowledge or constructs, in this case, new knowledge and models. The analysis of the in-depth interviews occurred through thematic analysis whereby semantic and latent

themes were identified. The inductive approach to theory and model development is discussed in *Section 2.3* while the data analysis procedures are mentioned in *Section 2.2.3.5*.

7. The verification and evaluation mechanisms

Through in-depth interviews, not only were the research questions answered, but the integrated business process model (*Figure 6.3:* South African Blockchain Real Estate Transaction (*SABLES*): Business Process Model) was assessed by specialised stakeholders. The integrated model's notation was also evaluated by BPMN specialists.

8. The process of delineating the outcomes and findings

The interpretation and discussion of the findings will be presented over two chapters, *Chapters Seven* and *Eight* – '*Findings'* and '*Discussion'*, respectively. *Chapter Seven* presents four thematic maps, one from each participant group. These maps resulted from the thematic analysis. The final and combined thematic map (*Figure 8.1:* Final and Combined Thematic Map) is presented in *Chapter Eight*. These chapters were split because the production of this map involved a detailed level of interpretation. The discussion chapter answers the research questions asked in *Chapter One* by elaborating on the main themes and how these themes align to the integrated model.

2.2.1 Research Paradigm

The interpretivist paradigm places significant emphasis on the principal investigator, who interprets the views and opinions of key stakeholders and draws conclusions from the information, meaning that reality is therefore socially constructed (Davis, 1995; Walsham, 1995). Throughout this study, existing and specific cases relating to blockchain technology in real estate transactions were interpreted. From this, patterns and themes from the information studied in literature and collected through documents were detected, as well as drawing upon the views from in-depth interviews with key stakeholders. From this array of data, explanations and conclusions were developed.

An interpretive approach gave the opportunity to interview various stakeholders and thus obtain different meanings and understandings of the topic at hand (Klein and Myers, 1999; McGregor and Murnane, 2010). According to Crotty (1998), interpretive research involves enquiring and examining social behaviour and interactions through human activities, events and processes. Based on the above description, it is clear that interpretive research will eventually result in context-specific meaning being obtained. This is due to various key stakeholders providing their own views which are based on various factors such as their contextual understanding, subject-matter knowledge, and how they think and operate within their specific social setting. Thus, data is collected within the context in which it appears

(McGregor and Murnane, 2010; Smith and Osborn, 2015). As a result, understanding of the world, and events within, are subject to the specific experiences of individuals, a key tenet of interpretivist research. According to Walsham (1995), knowledge and information of reality is socially constructed by human actors who experience and live through events. It is further stated that through interpretive studies, research intends to understand an information system based on its context and the interactions occurring within, and impacting on, that specific information system. Smith and Osborn (2015, p.53) provide insight into interpretive studies by stating:

> *"The aim of interpretive phenomenological analysis (IPA) is to explore in detail how participants are making sense of their personal and social world, and the main currency for an IPA study is the meanings particular experiences, events, states hold for participants."*

This differs from a positivist approach, which relies on scientific evidence through experimentation. However, Walsham (1995) states that data collected during interpretive research will always contain some form of value since the principal investigator and the participants are both acting and engaging based on their preconception and knowledge of the situation at hand. This is in contrast to research conducted in the positivist paradigm which is entirely objective.

In analysing the information collected during interpretive studies, the principle investigator views the world through the experiences of their participants, and from those views the study derives an understanding of the information system. Smith and Osborn (2015) mention that through in-depth interviews, the research itself is attempting to obtain an insider's perspective of a specific phenomenon and that based on this interaction, the study will then attempt to make sense of the information based on their understanding and worldview. Smith and Osborn (2015, p.53) formalise the process of interpretive analysis as a two-stage interpretation process:

> *"The participants are trying to make sense of their world; the researcher is trying to make sense of the participants trying to make sense of their world. IPA is therefore intellectually connected to hermeneutics and theories of interpretation."*

Thus, the principal investigator and the participants place themselves in their own situational context as well as in each other's worlds, and from this, meaning is established (Davis, 1995; Klein and Myers, 1999). The business process models for this study were constructed based on an interpretation of the documents collected and literature studied. The final integrated model and the research questions were evaluated and answered through the data collected in stakeholder interviews, after which conclusions could be drawn.

2.2.2 Case Study Methodology

Case study research methodology is one of various research strategies that can be used when selecting methods to collect and analyse data. Qualitative, quantitative, or mixed methods approaches can make use of case study research. Qualitative methods of collection and analysis were utilised in this study due to the unsuitability of quantitative methods. The unsuitability of quantitative methods will be motivated in *Section 2.2.3*. In their purest form, case studies examine current real-life phenomena (Stake, 1995; Baxter and Jack, 2008). In situations where cases are purposefully and specifically chosen for being novel and information-rich, it is necessary to generalising the findings (Yin, 2003). The aim of case studies is to depict a process, or set of processes, to explain how the process was implemented, why certain steps were taken, and the result of the process (Benedichte Meyer, 2001; Noor, 2008). Case studies are not meant to focus on an entire industry but rather represent particular instances and processes, or specific information systems, within a sector and are employed in research when an in-depth analysis of complex phenomena is required (Baxter and Jack, 2008; Hyett, Kenny and Dickson-Swift, 2014). Additionally, case studies assist in generating knowledge and understanding of human behaviour and interactions within processes (Stake, 1995). Yin (2003, p.87) defines a case study as:

> *"An empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident."*

According to Johansson (2003), when beginning case study research, it is important to identify what the 'case' of the study is, defined as the unit of analysis. Inter alia, cases may present themselves in the form of programs, events, or processes whereby context-dependent knowledge is produced, illustrating alignment to the interpretive nature of this study (Schramm, 1971; Johansson, 2003). Cases that focus on contemporary phenomena represent many areas of interest and will thus rely on multiple sources in the data collection process. In summary,

the case study research strategy encompasses modes of data collection as well as data analysis and methods thereof. Thus, case study research is not simply a method within a strategy but rather, a comprehensive research methodology in and of itself (Johansson, 2003; Baxter and Jack, 2008; Noor, 2008).

The aim of this study was to explore how blockchain technology can be integrated into the South African real estate transaction process. In order to achieve this, the two respective transaction processes were first understood in isolation, representing the two cases explored in this study. The current process of South African transactions was examined (*Chapter Three*) as well four international blockchain-based transactions (*Chapter Five*), two in the United States of America, and one each in Ukraine and Spain. This study adopted a case study methodology based on the following factors:

- It is recommended when the research questions being asked are 'How' (*main research question*) and 'Why' (*sub-question one*) questions.
- Blockchain-based real estate transactions represent a contemporary phenomenon which makes use of a new and emerging technology and has hitherto seen limited research.
- Real estate transactions represent a complex transaction process and an in-depth analysis is required to determine how blockchain technology can be integrated.
- It provides the research the opportunity to uncover differing areas of interest on the topic from various key stakeholders, each within their own context.

2.2.3 Research Methods

Qualitative research focuses on qualities and characteristics – both the principal investigator's opinions as well as interview participant's insight – and the interaction between the two informs the research results (Snape and Spencer, 2003; Conboy, Fitzgerald and Mathiassen, 2012). Additionally, the primary aim of qualitative research is said to answer '*How*', '*What*' and '*Why*' questions. Qualitative research is commonly associated with the interpretivist research paradigm, in which human understanding of real-world phenomena represents the cornerstone (Yilmaz, 2013). Qualitative research methods build off the philosophical pillar of constructivism and interpretivism, whereby reality is socially constructed (Creswell, 1994; Snape and Spencer, 2003; Yilmaz, 2013).

In contrast, quantitative studies describe specific phenomena through the use of numerical data supported by statistical explanation. Statistical studies rely on factual and proven data as opposed to taking multiple views and opinions into consideration (Creswell,

1994). Quantitative research does not examine human interactions within processes or events but makes conclusions through observations and derives results through mathematical proofs without considering context. Quantitative research is commonly associated with the positivist research paradigm, which relies on observation and reason and is supported by scientific and numerical evidence (Yin, 2011; Yilmaz, 2013). The quantitative approach is not suitable for this study and will not be able to answer the research questions which rely on detailed understanding from key stakeholders on technology's (potential) involvement in real estate transactions. This study therefore deemed the qualitative approach more applicable:

- To have a comprehensive understanding of such multifaceted social events (blockchain technology and its integration into real estate transactions), separating data from context followed by statistical analysis of variables would not suffice.
- This study relied on the in-depth understanding of the views and opinions of key stakeholders through interviews which examined how their social and contextual environment influences the meaning that they assign to blockchain, real estate, and the integration of the two.
- The business process models were constructed for the research and subsequently the final integrated model was evaluated by stakeholder review, thus relying on the interpretations of the interview participants.

2.2.3.1 Data Collection

This study made use of a multi-method qualitative approach, using document analysis and in-depth interviews. It is important to note that a multi-method approach significantly differentiates from that of a mixed-methods approach. As per Creswell (2007, p.273):

> *"Writers in mixed-methods are also careful to distinguish 'multi-method studies' in which multiples types of qualitative or quantitative data are collected; from 'mixed-method studies' that incorporate collecting both qualitative and quantitative data."*

Qualitative research typically uses multiple data collection procedures from multiple sources, ensuring that all information required to fully understand a phenomenon is captured (Creswell, 1994; Conboy, Fitzgerald and Mathiassen, 2012). The more information collected, through multiple methods and sources, the better the credibility of the findings and discussion, as explanations have a stronger foundation and become more sound (Benedichte Meyer, 2001;

Harder, 2012). When collecting data, the parameters necessary for data collection were identified, to certify that the data collected would significantly contribute to answering the research questions. This includes the sources of data (*Section 2.2.3.2*) and the quality of documents obtained and analysed (*Section 2.2.3.3*). Document analysis and in-depth interviews represent common means of data collection procedures (Creswell, 1994; Stake, 1995; Prior, 2003)

The research initiated the data collection process through document analysis of the two case studies, South African real estate transactions and blockchain-based real estate transactions. Document analysis was used due to the availability of official documents, resources, and publications pertaining to the two transactions and this contributed to an understanding of the processes involved. Subsequently, document analysis culminated in the creation of the first two business process models using BPMN (*Figure 3.9:* South African Real Estate Transaction Process: Business Process Model *and Figure 5.3:* Blockchain-based Real Estate Transaction Process: Business Process Model). From these two models, an integrated business process model was constructed (*Figure 6.3*), illustrating how blockchain technology can aid South African real estate transactions and land registry systems.

This integrated model was then evaluated by key stakeholders through in-depth interviews. Potential interview participants were initially contacted through email, and the study briefly explained. If participants expressed a willingness to assist, a date and time and method of interview (telephone or video call) was arranged. Interviewees were sent their questions, the integrated model, as well a two-page summary of the study. The interviews varied in length, as is the case with semi-structured interviews, from 30 to 60 minutes, with each interview being voice recorded, as per consent given from each participant (Yin, 2011).

Document Analysis

Document analysis was employed as there was sufficient documentation, publications, reports, and articles, pertaining to the study. According to Bowen (2009) document analysis is applicable for qualitative case studies. This is useful when the research aims to disclose information about a specific phenomenon through analysis of available documents and reports, which provide a rich description of a single scenario. Analysis provided an orderly approach for reviewing and inspecting the documents and their content to develop an understanding of the transaction processes. Documents obtained, either digital or manual, can provide significant value and contribute substantially to a study. Where direct observation or involvement in the case study is not possible (as was the circumstance in this study), documents serve as one of

the most effective and the most viable options when collecting data (Stake, 1995; Bowen, 2009). In describing the use of documents in social science research, Prior (2003, p.03–04) states:

> *"Document content is important and there are numerous routes by means of which such content may be studied. We should not, however, let the presence of content bedazzle us to the exclusion of other qualities. Above all we should recognise the quality of documents as things, as things that can be produced and manipulated, used or consumed, and as things that can act back on their creators. Text and documentation are not only produced, but also, in turn, are productive."*

Document analysis was therefore a suitable data collection method for this study as:

- The cases being researched, South African real estate transactions and blockchain-based real estate transactions, had either taken place prior to this research or taken place overseas.
- The study was not able to participate in or observe the transactions that occurred, and transaction documents served as the best medium for obtaining the correct the necessary information.

In-Depth Interviews

The integrated model was evaluated by various stakeholders, each possessing specialist knowledge in their field, in other words, real estate, blockchain technology, or PropTech. This evaluation occurred by in-depth semi-structured interviews. These interviews also provided a deeper level of understanding regarding the areas of interests. In discussing the meticulous and detailed information that interview participants can provide, Prior (2003, p.97–98) states:

> *"The emphasis that social scientists commonly place on human actors manifests itself most clearly in the attention that they give to what such actors say and think and believe and opine."*

The principal investigator prepared and organised questions prior to the interview, but some improvisation was necessary, depending on the context and the environment in which the interview occurred. Semi-structured interviews are the most commonly adopted interview

approach in qualitative research (Conboy, Fitzgerald and Mathiassen, 2012; Yilmaz, 2013). According to Smith and Osborn (2015, p.57) qualitative interviews, specifically semi-structured interviews, allow the study to enter novel areas and obtain richer information.

> *"…probably the best way to collect data for an IPA study and the way most IPA studies have been conducted is through the semi-structured interview. This form of interviewing allows the researcher and participant to engage in a dialogue whereby initial questions are modified in the light of the participants' responses and the investigator is able to probe interesting and important areas which arise."*

One of the main benefits of the semi-structured approach is that it allows new questions and discussions to arise, affording the opportunity to explore deeper contexts and situations perhaps not originally expected (Klein and Myers, 1999; Yin, 2011). Thus, a semi-structured nature not only allowed the topic areas to be investigated in this study but also allowed for the emergence of new information. Therefore, the principal investigator needed to be fully focused at all times and listen carefully in order to construct new questions and engage further (Smith and Osborn, 2015). All questions were thoroughly prepared prior to the interview, mapped against the literature informing them, the research questions addressed, the literature opportunities/challenges addressed, and the aspects of the integrated model addressed. This approach to development of the interview questions added rigour to the data collection process through illustrating the connections throughout the study. The tables of interview questions are contained in *Appendix A.*

Interview Protocol

The purpose of the interview protocol was to ensure adherence to ethical considerations and to provide structure to the process of data collection.

1. The opportunities and challenges identified in the literature review, together with the integrated business process model, assisted in creating the official interview guide.
2. The principal investigator then contacted 16 participants (key stakeholders) via email to enquire whether or not they would be willing to contribute to the study.
3. Upon agreement to participate in the interview, a date and time was arranged as well as a method of interview. The participants had the option of either a telephone call or a video call through Skype, Zoom, or WhatsApp.

4. The principal investigator obtained signed letters of consent before every interview. Each participant signed consent to participate in the interview as well as have it voice recorded. All participants were sent their interview questions, a summary of the study, as well as the integrated business process model that had already been produced.
5. Once the interview started, participants were thanked for their willingness and given the right to terminate the interview at any time. All participants were reminded that the call would be voice recorded.
6. Upon completion of the interviews the recordings were transcribed while maintaining the confidentiality for participants.

2.2.3.2 Sources of Data

Qualitative research is known to use multiple sources for data collection in order to add increased integrity into the process (Creswell and Plano Clark, 2007; Yin, 2011). In this study the collection instrument was the documents themselves due to their relevance and availability. Document analysis did not constitute the collection of primary data but was carried out in order to develop the business process models in *Chapters Three* and *Five* as well as assist in formulating the interview questions. This study collected its primary data through in-depth interviews from various key stakeholders. Non-randomised purposive sampling was used. According to Yin (2011) purposive sampling allows the research to yield the most relevant data, due to interaction with specialised individuals who possess specific knowledge in an area.

The participants were selected based on the knowledge they possessed in their specific areas. Blockchain technology introduced itself to the world in 2009, when a ground-breaking research paper was released putting forward the concept of a digital currency, Bitcoin. This cryptocurrency, and all others, functions through its underlying technology, blockchain (Nakamoto, 2008). This nascent technology has the potential to revolutionise many industries, with real estate representing one of its prime use cases. In 2017 there was a significant transition in the PropTech sector, from PropTech 2.0 to PropTech 3.0. PropTech 3.0 is characterised by emerging technologies such as blockchain (Baum, 2017) and their involvement in real estate transactions and land registry systems. The blockchain industry is a mere 11 years old while PropTech 3.0 is entering its third year. The combination of the two was always likely to yield participants with only a few years of experience. Therefore, participants with less specialist experience than traditionally be deemed necessary in long-standing fields (for example, Senior IT managers) were considered to be valuable knowledge experts.

2.2 Research Design

As this study covered various integrated aspects, it was necessary to gain the insights of professionals who only specialised in their respective areas, as well the integrated areas of blockchain technology and real estate. This approach of obtaining information from various participant groups is supported by Yin (2011) who states that it will allow the study to gather a broad range of information and perspectives as well as ensure that all concepts of the research and research questions are adhered to. Participants from these groups were selected as key stakeholders within their field, being either:

- Conveyancing Stakeholders.
- Blockchain Stakeholders.
- PropTech Stakeholders.
- Information and Communications Technology (ICT) Legal Stakeholders.

Although not directly related to the use of property in technology, *conveyancers* possess specialist knowledge with regards to the current South African real estate ecosystem and its transactions and land registry systems, making them a valuable source of information. Three participants were interviewed on their views of the current transaction process and where they think technology can assist. *Blockchain stakeholders* offered insight into the technological aspects of how such a technology could be integrated into traditional systems. The questions in their interview guide focused specifically on a technical point of view to better understand how blockchain technology can be incorporated into real world operations, and more specifically into real estate transactions. Five *stakeholders* were interviewed in this group. *PropTech stakeholders* provided the necessary information regarding how the technology is currently being used within the real estate sector as well as its future potential in the space. This *stakeholder* group arguably represented the core participant group in the study, possessing both real estate and blockchain knowledge. As a result, it was the largest group, with seven participants. The use of technology in any business process, especially those involving governmental transactions and records, will need to abide by certain regulations. It was therefore necessary to engage with an *ICT legal stakeholder*. One participant was interviewed on potential laws and bills relating to technologies as well as the possibility of emerging technologies entering current processes. The study gathered information from these participants through 16 in-depth, anonymised interviews. According to Smith and Osborn (2015), qualitative studies tend to draw on smaller sample sizes, ranging from six to twelve participants. Smith and Osborn (2015, p.56) go on to define the sample size as follows:

> *"...IPA studies to be conducted with a very small number of participants. A distinctive feature of IPA is its commitment to a detailed interpretative account of the cases included and many researchers are recognising that this can only realistically be done on a very small sample."*

The four participant groups were larger than the average amount of typical qualitative studies and thus resulted in a slightly bigger total sample size. However, within each participant group, no more than seven participants were sampled, following guidelines of the qualitative nature of eliciting in-depth knowledge from smaller sample sizes. Participants not only came from different areas of specialisation but brought with them different social and contextual backgrounds. Therefore, the research collected a range of information which was rich in quality as well as depth (Schwandt, 1998; McGregor and Murnane, 2010).

2.2.3.3 Data to be Collected

The two respective data collection instruments will be further described below.

Document Analysis

This was undertaken to understand the two case studies, representing the two types of transactions. Documents were collected, inspected, analysed, and the necessary information was extracted. This assisted the study in the construction of the first two business process models (*Figures 3.9 and 5.3*). According to Bowen (2009), to add rigour to a study making use of document analysis, the research should provide a list of the documents analysed. In constructing the business process models, the following documents were analysed:

South African real estate transactions

- Schindlers, 2016: Property Law Manual.
- Louise Tonkin, 2012: Property Transfer Guide: Meeting Your Unique Needs.
- SA Home Loans, 2016: Your Complete Guide to Buying a Property.

Blockchain-based real estate transactions

- Propy, 2017: Propy Completes the First Real Estate Deal Recorded on Blockchain in the US.
- Propy, 2017: Global Property Store with Decentralised Title Registry.

- Karayaneva, 2017: How A Smart Contract replaced An Escrow Company in a $60k deal.
- Brett, 2018: Propy sells Sevilla property via blockchain: a first in the EU?
- Voloshyn, 2017: Technical Overview: The First Real Estate Deal on the Blockchain.

After document analysis, and the consequent business process models, it was possible to create the integrated business process model illustrating how blockchain technology can be integrated into the South African transaction process (*Figure 6.3*). This was done through the inspection of each individual model in isolation and drawing upon aspects and areas of integration based on the study's interpretations and understandings.

In-Depth Interviews

This study drew on data and opinions from four key stakeholder groups, Blockchain stakeholders, PropTech stakeholders, Conveyancing stakeholders, and ICT Legal stakeholders. Document analysis was carried out in order to develop the business process models produced. Both the opportunities and challenges identified in the literature review and the models created were used in the construction of the interview guide to ensure that the right questions were asked. Bowen (2009) states that document analysis can assist in generating interview questions, illustrating how one method of data collection compliments another method in an interactive manner. While it is important to ask interview questions that yield insightful answers, it is vital to ensure that the questions asked are relevant to the study and its research objectives. According to Noor (2008) this issue of misalignment between 'interest' and 'relevance' is commonly encountered in qualitative research. It is necessary to ask questions that are open-ended and that can lead to further discussions such as '*How*' and to be wary of asking '*Why*' questions (Snape and Spencer, 2003; Yilmaz, 2013).

In constructing the interview questions, the study developed four interview guides (*Tables 2.1 to 2.4*), one for each participant group. Within each group, a maximum of five questions were asked. The complete interview guide (*Appendix A*) consisted of a table which described the five elements in relation to the interview question: the purpose of the question, the literature informing the question, the research question addressed, the opportunities and challenges (*as per the literature review*) addressed, and the aspect of the integrated model addressed. This was done in an attempt to add rigour to the study and to ensure that the interview questions asked provided information of substantial quality that could be used to

answer the study's main research question. Questions were open-ended to allow for follow-up questions to be asked.

Table 2.1: Summarised Interview Guide: Blockchain Stakeholders Interview Questions

#	Interview question	Purpose of question
1	What opportunities does blockchain technology offer in terms of record-keeping, taking into account digitisation of documents and digital signatures?	Blockchain technology represents a decentralised digital ledger containing transactional records. According to Vos (2017) and Bal (2017) real estate record-keeping represents one of the technology's biggest use cases. By implementing a blockchain-based land registry, digitisation and automation can occur. This is in contrast to traditionally manual approaches. Through blockchain-based record-keeping systems, transparency is improved as real-time tracking of transactions is possible. Records are more secure as records on blockchain are immutable and transactions are enhanced as costs are reduced are processes are expedited Bal (2017). The purpose of this question is to gain views on how blockchain-based record-keeping can trump manual approaches and the advantages thereof. Furthermore, it aims to uncover what needs to be considered for putting ownership records onto a blockchain network. These answers can then be applied in relation to property records and how a blockchain-based land registry solution could operate.
2	How would core characteristics, such as immutability and transparency, influence adoption of blockchain-based operations?	In S*ection 4.5* of the literature review immutability and transparency were recognised as key characteristics (and thus opportunities) for blockchain technology's involvement in the estate sector. Transparency allows all records on blockchain to be visible to all participants in a network and immutability means information in the ledger cannot be tampered with (manipulated or deleted), making it both safer and more trustworthy Malviya (2017) and Veldhuizen (2017). This purpose of this question is to understand whether or not blockchain stakeholders see these benefits in the same light as the literature. This question is also aimed at probing their views on the main aspects that can drive the acceptance and adoption of blockchain technology both in South Africa and globally.
3	Real estate transactions represent a cumbersome business process – one that primarily adopts a manual paper-based approach comprising various stakeholders and costs. In light of this, how could blockchain technology's qualities such as: transparency, accessibility and speed, and cost reduction, be integrated and used to impact the business process of real estate transactions?	Throughout the literature review, blockchain technology's applicability in the real estate sector was highlighted. Real estate transactions can benefit from: increased speed through smart contracts; concurrent payments and transfers through smart contracts; improved real-time transparency; and reduced fraud as property ownership can be clearly stated, verified, and immutably recorded. The purpose of this question is to determine how applicable stakeholders view blockchain's use in the real estate sector. Additionally, this question probes to determine where the technology can be best adopted in the real estate sector – primarily in transactional tasks or in property record-keeping through a blockchain-based land registry.
4	Once information is entered into blockchain's ledger it is near impossible to edit and change this information. As a result, it is important that initial information is correct. How would you view both the opportunities and challenges that this brings to real estate transactions and record keeping, given that South Africa (a developing country) has a strong history related to corruption and ambiguity surrounding governmental administration procedures?	From *Section 4.6.2* a key challenge for blockchain's implementation was identified – importing the correct initial property information and ownership rights for a blockchain-based land registry system. Graglia and Mellon (2018) state that records should be entirely correct before being imported onto the blockchain. This is reiterated by Veuger (2017) who states that initial consensus of property rights is vital before records are uploaded to an immutable network. Barbieri and Gassen (2017) sum it up by saying that blockchain technology will not solve the problem of corruption – disputes on property ownership rights will not be rectified by the technology. Once the correct initial information is uploaded, then blockchain's true potential will be realised. This question aims to understand the severity of this challenge in terms of blockchain-based record-keeping. It enquires whether or not a move towards blockchain-based record-keeping systems will be more beneficial than current manual and paper-based systems employed, once (if) hurdles are overcome.

Table 2.2: Summarised Interview Guide: PropTecc Stakeholders Interview Questions

#	Interview question	Purpose of question
1	How would you view the impact that blockchain technology has already had on the real estate sector, taking into account the challenges that come with the adoption of emerging technologies?	The integration of technology in the real estate sector is known as PropTech. However, literature shows that real estate practices have been slow to adopt new technologies. PropTech 3.0 sees the incorporation of blockchain technology but with new technologies and new business processes, come new challenges. An obstacle for emerging technologies is the legality involved – for blockchain to be used in real estate transactions, a legal framework must be developed (Couse, 2017; Graglia and Mellon, 2018). Nevertheless, real estate blockchain start-ups are tackling land registration systems and real estate transactions - partnering with governments for blockchain-based transaction laws to be passed (Karayaneva, 2017). Given the technology's involvement in the real estate sector, this question aims to find out the degree to which blockchain is impacting real estate and how. In essence, this question will seek to understand the core aspects of, and areas where blockchain technology has penetrated the real estate sector and will provide knowledge on its implementation and adoption despite present obstacles.
2	Smart contracts can provide increased security and transparency to transactions. How do you view the opportunities that smart contracts, in blockchain technology, can bring to real estate	Smart contracts offer an alternative to traditional paper-based contracts (*see Section 4.3.1*) – representing digital automated contracts that are self-executing once predetermined conditions are met. According to Bal (2017), smart contracts ensure that digitised contracts are regulated by predetermined rules – allowing smart contracts to certify that real estate transactions adhere to government regulations in a land registry

	transactions, taking into account the traditional processes used?	system. Smart contracts need data fed into them. This is made possible through oracles (*trusted 3rd parties on a blockchain network)* – which may prove to be beneficial in real estate transactions. Smart contracts also permit for real time status tracking of transactions. The purpose of this question is to examine how influential smart contracts can be in real estate transactions and how they can be employed. Due to the nature of real estate transactions, the question aims to probe participants to elaborate on oracles and their potential inclusion to smart contracts.
3	Blockchain technology represents the underlying technology on which cryptocurrencies run but that is just one application of the technology. Physical assets, such as real estate, can be represented and virtually stored on blockchain's networks through tokens – "asset backed tokens". In your opinion, how can tokenisation of physical properties enhance real estate practices, taking into account how it would be executed and the benefits it can provide thereafter?	Representing physical assets on the blockchain can occur through tokenisation. Digital tokens can represent physical property - storing property information and being linked to the blockchain address of the owner. Tokenisation allows for fractional and shared ownership (more common in commercial real estate). These tokens aid quicker transaction turnaround times as smart contracts are embedded into them meaning upon completion of predetermined conditions, tokens can be seamlessly transferred. The purpose of this question is to uncover the value of tokenising physical assets such as real estate. While fractional ownership is usually discussed in conjunction with commercial real estate, the possibilities of it in residential real estate will be discussed (*i.e. a couple wants a property in both of their names upon title transfer*). Information on how tokens can be traded and enhance the process will be collected. This question addresses areas of digital identities, not only for people but also for assets.
4	Once information is entered into blockchain's ledger it is near impossible to edit and change this information. As a result, it is important that initial information is correct. How would you view both the opportunities and challenges that this brings to real estate transactions and record keeping, given that South Africa (a developing country) has a strong history related to corruption and ambiguity surrounding governmental administration procedures?	From *Section 4.6.2* a key challenge for blockchain's implementation was identified – importing the correct initial property information and ownership rights for a blockchain-based land registry system. Graglia and Mellon (2018) and Veuger (2017) state that records should be entirely correct before being imported onto blockchain's immutable network. Barbieri and Gassen (2017) state that blockchain technology will not solve the problem of corruption – disputes on property ownership rights will not be rectified by the technology. Once the correct initial information is uploaded, then blockchain's potential will be realised. This question aims to understand the severity of this challenge in terms of blockchain-based record-keeping. It enquires whether or not a move towards blockchain-based record-keeping systems will be more beneficial than current manual and paper-based systems employed, once (if) hurdles are overcome.
5	There exist numerous blockchain-based real estate start-ups that accommodate for either property transactions and/or land registration (Propy, ChromaWay, Ubitquity etc.). For blockchain-based real estate start-ups entering the PropTech sector, what aspects (of current real estate transactions) do you believe need immediate technological intervention and adherence?	The literature review revealed there exist various real estate blockchain-based start-ups working on transactions and land registry systems – Propy, ChromaWay, and Ubitquity (Graglia and Mellon, 2018). This paper focusses on Propy, who have conducted numerous real estate transactions through blockchain technology as well implemented blockchain-based land registries. The purpose of the question is to uncover how accommodating real estate practices are for blockchain's involvement and to reveal where the technology is needed most when considering the current transaction process. The question will probe the participants into answering whether or not they are familiar with PEXSA (*a South African based e-conveyancing platform with identical characteristics to blockchain*) and how it assists in South African real estate transactions.

Table 2.3: Summarised Interview Guide: Conveyancing Stakeholders Interview Questions

#	Interview question	Purpose of question
1	How would you describe the current processes of real estate transactions in South Africa, while specifically considering the costs, time, stakeholders involved, and the transfer of funds and property rights?	The literature review conducted on South Africa's current real estate sector (*see Section 3.2*) revealed four areas of concern – predominantly paper-based, multiple stakeholders, costs, and a mismatch in payment for property vs transfer of title. Amadi-Echendu (2013) and Stoman (2017) believe the process is too reliant on intensive human resources resulting in lengthy transaction turnaround times. PEXSA (2017) stress the inefficient practice of funds being transferred before the title changes ownership represents a situation of risk for the buyer. The purpose is to ascertain whether or not conveyancers in the current market share this point of view and how they would describe the real estate transaction process.
2	Many of the processes involved in South African real estate transactions (such as FICA, bonds, and deeds) are conducted manually and supported by paper-based documents. How would you view this manual approach which is reliant on paper-based documentation, in terms of transaction transparency and overall efficiency?	Real estate transactions in South Africa are dominated by paper-based processes with manual methods of inputting the information. There exists a minimum of 25 physical paper-based documents needed per transaction. Stoman (2017) states that the pressure on the conveyancers coupled with large volumes of paper-based records is prone to error and fraud. Consequently, transaction transparency (specifically to buyers and sellers) is blurred, and stakeholders are reliant on asking others to inform them. However, Couse (2017) mentions that people tend to prefer physical dealings and interactions when it comes to high value assets (real estate), stating that full trust in a decentralised solution which manages information and documents will take time. The purpose of this question is to understand conveyancers and deeds official's views towards how paper-driven the process is and how a manual approach hinders transparency and efficiency. This question will probe participants to share their opinions on moving towards digitised and automated processes where information capture is seamless manner and once recorded, available for real-time view to everyone involved.
3	In what stage of South African real estate transactions do you believe technological innovations could significantly enhance the process?	Blockchain technology has assisted real estate transactions in three core areas – reduced paper-based operations through digitisation, concurrent payments and transfers through smart contracts, and an immutable record keeping through blockchain-based land registries Vos (2016). This question will examine where current conveyancers believe technology can assist the process. Their views will either agree with the literature or give insight into other key areas where property transactions could benefit from technological innovation. This question aims to uncover the motivations for why the technology should be integrated into South African processes.

4	In December 2017, South Africa passed the Electronic Deeds Registration System Bill – intending to expedite the deed registration process and increase transaction turnover times. These intentions replicate those of blockchain technology. In your opinion, how does this legislation support the potential use of blockchain technology for South African real estate transactions?	In 2017, the e-DRS bill was passed in South Africa – allowing conveyancers to lodge deeds electronically (digital documents) thus reducing paper-based documents and saving time. The e-DRS has not yet been fully developed or implemented but the bill is being circulated and finalised. A pilot phase was conducted in July 2018 when the Bloemfontein deeds office lodged the first electronic deed. Furthermore, the Payment Exchange of South Africa (PEXSA) platform was launched in May 2017 – for concurrent delivery vs payment (funds and title transfer) in real estate transactions. PEXSA allows South African real estate transactions to be settled electronically in a streamlined manner. Thus, local laws and systems for e-conveyancing are being put in place and a move towards digitisation in real estate is occurring. The purpose of this question is to uncover where South Africa is in terms of technology assisting real estate transactions. Furthermore, the question seeks to understand how and when a technology such as blockchain can be accepted into South Africa's legal framework, given the above-mentioned movements. In essence, this question looks to gain a conveyancing perspective on when/how such technologies can be legitimately incorporated into lawful transactions. The question seeks to expose the views of conveyancers towards technological assistance and whether they deem it necessary.
5	In your opinion, what are the major challenges preventing the adoption of emerging technologies (specifically blockchain technology) in real estate transaction processes?	Five challenges for blockchain's involvement in the real estate sector were identified (*see Section 4.6*). Of the challenges, the need for a legal framework that accounts for blockchain technology would need to be developed. Furthermore, when incorporating any new systems, skills will be needed for implementation and maintenance. Thus, the role of conveyancers may shift. Implementing a blockchain-based solution in a third world/developing country has been questioned. Vos (2016) states that developing nations usually have corruption issues and current property rights may not be a true reflection of reality. Thus, the question aims to understand the views in terms of challenges and whether these align with literature. Based on the answers given, this question will seek to uncover how participants think their role (as a conveyancer) could shift with the introduction of newer technologies involved in the process.

Table 2.4: Summarised Interview Guide: ICT Legal Stakeholder Interview Questions

#	Interview question	Purpose of question
1	Blockchain technology permits the use of smart contracts with digital signatures as well as facilitating payments being made in cryptocurrency. For blockchain-based real estate operations (smart contracts; blockchain-based property documents; and cryptocurrency payments) to be deemed lawfully acceptable, what aspects will need to be considered and what will need to be put in place by South African conveyancing/legal regulations?	The term PropTech refers to how technology is used and incorporated in the property market. Currently in its third phase, PropTech 3.0 involves blockchain technology being utilised in land registries and property transactions (*see Section 4.4).* As per Couse (2017) and Karayneva (2017) legislation for blockchain technology has been passed in various nations such as America, Brazil, and Ukraine. Such legislation permits the acceptance of digitised documents and cryptocurrency payments. Furthermore, companies such as Propy are partnering with government officials to offer both a blockchain-based real estate transaction platform and land registry system. These nations have recognised the efficiency that PropTech 3.0 brings and are adopting emerging technologies. However, for blockchain-based operations to be legally accepted, a legal framework needs to be developed. The purpose of this question is to ascertain where South African legislation is in terms of emerging technologies and technologies used in government recognised transactions. Furthermore, the question aims to understand the legal challenges that come with emerging technologies. The use of blockchain technology in real estate transactions will require a legal framework to be developed and this question seeks to elaborate on when and how such a framework will come about.
2	What role do you think digital identities could play (both for individuals and for assets) in online transactions, taking into account reducing paper-based processes (such as FICA in South African real estate transactions) and security of verified identification?	In conducting the literature review on the South African real estate sector, the reliance on the paper-based process was highlighted (*see Section 3.2.1*). Of the paper-driven process is the FICA documents required by both transacting parties. Buyer and seller are required to submit five physical documents each to the conveyancers involved as well as the municipalities when obtaining rates and clearance (*see Section 3.5.4*), Schlinders (2016). This leads to duplicated information in various siloed systems. Research conducted by a number of authors suggest the use of digital identities for a more secure proof of identification as well as a safer environment of personal privacy, Amadi-Echendu (2016); Ahmed (2017); and Graglia and Mellon (2018). These authors state how blockchain technology can enable digital identities to be created for both individuals and properties (through tokens or coloured coins). A positive factor that these authors mention is that digital identities can be shared and made available for all parties involved in online transactions to whatever degree you wish as long as you can be legitimately and legally verified. The purpose of this question is to determine whether or not digital identities can serve as a valid form of identification for (online) transactions. Additionally, this question seeks to open doors relating to the benefits they could provide (reduce fraud and identity theft and reduce paper-based processes) and the challenges that they possess (access controls and hacking). Primarily, this question aims to evaluate the legality of online digital identities and whether or not digital identities can be legally accepted.
3	In December 2017, South Africa passed the Electronic Deeds Registration System Bill – intending to expedite the deed registration process and increase transaction turnover times. These intentions replicate those of blockchain technology. In your opinion, how does this legislation support the potential use of	In 2017, the e-DRS bill was passed in South Africa. This bill allows the conveyancer to lodge deeds electronically thus reducing paper-based documents and saving time as they do not have to be physically present at the deeds office. The e-DRS has not yet been fully developed and implemented but the bill is being circulated and finalised. However, a pilot phase was conducted in July 2018 when the Bloemfontein deeds office lodged the first electronic deed. Furthermore, the Payment Exchange of South Africa (PEXSA) platform was launched in May 2017. PEXSA represents a platform with concurrent

	blockchain technology for South African real estate transactions?	delivery vs payment (funds and title transfer) in the real estate sector. The e-conveyancing platform allows real estate transactions in South Africa to be settled electronically in a streamlined manner. As can be seen, laws and systems for e-conveyancing are being put in place in South Africa and there seems to be a move towards digitising real estate transactions. The purpose of this question is to uncover where South Africa is in terms of technology assisting real estate transactions. Furthermore, the question seeks to understand how and when a technology such as blockchain can enter and be accepted into South Africa's legal framework, given the above-mentioned movements. In essence, this question looks to gain a legal perspective on when/how such technologies can be legitimately incorporated into lawful transactions.

2.2.3.4 Data Recording and Organisation

When conducting a qualitative study, it was anticipated that large amounts of data would need to be stored and organised. Technological solutions therefore exist to assist studies conducting qualitative analysis to organise large amounts of documents generated from transcriptions (Baxter and Jack, 2008; Silver and Lewins, 2014). These software solutions are formally known as CAQDAS (Computer-Assisted Qualitative Data AnalysiS). CAQDAS software is a project management tool which allows one to efficiently organise and store qualitative data. These tools only support for the storage and organisation of data, but do not assist in conducting the analysis, which is primarily down to the principal investigator (Castleberry and Nolen, 2018). Atlas.ti[4] was used for this study. The interviews were transcribed by the principal investigator to connect with the data. The transcriptional documents were then imported into the program for review and analysis. Atlas.ti was used to give a complex and deeper view of the data, aiding a stronger analysis. Atlas.ti allowed for relationships between themes to be viewed in context with one another. This gives a clear overview of the data and the chance to link and present aspects in a more coherent and free flowing manner.

2.2.3.5 Data Analysis

This study followed an inductive approach together with thematic analysis. Despite its use in many qualitative studies, thematic analysis is not often given the introduction and definition it requires (Boyatzis, 1998; Silver and Lewins, 2014). In defining thematic analysis, Boyatzis (1998, p.04) states that it is:

> *"…a process for encoding qualitative information. The encoding requires an explicit code…[which] may be a list of themes…[where] a theme is a pattern found in the information that, at minimum, describes and organises the possible observations and, at maximum, interprets aspects of the phenomenon."*

[4] https://atlasti.com/

Thematic analysis is a reoccurring method of analysis within interpretive and qualitative studies and remained the cornerstone of this study's analysis technique. It is a beneficial approach of analysis for novice researchers (Creswell, 1994; Creswell and Plano Clark, 2007). Thematic analysis allowed for the detection of patterns and the uncovering of meaning not typically apparent to other techniques, demonstrating its interpretive analytical nature (Boyatzis, 1998). Furthermore, it permits analysts to relate the data to ideas about the data and aids the process of understanding by increasing the accuracy with which one interprets a given phenomenon. This study made use of the thematic analysis method posited by Braun and Clarke (2006) who put forward a six-phase approach: familiarisation, initial coding, theme searching, theme reviewing, theme defining, and reporting.

During phase one, the principal investigator familiarised themselves with the data collected by personally transcribing all of the interviews, connecting them to the information before analysis occurred. After each transcription, a brief summary of each account was produced and the transcriptions and summaries would then be read again during execution of analysis, illustrating the iterative process of becoming acquainted with the data (Braun and Clarke, 2006). Through this compiling process of organising, arranging, preparing, and transcribing all of the data, the study was able to commence interpretation of the data and begin to search for answers, leading to a meticulous approach of analysis.

Phase two required the development of initial codes pertaining to the various aspects presented in the transcripts. Here, the data was dismantled and assigned to relevant groups, categories, formally known as themes. The activity of coding requires recognition of interesting ideas and concepts that are present in the transcriptions, linking to the research questions and concepts discovered in the literature review. For this reason, the study recognised that an element of deduction did initially occur but posited that an inductive approach constituted the most part of the analysis and interpretation procedure as more meaning became apparent from within the information. Here, raw data was transformed into usable data and the resulting outcome was that of an initial coding framework (Braun and Clarke, 2006). This coding framework consisted of several themes, each with multiple data extracts attached to them.

Phase three, searching for themes, began with developing candidate themes as codes from the previous phase were now grouped and categorised. The respective codes and their extracts were analysed in context, and alongside one another, to recognise similarities and differences which led to the creation of themes. Essentially, cross-code analysis showed a distinct patterned response visible through multiple codes, which allowed themes to be

formulated. During phase three, semantic themes and latent themes became clear. Semantic themes presented themselves directly from the text in the interview transcriptions while latent themes went beyond the semantics of the data and required more interpretation based on ideas and concepts in the study. The developed themes began to portray the bigger picture and comprised several codes. Candidate themes, regardless of how significant or insignificant the research deemed them to be, were all kept as they were to be merged in phase four. Phase three culminated in the expansion of the initial coding framework whereby codes and extracts were linked to the identified themes. During this phase, the research began producing the thematic maps.

In executing phase four, the candidate themes were refined either through the identification of new themes, merging of themes, or discarding of themes. Here, the final coding framework was presented. Yin (2003) says that the process of assigning codes and defining and refining themes sees the research involved in a continuous process of interpretation. Phase five involved formally defining each of the candidate themes by providing a clear description to go with the theme's label/name, as is evident in the discussion in *Chapter Eight*. Phase five ended with the creation of the final thematic map. Lastly, phase six was concerned with the detailed analysis of each theme within the framework of the final thematic map, created at the end of phase five, and how these themes related to the integrated business process model. Once all themes were analysed, refined, and defined, phase six commenced, reporting on the findings. Here, the research provided a detailed reporting and analysis for each of the themes. In this phase, the study attempted to use the data collected and analysed to answer the research questions.

2.3 Approach to Model Development

When analysing data, developing concepts and generating knowledge, studies can follow an inductive, deductive, or hybrid approach. An inductive approach, often termed as inductive reasoning, moves from specific instances into a more generalised conclusion, developing knowledge, concepts, and constructs along the way (Hayes, Heit and Swendsen, 2010). A key use of an inductive approach happens when the research intends on developing a model, or models, which depict the structure of processes and information systems that are evident in the collected and analysed data. When conducting inductive research, the research examines raw data with no prior theories or coding structures, instead developing these along the way and themes and patterns emerge from collected data (Castleberry and Nolen, 2018). Inductive reasoning is described as a bottom-up approach in that multiple premises, all believed true, are

combined to reach a specific conclusion. Detailed observations of the world are used to produce abstractions and generalisations through the recognition of themes, patterns, and ideas. However, conclusions drawn in inductive research are said to be probable, possessing more certainty based on the strength of data collected (Yin, 2011). Induction methods are particularly useful when exploring new and emerging topics, areas or phenomena. Both Hayes, Heit and Swendsen (2010) and Yin (2011) agree that inductive approaches are more common in qualitative research. In contrast, deductive works move from the generalised values, known to be truthful, towards a precise and specific conclusion, which can be described as certain. Deductive studies attempt to test and confirm existing theories and are more commonly associated with quantitative methods through statistical analysis (Hayes, Heit and Swendsen, 2010). This interpretive study adopted an inductive approach whereby inductive reasoning was used throughout for the following reasons:

- This interpretive study made use of qualitative methods in data collection and data analysis, making it more fitting to inductively conduct the research.
- This research investigated two specific cases studies of real estate transactions, South African real estate transactions and international blockchain-based real estate transactions and illustrates the potential integration of the two on a general scale.
- Inductive approaches are particularly advantageous when exploring new and emerging topics, as is the case with blockchain technology in real estate transactions.

2.4 Business Process Modelling and Notation (BPMN)

The goal of this research was to produce an integrated business process model. Prior to this, and mentioned in *Section 1.3*, two business process models representing two types of real estate transactions would have to be produced. These process models were constructed using the Business Process Modelling and Notation (BPMN) technique.

A business process is a structured and measured set of activities which are designed to produce a specific output (O'Loughlin, 2009). Processes can be defined as specifically ordered activities, with a beginning and an end, that take inputs are convert them to outputs. When offering a service to customers, a '*process approach*' is encouraged when defining how processes run. This approach considers processes from a customer point of view with the goal of process efficiency and product value (O'Loughlin, 2009; Keramati, Reza Golian, and Afshari-Mofrad, 2011). In terms of this research, real estate transactions (regardless of the transaction type) represent a collection of processes which are grouped together with the

intention to streamline the property transaction process (Bajaj and Ram, 1996). As will be seen with regards to the current transactions (*see Chapter Three*), these processes are not as efficient as they could be which means that the transaction process as a whole is a strenuous and enervated endeavour for all participating stakeholders (*see Figure 3.9*). By modelling international real estate transactions that utilise blockchain technology (Figure 5.3), the research was able to combine the required elements from each of these models and put forward an enhanced business process for South African real estate transactions (*Figure 6.3*).

A business process model can be defined as a formal representation of an organisation's workflow performed, alongside the associated information, when delivering a product or service. A business process model will define which business group or stakeholder performs specific processes (Bajaj and Ram, 1996; O'Loughlin, 2009). Through business process modelling, a proposed plan for the successful implementation and execution of business activity can be put forward. BPMN was chosen as it is a modelling methodology applicable for detailed and complex business processes (Wohed, et al., 2006). According to Aguilar-Saven (2003) modelling business processes is increasingly common as it adds value to business and systems, allowing an understanding of the complete process from start to finish. BPMN 2.0 represents a modern notational tool having been officially released in 2014. There are numerous notational modelling tools available, such as BPMN, Unified Modelling Language (UML), and Event-driven Process Change, however, a recent study of 37 participants who are actively involved in business process modelling showed that the majority (64%) recommend BPMN (Marrella, et al., 2015).

A sound understanding of the current process was needed to model these processes. F*igures 3.1* to *3.8* were modelled using Business Modelling Language (BML). Business Modelling Language (BML) is a process language that provides a business friendly and consistent approach for the identification, extractions, organisation, and communication of business knowledge and processes (O'Loughlin, 2009). A commonly used technique in BML is the W5 technique which assists in defining and modelling the current state of business processes. The W5 models are the *Who*, *What*, *Which*, *Where*, and *When* models. This technique was employed in *Chapter Three* whereby *What*, *Who*, and *Which* models were developed. The study did not deem the '*Where*' or '*When*' model necessary. These models were developed in order to comprehensively understand the current processes and stakeholder interactions for South African real estate transactions. In order to improve business processes and move towards enhanced solutions (involving innovative technologies such as blockchain), it is vital to understand how processes are currently conducted (O'Loughlin, 2009; López-

Pintado, et al., 2017). Business process modelling assists in describing activities and processes which in turn provides a roadmap for how these processes can be optimised, controlled, managed, and automated (Keramati, Reza Golian, and Afshari-Mofrad, 2011; López-Pintado, et al., 2017).

BML was born originally from the Information Engineering (IE) methodology. Information engineering was developed in the latter half of the 1980s with the goal of bringing process understanding to business systems, aiming to map the underlying structures and processes involved in developing information systems (Davids, 1992). To ensure that the models were constructed correctly, the research engaged with two BPMN stakeholders (not included in the 16 participants mentioned in 2.3.3.2) and asked them two questions on the notational correctness of the integrated model (*Table 2.5*). The integrated model's notation was adjusted according to their responses.

Table 2.5: Summarised Interview Guide: BPMN Stakeholders Interview Questions

#	Interview question	Purpose of question
1	In BPMN, models are connected through sequence flows and/or message flows which occur in swim-lanes within pools or across independent pools. Based on the models provided, are the flows of information illustrated correctly as per the specific notation?	In BPMN, business processes are presented as sequences of activities with connected flows linking said activities. When communicating within a swim-lane, sequence flows are typically used but when communicating across pools (i.e. communication between different actors) then message flows will be employed, Aguilar-Sven (2004). The purpose of this question is to ensure that the BPMN constructs that have been developed, abide by the correct notation. This question aims to make sure that activities and processes are connected through the right flows both within swim-lanes and across swim-lanes within pools.
2	In BPMN-based models, activities and processes can be carried out through various tasks (user, manual, service, etc). In the models provided, is the use of the various tasks correct, taking into account the action they are performing?	BPMN models represent business processes. Business processes are carried out by means of activities and tasks. Depending on the task at hand, there is specific notation to illustrate different activities (*i.e. is it manual? does it employ a system? Is it executed automatically?*) Aguilar-Sven (2004). In the BPMN diagrams constructed that illustrate real estate transactions, there exist many different tasks that are executed which all contribute towards achieving the main business process. The purpose of this question is to ensure that all tasks are properly represented for the activity that they are performing.

2.5 Summary

In this chapter, all the elements of the study's research design were explicitly defined. Specific attention was given to the research paradigm in which the study was carried out and the methods undertaken in data collection and data analysis. The summarised interview guides used in the data collection process which will inevitably answer the research questions were presented. The following chapter will explain the processes involved in South African real estate transactions and will be finalised with a business process model illustrating this process.

Chapter 3: South African Real Estate Transactions

3.1 Introduction

Chapter Two delineated the nature of how this research study was conducted, allowing for a full audit trail of the study's steps that were followed. The reader was presented with the methodological approach containing the methods of data collection and analysis that were employed. This chapter focuses on the current real estate sector in South Africa and its transaction process. It begins with an introduction into the South African real estate sector which is then followed by a precise overview and discussion of the South African real estate transaction process. Conveyancing law is defined as the legal procedure of transferring immovable property from one owner to another. In South Africa, ownership of immovable property is represented by the registration of a legal title deed. Real estate transactions are conducted by conveyancing attorneys, the only professionals who can sign off documents concerning the transfer of property. Within the South African real estate transaction process there are issues such as numerous costs, timely delays, the number of stakeholders involved, fraudulent financial activities, and cumbersome payment and settlement risk which can affect the process. Additionally, there is little transparency in the process and the buyers and sellers are often unaware of what stage the transaction is in. Properties are registered in the new owner's name before funds are transferred to the seller (Stoman, 2017) and there are several sub-transactions within this process such as obtaining finance or settling and paying taxes. All transactions contain information comprised of data and require documentation and payment. Thus, transactions can quickly become complicated. With more than 285 000 property transactions occurring per year in South Africa, it is important that this process be revisited in order to maximise efficiency and security (PEXSA, 2017).

3.2 The Current Real Estate Sector in South Africa

3.2.1 Paper-Based Processes

The current process of conducting real estate transactions in South Africa is largely manual. It is a paper-based and paper-driven process whereby a minimum of 25 pieces of physical documentation are needed per transaction (Schindlers, 2016; PEXSA, 2017). South Africa makes use of a deeds registry system where all records on properties (and their transactions) are stored. While the deeds registry system in South Africa is well functioning, it is has also

been described as antiquated due to the predominantly paper-based process that has failed to keep up with a modern digital society (Stoman, 2017). The same can be said for many real estate transaction practices around the world, as there is a consensus that property transactions have lagged behind in modernisation on a global scale. The paper-driven process has a knock-on effect as it makes the process extremely dependent on human resources. There is great pressure on conveyancing professionals to conduct these complex transactions in an efficient manner while also managing all the different stakeholders involved. In addition, property records and title deeds are stored manually by filing or uploading documents into centralised systems. With this comes an opportunity for fraud through hacking and document manipulation. There is also a risk of loss of documents through theft or natural disaster. Consequently, records are vulnerable and there is no guarantee that they will exist and be accessible forever (Louise Tonkin Inc, 2013; PEXSA, 2017). The process is susceptible to human error and administrative mistakes, process delays, and on a higher level, market disruption and security threats (Amadi-Echendu, 2013; Schindlers, 2016).

The manual approach that is taken when conducting and completing property transactions in South Africa is a primary reason for transaction duration. Conveyancers are required to manually request and obtain certificates from other stakeholders for the lodgement of documents at the Deeds Office. Manually scripting documents for signage opens the door for erroneous data to be input, which could slow the process and cause time delays. This paper-based process coupled with the inefficiencies above, combined with the stakeholders and documents needed and one can see how complex the process can become (Amadi-Echendu, 2013).

3.2.2 Multiple Stakeholders Involved

A minimum of 12 stakeholders are involved in the average South African property transaction. Most of the time this number is increased because among these stakeholders, certain tasks may be distributed or outsourced to specialists or other parties. For example, the local municipality is responsible for issuing a rates and clearance certificate but this job may involve more than one person within the municipality (Amadi-Echendu, 2013; Louise Tonkin Inc, 2013; Schindlers, 2016). With more stakeholders come more documents needed, more costs incurred, and a more complicated chain of events. Another drawback of having so many stakeholders involved is data redundancy (Stoman, 2017). While 25 documents may be the minimum number of documents needed for the transaction to take effect, these may be needed by more than one party in the process. Consequently, the same information may be stored both physically (across various locations) as well as being manually uploaded and added to more

than one system. This is due to the fact that not all of the systems used by all participating stakeholders are interlinked with one another and therefore, no common database or transaction platform exists (SA Home Loans, 2016; Stoman, 2017).

3.2.3 Costs

Currently, all documentation pertaining to a property transaction is stored by the Deeds Offices across South Africa. The significant amount of physical paper documentation needed means that sufficient storage and safekeeping is required. Records need to be filed, labelled, and stored correctly. However, common errors include misplaced or misfiled records and lost title deeds (Amadi-Echendu, 2013; SadlerInc, 2015). Costs are incurred in recovering or generating new copies of said documents. In addition, all Deeds Offices secure these documents in fireproof facilities, which have their own associated costs. While these costs may not be incurred directly by the buyer and seller (they may however be filtered down to them) it still illustrates the costs incurred in this business process. The numerous stakeholders involved will also require service fees and payment for each transaction undertaken. As will be discussed further in this chapter, there are various costs incurred during the process such as conveyancing costs, municipality costs, finance (bond) costs and Deeds Office costs, and if property owners want a copy of their title deed in digital form then this will have to be requested and will only be issued at a fee (Joubert Galpin Searle, 2017; Stoman, 2017).

3.2.4 Payments and Settlements

Currently, the changing over of assets and funds do not happen concurrently in property transactions, which opens the door for financial deceit. Right now, sellers need to give up their houses (and transferring property ownership at the Deeds Office) and stakeholders their services before receiving their payment, placing these people in a situation of risk (Stoman, 2017). There is a time delay between the registration of property and the seller receiving their funds. This is not the case with other asset classes yet in real estate transactions, processes and their payment systems have lagged behind in modernisation (Stoman, 2017; Smith Tabata Buchanan Boyes, 2018). The concept of simultaneous delivery and payment is termed ‘Delivery Vs Payment’ (DVP) and it states that as an asset is transferred from one owner to another, so the funds should flow in the other direction instantaneously. When it comes to the South African securities market (equities or bonds, for example), DVP applies but this is not the case with property transactions. The current process and its payment systems are vulnerable to fraud and money laundering, and indeed, South African property transaction fraud reached

a staggering R161 million rand in 2016. The Attorneys Fidelity Fund[5] of South Africa has paid out more than R 750 million rand in the last eight years to individuals who have been scammed or had money stolen in property transactions (Joubert Galpin Searle, 2017; Stoman, 2017). Even once funds are eventually received, conveyancers must use multiple banking payment systems and platforms to distribute payments accordingly, which highlights inefficiencies faced in the payments and settlement process.

3.3 South African Real Estate Sector Summary

With the property sector in South Africa being one of the largest asset classes (valued at over R5.8 trillion rand), customers involved in transactions need secure, fast, and responsive services whereby money and assets (ownership) can move immediately and concurrently (PEXSA, 2017). Moving towards digitally modernised systems and transaction platforms, puts more trust in the process and eases the pressure on the people currently running it (Amadi-Echendu, 2013). A contributing factor to errors and delays in the current process is the fact that the transaction process is heavily reliant on the conveyancers controlling it (PEXSA, 2017). There is immense pressure on human resources as conveyancers are the bridge between all parties as well as being responsible for the majority of events that occur, while at the same time adhering to the needs of all stakeholders involved (Louise Tonkin Inc, 2013; Stoman, 2017). With a more modern business process, activities can be made more efficient and pressure on conveyancers can be rightfully relieved.

3.4 The South African Real Estate Transaction Process

In South Africa, property law makes use of the deeds registration system (Schindlers, 2016; Joubert Galpin Searle, 2017). There are ten Deeds Offices across South Africa which record the ownership of property, bonds attached to the property and other property rights. In South Africa, titleholders rely on the accuracy of records and deeds that are lodged at the Deeds Office. In addition, the security of title that South African property owners possess is a result of the collaboration between the national Deeds Offices and conveyancing attorney professionals. This is due to the fact that all documents related to the transfer of the property are the responsibility of the conveyancers involved and once examined and lodged, their safekeeping is in the hands of the Deeds Office (SAHomeLoans, 2017).

[5] http://www.fidfund.co.za/

3.4 The South African Real Estate Transaction Process

The process of buying and selling a property in South Africa can involve up to 15 different stakeholders, including the buyer and the seller. The entire duration of this process, from the date that the Offer to Purchase is signed to the date that the new title deed is executed and registered, will usually take just over three months, or 13 weeks. The process can be extended further, and the transaction made more complex if for example, the purchase of one property depends on and involves the sale of another. If the process is initially looked at from a high-level point of view before breaking it down into its intricacies, one can identify five main stakeholders and an overall sequence of events. These stakeholders are the buyer, the seller, the bank, the conveyancing attorney and the Deeds Office. The process begins with a homeowner (seller) wanting to sell their property and a buyer identified. If the seller still has an outstanding bond on the property that is being paid off, and the buyer is to take out a bond for the purchase of the property then both respective bonds will be cancelled and registered with the bank. In the average property transaction, most cases will see bonds being held and registered. Once this has occurred the title deed is transferred into the buyer's name at the Deeds Office. This process is managed and linked by conveyancing attorneys. Both the buyer and the seller will deal with the conveyancing attorneys throughout the duration of the deal (Amadi-Echendu, 2013; Schindlers, 2016).

The following discussion elaborates on the different processes involved in a South African real estate transaction, describing what activities occur and the data on which they rely. A series of diagrams through a '*W5*' '*What' and 'Who'* model, as outlined in *Sections 2.4*, illustrate the actors (stakeholders) involved, the data needed as inputs for each process, as well as the resultant outputted data (*Figures 3.1–3.7*). This culminates with an '*ERD Which*' model illustrating a holistic view of all the data points involved (*Figure 3.8*). The purpose of the *What* model is to understand what business activities need to be completed. This model incorporates elements from the *Who* and the *Which* model, acting as the bridge between all three models. A skeleton of the *What* model has been provided in *Figure 3.1* to ensure that the reader understands the entries made in subsequent *What* models (see *Figure 3.2 – 3.6*). In *Figure 3.1* the main business processes are detailed. The subsequent *What* models focus on each of these main processes in isolation, breaking them down into their sub-process. This is done to differentiate between the main processes for the purpose of simplification as well as space restrictions in the document.

3.4 The South African Real Estate Transaction Process

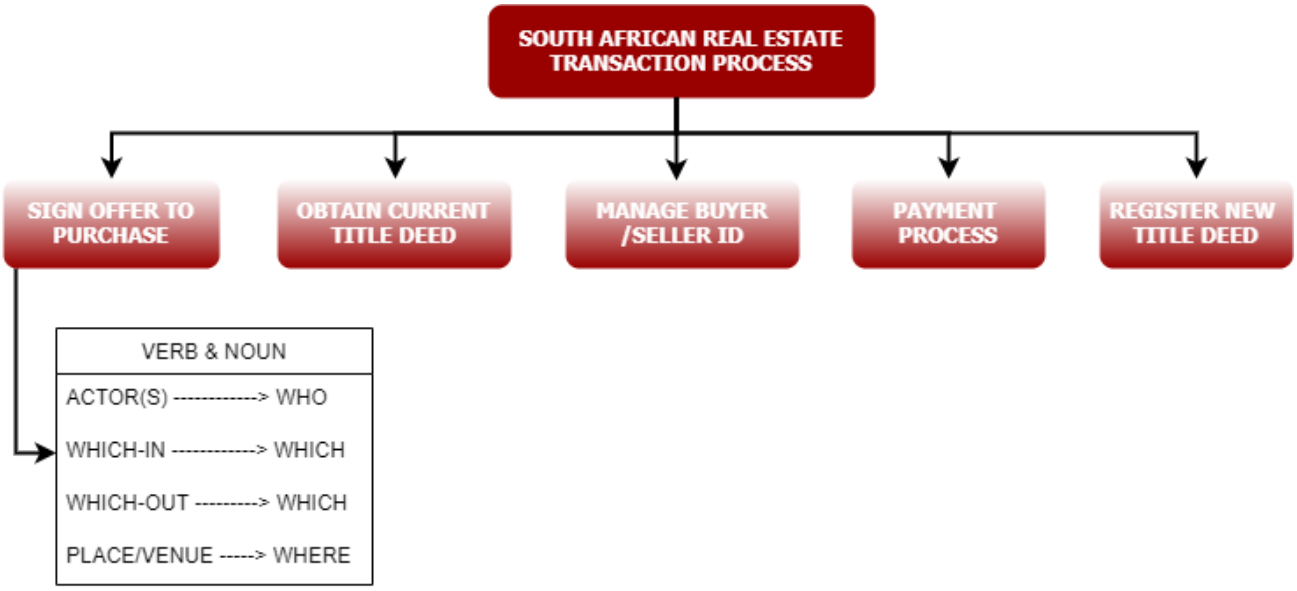


Figure 3.1: South African Real Estate Transaction Process: WHAT Model

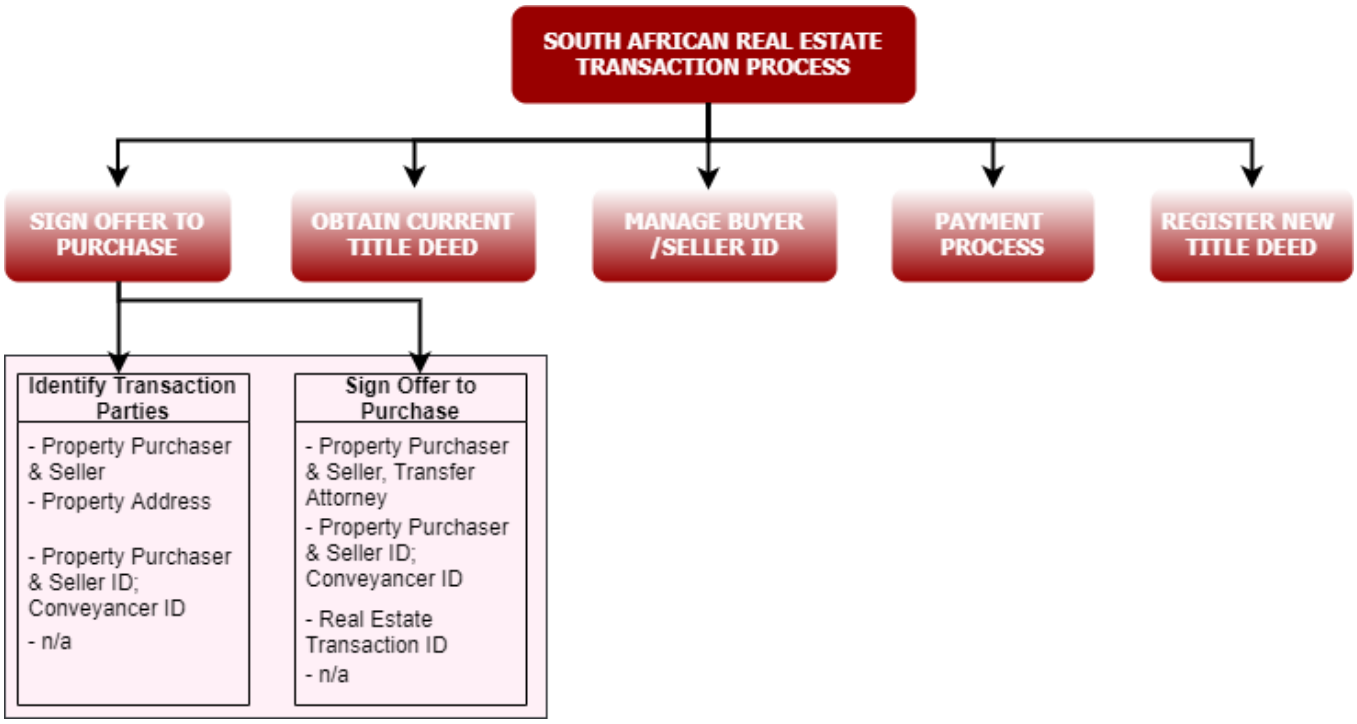


Figure 3.2: South African Real Estate Transaction Process: WHAT Model – Offer to Purchase

The South African property transaction process begins when a prospective buyer and seller for the same property have been identified. These two stakeholders can choose to work through a real estate agent who will assist them throughout the process, or these stakeholders can begin the transaction in a private manner. In support of the latter process, there are online listings for sellers to privately sell their property which negate the need for real estate agents.

However, these private services (such as the "No Agent[6]" listing website for South African private sales), often involve online agency, registration, and commission fees. The agency costs in both scenarios do not significantly differ (Amadi-Echendu, 2013; Louise Tonkin Inc, 2013; Chas Everitt International Property Group, 2017). Once a genuine buyer has been identified, an offer to purchase will be signed by both the buyer and the seller (*Section 3.5.1*). This document will be arranged and overseen by the transfer attorney. It is at this stage of the transaction where the relevant conveyancing attorneys are appointed. Every property transaction must consist of a transfer attorney who assists both the buyer and the seller throughout the duration of the transaction. The transfer attorney will be selected and appointed by the seller, with the buyer being made responsible for conveyancing fees and transfer costs (Joubert Galpin Searle, 2017; SAHomeLoans, 2017). If existing bonds on the property are to be cancelled and new bonds are to be registered, then bond registration attorneys (representing the buyer) and bond cancellation attorneys (representing the seller) must be appointed. However, this is dependent on the specifics of the transaction.

Once the conveyancers have been appointed and the offer to purchase has been signed, the transfer attorney will request a copy of the current title deed. This will either be sourced from the seller (if the property is fully paid off) or from the financial institution (if there is still an outstanding bond figure owed by the current owner). In both of the aforementioned cases, a copy of the title deed will be sent to the transfer attorney for inspection (Chas Everitt International Property Group, 2017). However, upon lodgement and registration of the sale, the transfer attorney will request the original title deed from the relevant source. If there is still an outstanding bond amount, this will need to be settled and cancelled. This means another stakeholder to the transaction will be introduced, a bond cancellation attorney. Next, the transfer attorney will need to obtain the Financial Intelligence Centre Act[7] (FICA) documents from both the buyer and the seller (Schindlers, 2016). The transaction cannot progress without these documents. FICA is an anti-money laundering legislation which aims to ensure safety in transactions. FICA helps transfer attorneys to fully identify who they are dealing with. The documents needed from each party include proof of identification, proof of residence, marital status, tax number, and a salary slip. The conveyancer, on behalf of the seller, will also need to obtain a rates clearance certificate (RCC), an electrical compliance certificate (ECC), and a SPLUMA certificate from the municipality and other relevant stakeholders (*Section 3.5.4*).

[6] https://noagent.co.za/

[7] Financial Intelligence Centre Act 38 of 2001

3.4 The South African Real Estate Transaction Process

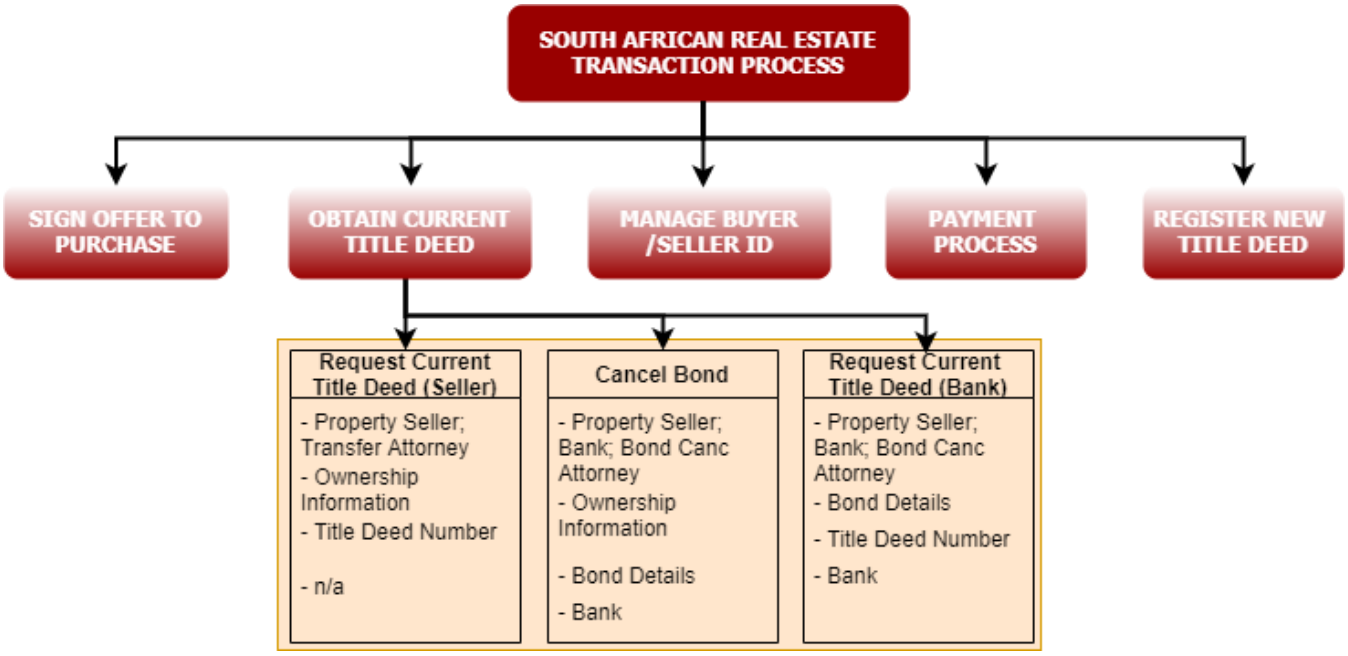


Figure 3.3: South African Real Estate Transaction Process: WHAT Model – Obtain Title Deed

The transfer attorney will now start drafting the new title deed in the buyer's name. If the buyer is to purchase the property by means of taking out a bond, this process will need to get underway. This requires the buyer approaching a financial institution to begin the process of registering a bond. The bank in question will select a bond registration attorney from their panel (banks have panels of attorneys, often more than one attorney firm, and will appoint conveyancers from their panel to carry out bond registration and bond cancellation tasks) to oversee and manage the process on behalf of the buyer. If the buyer is not taking out a bond, then they will arrange with the estate agent (if applicable) or the transfer attorney to make the payment to the seller. Proof of funds and availability to purchase without a bond will need to be presented to the transfer attorney. When paying either by cash or through taking out a bond, the purchaser or the issuing bank will first settle any guarantees and then the remaining purchase price (profit) into the conveyancer's trust account and the conveyancer will then distribute the funds to the seller (Louise Tonkin Inc, 2013; Chas Everitt International Property Group, 2017; Joubert Galpin Searle, 2017). The process of taking out a bond involves a collection of documentation as well as a collaboration between all the conveyancers involved in a property transaction which are the bond cancellation attorney, the transfer attorney, and the bond registration attorney (*Section 3.5.3*). Once the new bond is issued and old bond settlements are in place, the bank of the new bond will present guarantees for payment and ensure that the old bond has been settled (if applicable). Alternatively, if the purchase is made in cash then the purchaser's bank will settle any guarantees (if applicable). Next, the transfer

attorney will prepare the transfer documents and finalise the new title deed which will be registered in the buyer's name. The transferring attorney will then request a deposit to be paid by the purchaser. This deposit, however, depends on the offer to purchase agreement and what was stipu1lated. In most cases, sellers will want a deposit to be made as a means of guarantee and security to show that the buyer is not going to opt out of the transaction. Transfer duty fees will then need to be paid to the receiver of revenue, the South African National Revenue Services[8] (SARS) in order to obtain the transfer duty receipt (*Section 3.5.5*) (Schindlers, 2016).

Once this is done, the relevant conveyancing attorneys will need to arrange to physically meet with one another to ensure all documentation and information is in order. This will commonly involve the transfer attorney, the bond cancellation attorney, and the bond registration attorney. These attorneys will then arrange to lodge their documents (transfer documents, bond registration documents, and bond cancellation documents) which apply to the property transaction at the Deeds Office. The transfer documents will need to be signed by the buyer and the seller (SAHomeLoans, 2017). The lodgement will need to be done simultaneously and thus all conveyancing attorneys need to be physically present at the same time (transfer attorney and transfer documents, bond registration attorney and registration documents, and bond cancellation attorney and cancellation documents). All the documentation and information mentioned in previous steps are pre-requisites for the lodgement at the Deeds Office. These documents then undergo an examination process at the Deeds Office in a practice that takes between eight to ten working days (*Section 3.5.6*). Once the relevant documents have passed inspection, they will be put forward to the chief registrar of the Deeds Office for registration. The transfer of the property, the registration of the new bond, and the cancellation of the old bond are all executed and registered by the chief registrar. The final execution and registration of the transfer can take up to seven working days. Once the transfer is registered the buyer and the seller will receive a letter of transfer completion from the transfer attorney. Before the transfer attorney can finalise the transaction, they will need to take the funds from the conveyancer's trust account and distribute them accordingly. In addition to this, final payments of conveyancing fees will be settled as well as estate agent commission (if applicable). The new title deed will now be registered, and ownership changed. All old title deeds are kept at the Deeds Office for a period of five years before being (physically) discarded. A digital copy will be made but the Deeds Office still requires that

[8] http://www.sars.gov.za/Pages/default.aspx

manual updates are provided when data is inputted. In a process that takes three months, the property transaction between the buyer and the seller can now be considered complete.

3.5 South African Conveyancing: General Concepts

3.5.1 Offer to Purchase

An Offer to Purchase (OTP) will be drawn once a willing buyer has been found and once the transfer attorney has been assigned (Schindlers, 2016). The document acts as a binding contract between the buyer and the seller for the agreement and terms of the sale. The document will include aspects such as the selling price, deposit, and certificates that the buyer/seller is required to provide such as a transfer duty receipt or an electronic compliance certificate (ECC). Usually, a real estate agent will request an OTP from the transfer attorney on behalf of the two parties but if no real estate agent is being used then the buyer and the seller will request this document from the transfer attorney directly. The OTP can be seen as security for the seller (to ensure that the buyer doesn't back out of the deal or purchase another property while in current negotiations for the seller's property) and protection for the buyer (to ensure that the seller does not sell the property to anyone else). Both the buyer and the seller will be required to sign this document (Louise Tonkin Inc, 2013).

3.5.2 Bond Cancellation

If the person selling the property is currently paying off a bond, then this bond will need to be cancelled and the outstanding amount payable will need to be settled. In this scenario, a person must give the bank 90 days' notice for cancellation. Alternatively, if not planned in advance by the seller and immediate cancellation is needed, the bank is entitled to ninety days' worth of interest, potentially adding another cost to the process (SAHomeLoans, 2017; Smith Tabata Buchanan Boyes, 2018). In order to sell a property with an outstanding bond attached to it, the seller will need to arrange and submit guarantees which will need to be obtained from the purchaser (if no bond is in place and the seller is the rightful owner of the property, then no guarantees are needed). These guarantees will state that the funds used to purchase the property (the funds the seller will receive) will first be allocated towards the settlement of the existing bond and profits thereafter will be paid to the seller. Guarantees are imperative for the transaction to go through. Without receiving and presenting guarantees, the seller will not have authorisation from the bank which holds the current bond to proceed with the sale. Obtaining these guarantees early is advised to avoid payment delays. The seller will need to approach the bank which holds the bond and request the cancellation figures

(SAHomeLoans, 2017). The bank will appoint a bond cancellation attorney from their panel to adhere to the specific transaction. The bond cancellation attorney will forward the cancellation figures to the transfer attorney along with a copy of the title deed *(Figure 3.4*). The transfer attorney will then take the guarantee requirements into consideration when arranging payment plans with the purchaser (either through a bond or cash). If the buyer is purchasing the property by means of a bond, then their bond registration attorney will draft their bond documents in such a way that accommodates for the settlement of the sellers existing bond (SA Home Loans, 2016; Schindlers, 2016). Once the documents are issued, the bond registration attorney will notify the buyer's bank (bank of the newly registered bond) to settle the current bond with the seller's bank (bank of the previous bond). Alternatively, if the purchaser is paying in cash then they will have two options when issuing the guarantee:

- The purchaser could deposit the funds (the full purchase price) into the conveyancer's trust account and allow the conveyancers to issue the required guarantee and pay the remaining profits to the seller.
- The purchaser could request that their bank pay the required guarantee to the seller's bond bank. However, the purchaser will still need to distribute remaining profits (after guarantees) of the sale to the conveyancer's trust account making option two rather ineffective.

However, the seller will have to pay a fee with regards to both options above for the issue of the guarantee(s). Before the bond cancellation can be put into effect, the bond cancellation attorney must be in possession of the cancellation guarantees. Once these are received, the bond cancellation attorney can lodge these documents at the Deeds Office (SAHomeLoans, 2017; Smith Tabata Buchanan Boyes, 2018). Once lodged, they can be considered as binding and ready to be put into effect. Once all documents are registered at the Deeds Office, the guarantees are paid out within 24 hours and the bond is settled. The bond cancellation process does come with its expenses in the form of bond cancellation fees and bond cancellation costs. Both are payable by the seller when cancelling a bond.

- **Bond cancellation fees**: These are the fees that the seller will pay to the bond cancellation attorney for their services in cancelling their existing bond.

- **Bond cancellation costs**: These costs are the costs payable to the bank for cancelling an existing bond. The cost will depend on the outstanding amount payable at the point of sale.

These two costs can be included as guarantees, and as a result will be distributed accordingly from the conveyancer's trust account before remaining profits are paid to the seller. Alternatively, the seller can choose to pay these amounts directly instead of employing guarantees (SA Home Loans, 2016; Stoman, 2017).

3.5.3 Bond Registration

If the person buying the property is doing so by means of a bond, then they will need to register a bond with a bank. Before the issuance of a bond, the bank will conduct a financial evaluation on the applicant in accordance with the National Credit Act whereby the financial status of the applicant is checked (involves credit score, debt payment, and management of finances). Banks will send evaluators to the property in question to ensure that the valuation is correct, and the bond being granted is of fair value. This may be done in the case that the bond is not repaid and now the property belongs to the bank and they need to sell it to make their money back (Louise Tonkin Inc, 2013).

As is the case with bond cancellations, the bank will appoint a bond registration attorney from their panel. The bond registration attorney will then contact the purchaser to make certain they want to take out a bond and if so, pre-loan agreement forms are signed whereby the purchaser accepts the bond. The attorney will request FICA documents from the purchaser for security purposes. If there is an outstanding bond on the property, the bond cancellation attorney will forward the cancellation figures to the transfer attorney who will pass them on to the bond registration attorney in order for the guarantees to be drafted. The bond registration attorney will then draft the bond registration documents in a way that accommodates the settlement of the sellers existing bond.

Once all documentation is received, the bond registration attorney can begin drafting the bond documents. The attorney will then request the purchaser to attend a physical meeting where the documents can be signed, and bond registration fees can be paid (Louise Tonkin Inc, 2013). These fees are for the services of the attorney in registering the new bond in the purchaser's name. If guarantees were applicable, these will now be forwarded to the transfer attorney and passed on to the cancellation attorney as proof to the seller's bank. The bond registration attorney will obtain final approval from the bank to proceed with the lodgement and registration of the bond documents at the Deeds Office which finalises the bond procedure.

The bond registration attorney will then inform the bank and the bank will settle any guarantees. Thereafter, remaining funds will be transferred to the conveyancer's trust account before being distributed accordingly. Original bond documents and new title deed will be kept in the banks possession as safekeeping until the bond is settled (Schindlers, 2016).

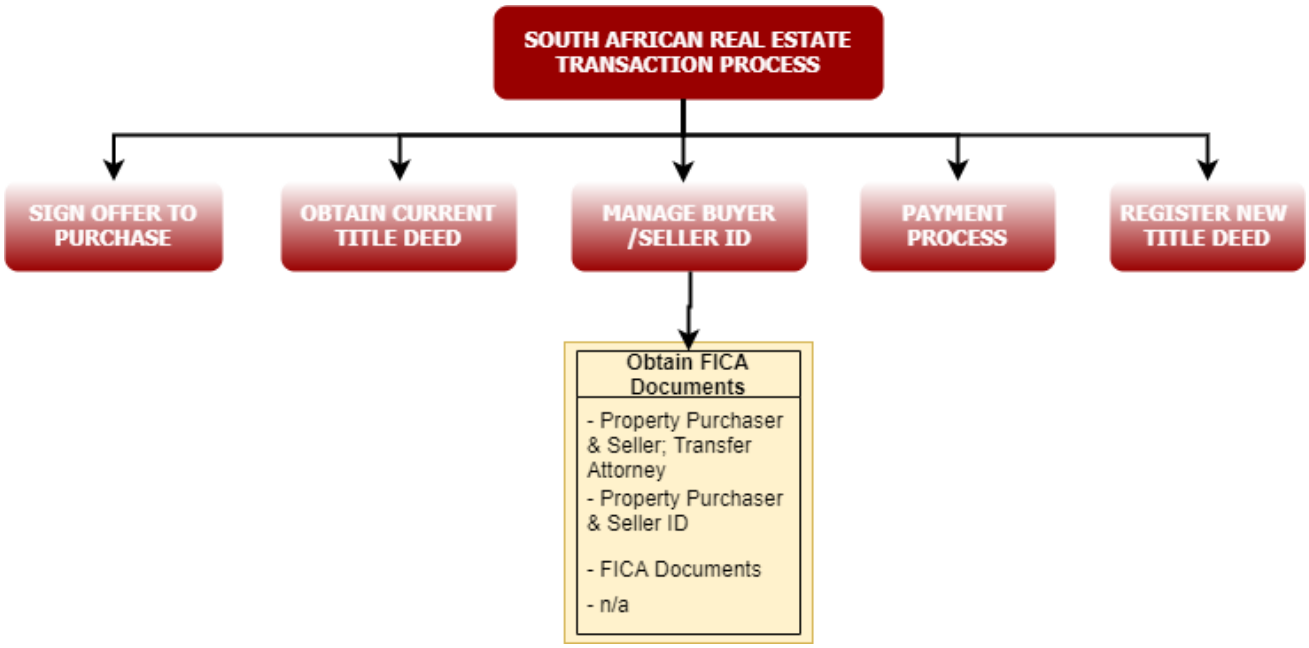


Figure 3.4: South African Real Estate Transaction Process: WHAT Model – Manage FICA Documents

3.5.4 Rates and Clearance Certificate, Electrical Compliance Certificate and SPLUMA

Rates Clearance Certificate (RCC): A rates clearance certificate is a certified document from the local municipality area in which the property is being sold. This certifies that the seller no longer owes anything to the council and that all payments and rates have been cleared. The certificate proves that all payments dating back to two years before the date of sale have been settled. The rates clearance certificate is a fundamental document needed to transfer the ownership of a property and without it, the Deeds Office will not transfer the property. The process of procuring the RCC begins with the transfer attorney conveyancer getting in touch with the municipality and requesting the rates figures. Once these figures have been received together with the advanced portion payment amount, the conveyancer will verify them with the seller and request the funds from the seller. The seller will pay this cost to the conveyancer who will transfer them to the municipality (Schindlers, 2016; Joubert Galpin Searle, 2017; SAHomeLoans, 2017). The seller cannot pay the municipality directly.

On top of the rates figures an advanced portion payment will be included which is also payable. This is an advanced rates payment for a period of six months, and it is included to cover the time between the house being on the market for sale to the time the property ownership is actually transferred. Should the seller complete the transfer prior to the six months being completed, they are eligible to be refunded for any amounts paid past the registration date and before the six-month period. This refund (if applicable) will be paid by the municipality to the seller. The conveyancer is not involved in refunding the seller. However, there can be frustration when it comes to the refund. Firstly, the refund does not occur automatically. The seller has to specifically request to be reimbursed. This involves contacting the municipality and completing a refund application form, a cancellation of consumer agreement form, and presenting the letter of transfer completion from the transfer attorney. Secondly, the municipal council will take between six to nine months to make the payment which illustrates that even beyond the transfer being complete there may still be certain on-going functions (SA Home Loans, 2016; Schindlers, 2016). Rates clearance certificates must be obtained for a standalone house but if the property is part of a block of flats or an estate then the seller will need to obtain a levy clearance certificate from the body corporate. Once obtained, these certificates are valid for three months.

Electrical Compliance Certificate (ECC): When selling a property, a seller will need to obtain an electrical compliance certificate which certifies that the electrics on the property are properly installed, safe, and not a danger to anyone living in the house (Schindlers, 2016). This certificate is to be issued by a qualified electrician which ensures electrical regulations have been met. Only a qualified electrician who is registered with an electrical board can issue the ECC. It is the responsibility of the seller to organise and pay for the ECC (Louise Tonkin Inc, 2013). The ECC is not a requirement for the transaction to be completed but in many cases, it is included. However, it is a legal requirement of all homeowners to be in possession of an ECC and thus, it is more often than not included in the transfer documents. For example, it may be required if:

- The offer to purchase states than an ECC is to be arranged.
- The buyer is taking out a bond for the purchase of the property, as the bank will request an ECC.

Spatial and Planning Land Use Management Act (SPLUMA): One of the most recent additions to property regulations is that of the Spatial and Planning Land Use Management Act (SPLUMA) of 2013. SPLUMA was put into effect on 1st July 2015. The purpose of SPLUMA

is to assist municipalities in knowing what land developments are occurring, and how, within their jurisdiction. When selling a property, it is a requirement of the seller to obtain a SPLUMA certificate, without which the transaction cannot be completed. The SPLUMA process will occur once the offer to purchase has been signed and it will involve the transfer attorney going to the municipality to request the certificate. It is the responsibility of the conveyancer to obtain the certificate from the municipality (Louise Tonkin Inc, 2013; Chas Everitt International Property Group, 2017; Joubert Galpin Searle, 2017). Sellers will need to ensure that their property is SPLUMA–compliant and this means appointing (and paying for) a professional land surveyor to inspect the property for encroachment of building lines and boundaries. The land surveyor will issue a certificate which will be used to obtain a SPLUMA certificate. Documents needed in this process are the land surveyor certificate, a SPLUMA application form, and an affidavit of the registered (current) owner. SPLUMA costs will be paid by the seller through the transfer conveyancer. The process of getting the SPLUMA certificate takes close to four weeks, meaning that it needs to be arranged early on in the process or delays can occur (Louise Tonkin Inc, 2013; SA Home Loans, 2016).

3.5.5 Transfer Duty

Once the transfer duty payment is received by SARS, the transfer attorney will receive an electronic certificate via the SARS e-filling system which states that the purchaser's transfer duty has been received (Schindlers, 2016). It is important to acknowledge the difference between transfer fees and transfer duty.

- **Transfer Fees**: This is the amount paid to the transfer attorney who has overseen and managed the transaction. This fee is paid for the services of the transfer attorney transferring the property into the buyer's name. This fee is dependent upon the price of the property and the law firm of whom the conveyancer belongs.
- **Transfer Duty**: This is form of tax which is paid when a purchaser buys immovable property in terms of the Transfer Duty Act. It is a government tax which is levied to transfer ownership of a property.

Both of the above payments will be made by the purchaser. When arranging the transfer duty receipt, the transfer attorney will request a declaration form via the SARS website. Both the buyer and the seller will fill out a respective declaration form which states their tax numbers, and should there be any outstanding taxes, these will first need to be paid. This can also delay the process (Amadi-Echendu, 2013; Louise Tonkin Inc, 2013; Law Society of South Africa,

2019). The declaration forms will be submitted electronically along with the draft deed of sale and the Offer to Purchase and upon completion and making the payment, SARS will issue an electrical transfer duty receipt. It is then the responsibility of the conveyancer to print the declaration forms and acquire the physical signature of the buyer and the seller. Once this receipt is received, the transfer attorney will print it and include it in the transfer documents for the Deeds Office. The transfer duty receipt is a pre-requisite for the transaction to go through.

3.5.6 Deeds Office Examination

Once all the necessary documents (transfer documents, bond registration documents, and bond cancellation documents) are ready, then all conveyancers involved will need to arrange a time to meet at the Deeds Office in order to lodge the documents. Once lodged then documents will then need to be registered, it is at this moment (registration) that the ownership will be changed from the previous owner to the new owner (Schindlers, 2016). The process of lodging the documents and getting them approved takes eight to ten working days while the registration process takes five to seven days. When documents are lodged at the Deeds Office, they will undergo an examination process before being sent for registration. This examination process involves three examiners (junior examiner, senior examiner, and a monitor examiner). As documents are approved by the previous examiner, they are passed on to the next. The monitor examiner will then pass or reject the deeds documents. Notes may also be added to the files which can be described as points of concern raised by examiners but minor enough for them to still pass the deeds (notes occur if mistakes are not too severe).

Rejected deeds must be collected by the conveyancers and disputes are discussed with the examiner who raised the issue (Nedbank, 2015; LexisNexis, 2018). Deeds may be rejected if required documents are forgotten or if certificates such as the RCC has expired. If deeds are passed, they are collected by the conveyancers who then adhere to the notes before submitting the deeds for registration. Each Deeds Office in South Africa has a Chief registrar and this person is responsible for registering all deeds. This process of lodgement and registration of deeds documents can be monitored through South Africa's online system called the Deeds Office Tracking System (DOTS). However, making use of this tracking system comes at a fee to conveyancers (Louise Tonkin Inc, 2013; Schindlers, 2016).

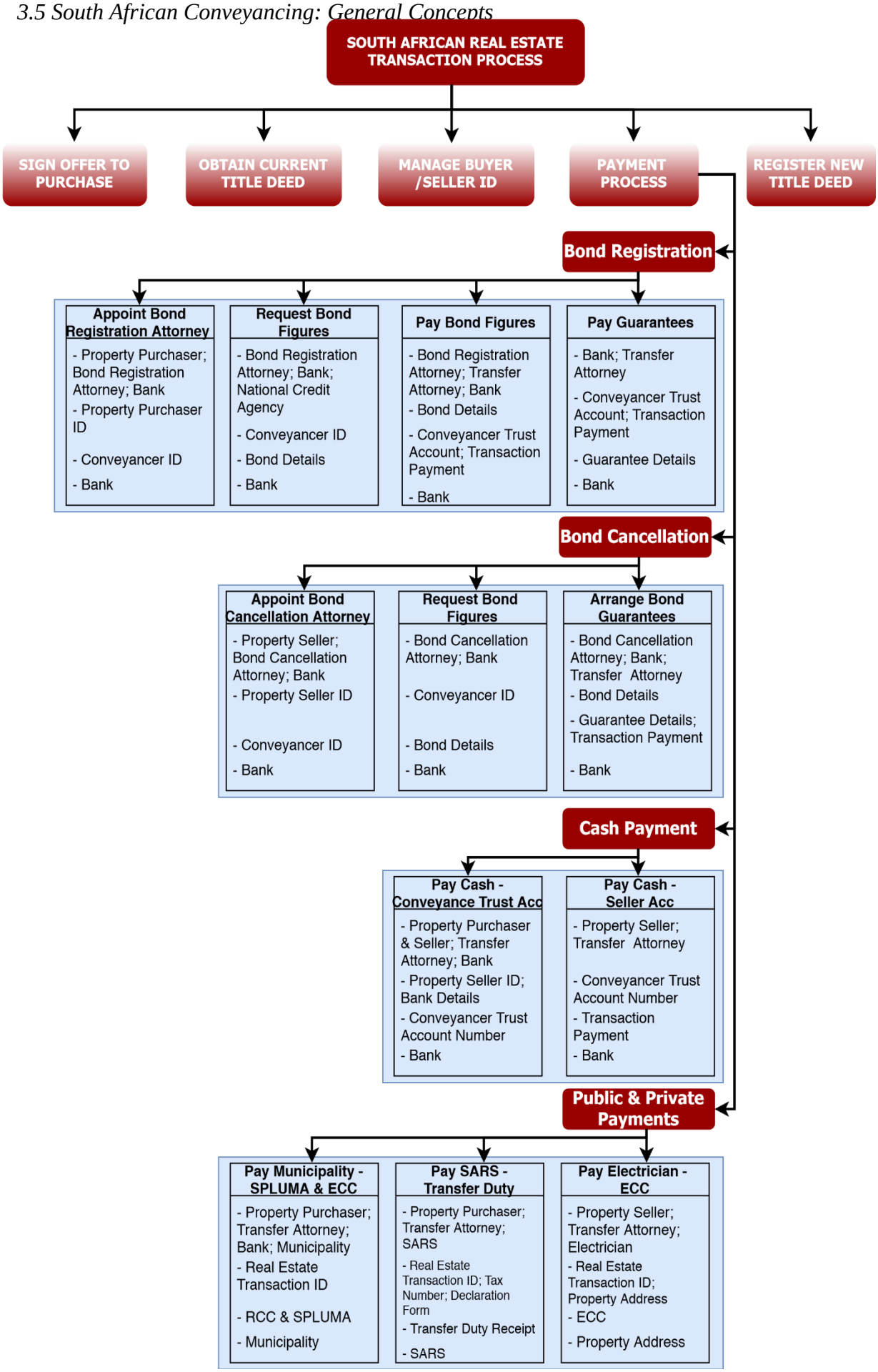


Figure 3.5: South African Real Estate Transaction Process: WHAT Model – Payment Process

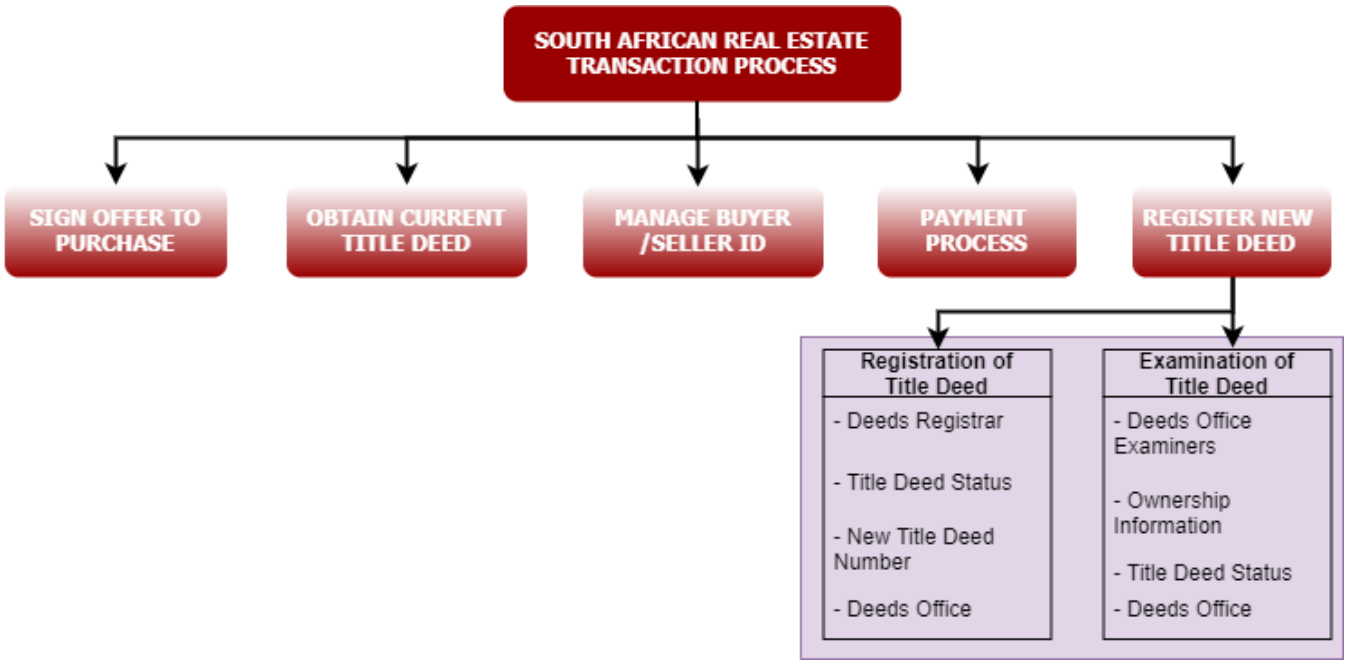


Figure 3.6: South African Real Estate Transaction Process: WHAT Model – Deeds Examination and Registration

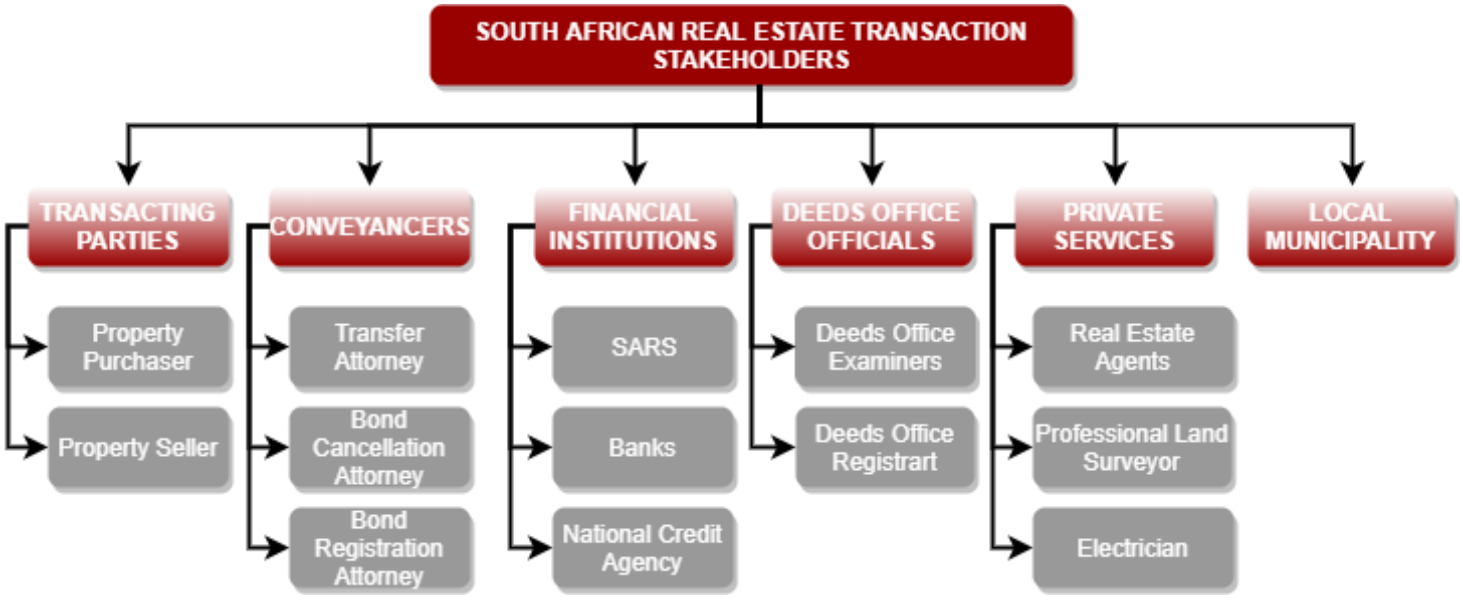


Figure 3.7: South African Real Estate Transaction Process: WHO Model

The purpose of the *Who* model is to define who the participating stakeholders are and what processes they are responsible for. In *Figure 3.7*, the participating stakeholder groups have been displayed and broken down to illustrate the exact stakeholders who are involved in the process. The most complex but most important of these diagrams is arguably the *Which* model. The *Which* model aims to illustrate the data and information that is needed in the organisation and used in the business processes. This model can be compared to an Entity Relationship

Diagram (ERD) which is a structured modelling technique for database design but unlike the ERD, it is not normalised. The *Which* model represents the business information and its associated attributes (the finer details of this information). Furthermore, this model highlights the relationships and interactions between the different data and information sets. Lastly, the physical artefacts (documentation or reports) that are produced from this information will be illustrated through the *Which* model. The Which model (*Figure 3.8*) represents all the entities of information that are used in South African transactions, as well as the artefacts that will need to be produced for the transaction to progress.

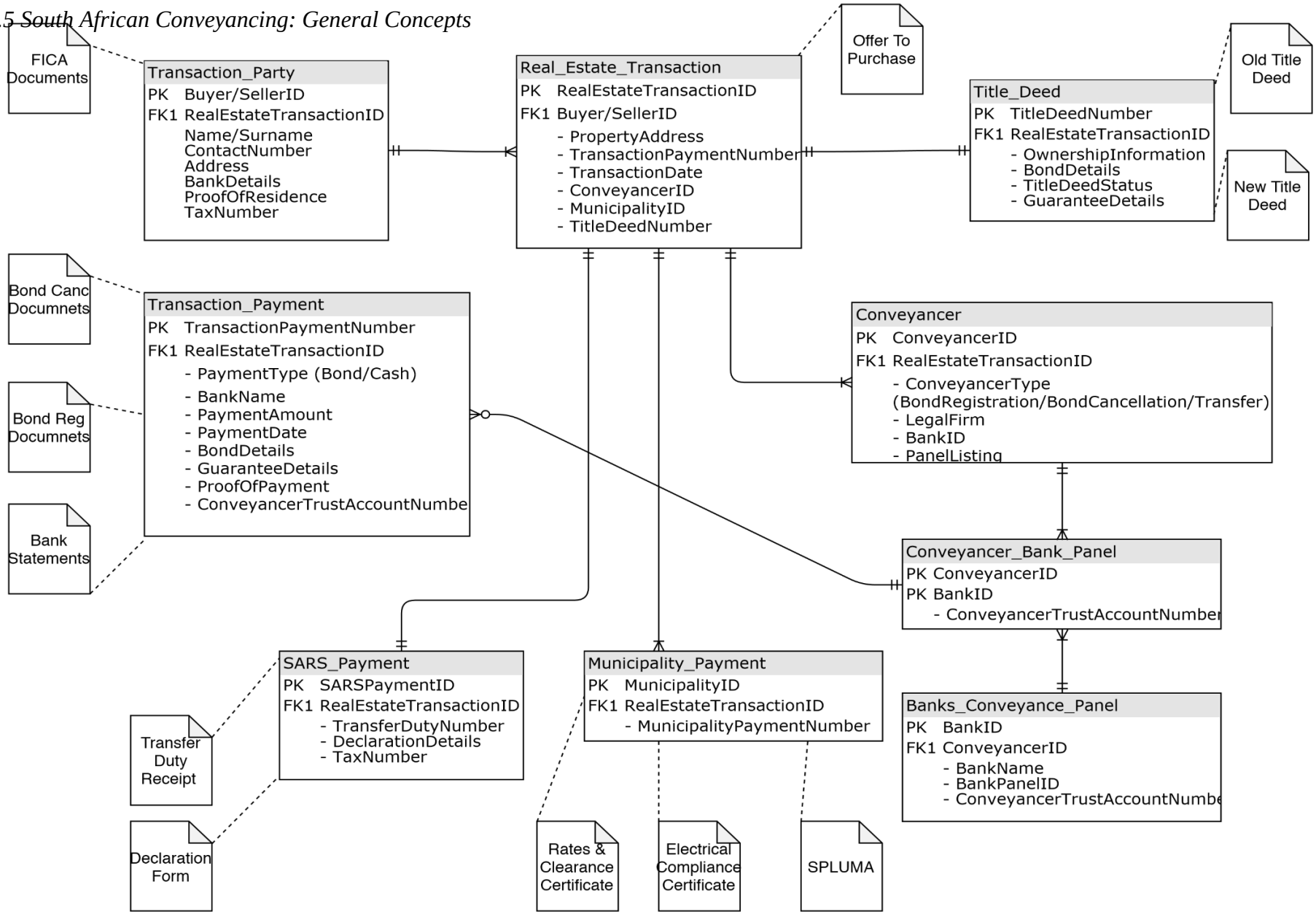


Figure 3.8: South African Real Estate Transaction Process: Entity Relationship Diagram

3.6 The South African Real Estate Transaction Process: Business Process Model

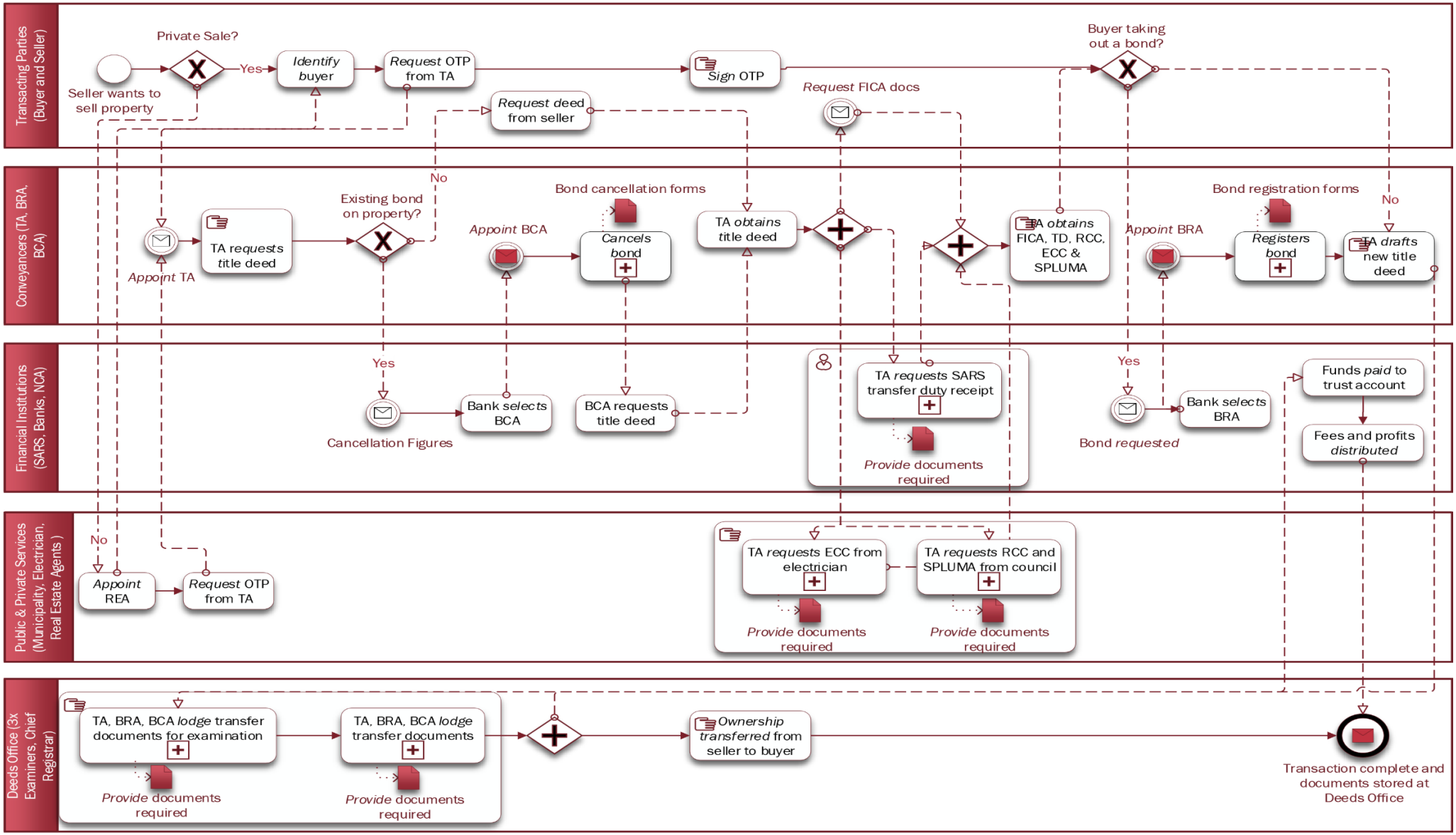


Figure 3.9: South African Real Estate Transaction Process: Business Process Model

3.7 Summary

South African real estate transactions can be grouped into three core process groups, namely Signing an 'Offer to Purchase' contract, financial arrangements, and transferring title deed ownership at the Deeds Office. The entire process is managed by the conveyancing attorneys involved, the transfer attorneys and bond attorneys. The fixed **stakeholders** involved in the process are buyer and seller, transferring attorney/transferring conveyancer, three Deeds Office examiners, Deeds Office Chief Registrar, SARS, municipality, electrician, professional land surveyor, and financial institution (bank). Other stakeholders that may then arise (but do not always have to be involved) could be two real estate agents, bond registration attorney, bond cancellation attorney, national credit agency, home appraisers and evaluators. This shows there are 12 fixed stakeholders allowing for an additional five, depending on the transaction, potentially permitting up to 17 stakeholders.

The fixed **documents included** in the process are transfer documents (new title deed; power of attorney letter, which is written permission to represent or act on someone else's behalf, RCC, ECC, SPLUMA certificate [SPLUMA application form, affidavit of owner, land surveyor certificate], transfer duty receipt [declaration form], affidavit of purchaser, affidavit of seller, offer to purchase, 2 x FICA documents [ID, proof of residence, marital status, tax number, salary slip], old/current title deed, letter of sale completion). Additional documentation may then arise (but are not always required) such as Bond cancellation documents (consent to cancellation sheet, power of attorney letter, copy of current title deed, old bond document, bond cancellation document, bond guarantee form) and, bond registration documents (power of attorney letter, bond registration document, blank bond registration document, pre-loan bond agreement form). This shows us that there are 25 fixed documents needed and 10 additional documents depending on whether bonds are registered or cancelled. This means that there is potential for the process to involve up to 35 documents.

Lastly, the fixed **costs incurred** in the process Deeds Office fees, transfer duty fees, SPLUMA fees, RCC fees, ECC fees, professional land surveyor fees, and transfer attorney fees. There may then be the possibility of additional costs depending on the scenario such as real estate agent cost, real estate agent commission, online agency cost, online agency commission, bond cancellation fees, bond cancellation costs, bond registration fees, bond initiation fees, guarantees issuing fee, DOTS fee, and requested scanned title deed fee. This illustrates that there are seven fixed costs with the possibility of 11 more, depending on the transaction, meaning that 18 different costs could arise.

Chapter 4: Literature Review

4.1 Introduction

Chapter Three evaluated the first case study, South African real estate transactions. Through conducting an analysis on the current state of transactions, the research was able to obtain a comprehensive understanding of what occurs, when it occurs, and by whom. *Chapter Four* will provide a literature review of blockchain technology and its involvement in the real estate sector. The reader will be presented with a definition of blockchain technology and the various technical components that come with it, namely, transactions, immutability, cryptography, and Proof of Work (PoW) vs Proof of Stake (PoS). The promise of blockchain technology and its relevance to transactions and record-keeping is then discussed before an in-depth review of the opportunities and challenges for blockchain technology in real estate transactions.

Blockchain technology is most commonly known for its role in cryptocurrency, specifically, Bitcoin. Blockchain technology represents the technological foundation on which cryptocurrencies are built. However, cryptocurrencies are just one application of blockchain technology. Blockchain can be defined as a Distributed Ledger Technology (DLT), a decentralised digital ledger that records transactions (and their metadata or subsets of data) amongst all participants in its distributed network (Deshpande, et al., 2017; Lemieux, 2017). Blockchain technology has two main characteristics, distributed and decentralised.

Distributed refers to all participants in the network having a complete real-time copy of the ledger (dating back to the genesis block). The technology is built on a 'peer-to-peer' basis meaning that all transactional information is dispersed and visible to every participant on the network. These participants are known as nodes and can be situated anywhere around the world. Nodes actively engage in the network through mining, a process involving solving mathematical algorithms resulting in transactions being verified and added to the blockchain network (Beck, et al., 2016; Deshpande, et al., 2017). As new nodes join the network, they receive a complete real-time copy of the ledger, allowing them to draw the same conclusions with regards to validating transactions, as the rest of the network. This eliminates data redundancy as all information can be stored on a blockchain network rather than multiple siloed systems. In addition, participants can interact and transact directly with one another without the need for third-party mediation. Decentralised implies that there is no central authority which controls the network and the accuracy of the database's transactions (however, this is

only the case in a public blockchain), with the onus for the state of the ledger falling on the nodes within the network to ensure all transactions added to the chain are secure and accurate (Beck, et al., 2016; Bal, 2017; Bryzek, 2018; Maklari, Kalata and Luper, 2018). This is achieved by the network reaching consensus concerning the credibility and correctness of potential transactions. Once consensus is reached and the transaction is deemed legitimate, it is added to the chain. Thus, a trust-less system is introduced whereby individuals no longer have to rely on third-party involvement in transactions. Blockchain's distributed and decentralised nature illustrates how the technology accommodates for direct, yet transparent, interaction between participants in a network. Blockchain technology provides a digital ledger that is self-sustaining by the participants in the network – representing the polar opposite to a traditional paper-based database characterised by authoritative access and control and central points of storage.

4.2 Blockchain Technology Technicalities

4.2.1 Transactions

Blockchain's digital ledger is made up of blocks, with each block containing a group of transactions. As transactions are added to the blockchain, they are disseminated through the peer-to-peer network and added to a pool of pending transactions. Before transactions are added to the chain, they need to be verified and approved by a certain number of valid participants on the network through mining, abiding by the blockchain's consensus protocol (Beck, et al., 2016; Mashatan and Roberts, 2017; Zlotowitz, 2018). The transactions are stored in blocks according to the time they were verified and approved by the nodes, resulting in an order of transactions being established. These blocks are 'chained' together, thus creating a chain of records and forming the blockchain. Once confirmed, approved blocks of transactions are added to the chain and the ledger information is updated and recorded for all nodes in the network. Network validation provides a transparent and secure environment for authentication of transactions. As blocks of transactions are added, these entries cannot be manipulated or deleted, highlighting a key characteristic of the technology, immutability (Deshpande, et al., 2017).

4.2.2 Immutability

Another key characteristic of blockchain is immutability, in other words, the contents of the distributed ledger cannot be modified. The safeguarding of blockchain's information is achieved through cryptography, timestamps, and hashing. Every block obtains a generated hash

vale (which acts as a cryptographic signature) which is linked to the proceeding block and is subsequently timestamped (Bridge, 2017; Compton and Schottenstein, 2017; Lemieux, 2017; Canfield, 2018). The process of hashing involves supplying data of any length and size to a hash function which results in a generated fixed length hash value, thus involving three areas: input, hash function, and output. The data supplied is from the blocks containing transactions and this represents the input. A hash function (such as SHA 256 in the case of Bitcoin) will then take the inputted data and produce a fixed length hash value representing the output (Beck, et al., 2016; Deshpande, et al., 2017; Mashatan and Roberts, 2017). The generated hash value acts as a unique identifier for the block's data. When connecting the blocks in a chain, each block will use the preceding block's hash value (dating back to the genesis block) together with its own data, in generating its own hash value, which will then be used by the following block and so on. Due to the linkage of the blocks (and consequently the hash values), any change to information on the chain will not only affect (and change) the hash value of the block in which they were made, but will also upset (and change) the hash values of all previous blocks, disrupting and breaking the chain (Bal, 2017; Corluka and Lindh, 2017). This is because a hash value is generated on a specified input of data and even the smallest change in input will result in a completely different hash value being produced, causing a break in the chain as the chain will no longer verify. This illustrates the difficulty in manipulating blockchain's information. Therefore, cryptographic hash values are used to ensure the integrity of the data in a blockchain, making it a tamper–resistant system (Corluka and Lindh, 2017). In summary, each child block contains the hash of its parent block and this hash value (together with the data content of the child block) is used to generate the hash value for the child block and so forth.

When computing the next block to be added to a blockchain ledger, there will be multiple possible blocks that all exist at the same time, each one containing the hash value from the previous block. This is true for the Proof-of-Work concept, whereby consensus must be reached for the correct block to be added to the chain. Multiple nodes compete to solve mathematical algorithms, and each miner assembles a block with new transactions and the previous blocks' hash value, proving that simply having the hash value in a block does not make that block unique (Deshpande, et al., 2017; Lemieux, 2017). This is the process of adding blocks to the chain, a hash value that points back to the previous block. However, the unique block will be the block that gets validated and added to the chain, and then the hash value will become a unique pointer and is now valid, due to the fact that this block points to a valid previous block. This illustrates the logic of adding blocks to the chain. As a result, there is a difference in the process flow compared to the logic behind blockchain as a ledger. To

summarise this, the process of computing blocks to add to the blockchain refers to passing a hash value forward as a parameter that contributes to the next process of calculation, but the logic of the blockchain itself would see this being referred backwards to a valid block and hash value (Bal, 2017; Corluka and Lindh, 2017). Blockchain and real estate will look to the past to validate ownership. The process flow is illustrated below in *Figure 4.1*.

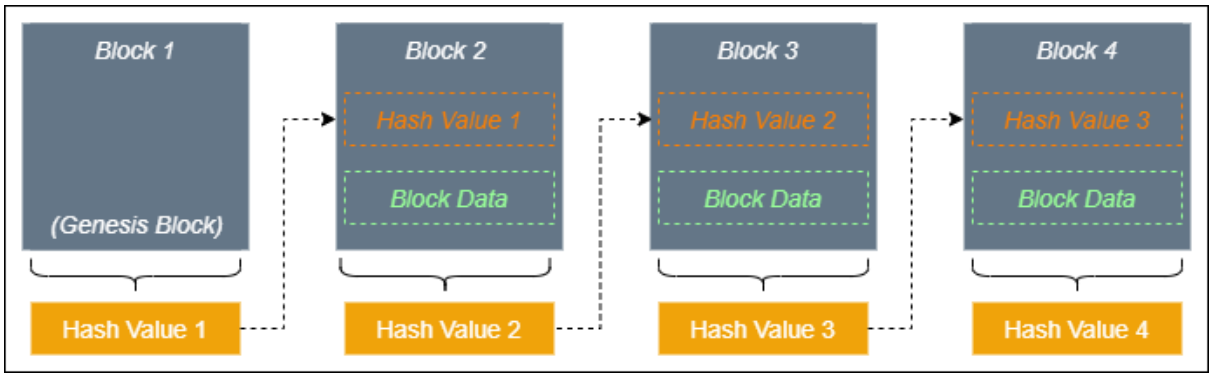


Figure 4.1: Hashing Process and Hash Values

4.2.3 Cryptography

When communicating with one another (verbally or electronically), individuals can do so through a private and secure communication channel. Private channels of communication are employed either when wanting to protect the identities of the communicators and/or protect the information being communicated. Secure channels of communication are also needed when conducting transactions, especially those involving high value assets such as real estate (Couse, 2017; Kejriwal and Mahajan, 2017). In conducting such transactions, individuals want to be assured that their personal and financial information is kept confidential. As the world becomes more digital and more transactions are carried out over the internet (internet banking; online shopping; stock trading), the need for more secure channels of communication increases. While the Internet allows society to communicate instantly and share information with one another, it is not an inherently secure network or channel of communication (Couse, 2017).

Cryptography can be defined as the act of obtaining a secure and confidential channel of communication between two parties while in the presence of others, using encryption and decryption techniques to ensure that only the intended parties can access and interpret the information being transferred (Anderson, 2008). Prior to the arrival of blockchain technology and the Internet, cryptography, timestamps, ledgers, and digital signatures were nothing new to the technological world. However, what makes blockchain technology so promising is the combination of the aforementioned facets. Before blockchain technology and the Internet a

form of cryptography known as 'symmetric cryptography' existed. Symmetric cryptography used a single key (the same key) to encrypt and decrypt communicated information. However, issues arose when it came to key distribution as both the sender and receiver needed possession of the key when encrypting and decrypting the communication information, meaning a secure channel of transfer without interception was needed to send the key (Corluka and Lindh, 2017). Thus, key distribution became an increased risk in symmetric cryptography. With blockchain, cryptography has now digitally evolved allowing parties to securely and privately communicate and transact with one another, this is achieved through public key cryptography. Public key cryptography uses a pair of keys, a public key and a private key. These two keys are used together and permit the following capabilities:

- Encryption and decryption of messages allowing for communication between the intended participants.
- Digital signatures for verification and authentication of participants.

Public keys are made available on the blockchain network, while private keys are kept secure. To demonstrate how public key cryptography is employed, imagine a situation where two parties want to communicate with one another, such as *Party X* and *Party Y*. *Party X* wants to communicate and transact with *Party Y* and as a result, will encrypt the message using the public key of *Party Y*, which is publicly available (Anderson, 2008). The message is then dispersed through the blockchain network and is publicly available for all participants to see, although only *Party Y* will be able to decrypt the message. This is because *Party Y* possesses the correct private key. Thus, public keys are used to encrypt communicated information, while private keys are used to decrypt communicated information (Barbieri and Gassen, 2017; Bal, 2017). Public key cryptography also provides verification that communicated information has been sent from the claimed source, without any intercepted interference, and been received by the intended recipient. This is all achieved through digital signatures. This is known as non-repudiation (another key characteristic of blockchain) which is the assurance that an individual cannot deny something (in other words, cannot deny the creation or modification of communicated information). In continuance of this example, *Party X* needs to verify themselves and this can be done by signing the encrypted message with their own private key. Once Party Y receives the intended communicated information, Party Y will decrypt the message using their private key as well as the public key of Party X. As a result, public key cryptography has solved the key distribution problem identified above (Anderson, 2008).

4.2.4 Proof-of-Work vs Proof-of-Stake

Blockchain technology is distributed in nature, meaning that there is no central authority controlling the digital ledger. The blockchain can be described as a digital distributed ledger which is accessible to all participants on the network. Due to the lack of a central authority, it is the responsibility of the network community to monitor and maintain the ledger's contents. The ledger must be correct at all times and only hold valid transactional entries, with no malicious or incorrect data entering the chain (Anderson, 2008). Thus, the onus falls on the participants in a network to validate and verify all transactions, collectively agreeing upon the contents of the ledger. There must always be consensus as to what will be accepted and what will be rejected, and consensus ensures that verified transactions are added to the blockchain (Vos, 2016; Graglia and Mellon, 2018).

Proof-of-Work (PoW) and Proof-of-Stake (PoS) can be defined as consensus mechanisms on the blockchain. Also known as consensus algorithms, PoW and PoS are the most common methods employed for verifying blockchain transactions, but they are not the only options. Delegated Proof-of-Stake (DPoS) and Federated Byzantine Agreement (FBD) also exist. Regardless of the consensus mechanisms employed, the goal remains the same, to verify and validate all transactions on the blockchain. What differs is the way in which they achieve this goal, with the main difference between PoW and PoS being how participants are remunerated and rewarded for verifying transactions (Corluka and Lindh, 2017; Al Ahmad, Al-Saleh and Al Masoud, 2018).

In a PoW consensus mechanism, miners of the network compete with one another to solve mathematical cryptographic puzzles. The process of mining, and the chances of mining transaction blocks, is reliant on computational resources. These computational resources include both hardware and energy consumption. Thus, miners compete with one another through computational power; the higher the energy and power you possess, the higher your chances of mining blocks. Once a cryptographic puzzle is solved and the transactions are verified, the block is added to the chain. The first miner to solve the cryptographic problem will be rewarded with a coin/token, a newly created coin/token from that particular blockchain. In contrast, a PoS mechanism has to do with how large a participant's stake in the network is (Vos, 2016; Al Ahmad, Al-Saleh and Al Masoud, 2018). The process of validating a new block of transactions does not require solving a cryptographic puzzle, rather, validators are selected by the size of the stake they hold on a blockchain network. The more coins/tokens a user possesses, the higher chance they have of being chosen to validate blocks. When it comes to

rewarding validators, they do not receive a block reward (a newly minted coin) but rather they are remunerated through transaction fees. As a result, high computational power is not needed and PoS is seen as a more cost efficient mechanism, one that is energy and environmentally friendly (Corluka and Lindh, 2017; Al Ahmad, Al-Saleh and Al Masoud, 2018).

A common threat to a PoW algorithm is that of a 51% attack, whereby a central authority or a collusion of miners takes control of 51% of the network. This attack can be carried out by possessing majority of the computer power within the network. Once an entity controls the network, it can control which transactions are valid and which are not. A 51% attack is can be conducted in order to try and 'double spend' coins, a situation where digital currency is duplicated and falsified which allows it to be spent more than once. The PoS mechanism is therefore seen as more secure but literature suggests that it is not been tried and tested enough for its challenges to be revealed (Lemieux, 2017; Graglia and Mellon, 2018). To accomplish a 51% attack in a PoS protocol would require acquiring 51% of the network's tokens, rendering this attack a lot less likely. It is more difficult to obtain 51% of the network's tokens than it is to rent computational power. The more tokens you purchase in a PoS network, the higher the price becomes (increased demand leads to increased price) but due to the size of the market for computational power and hardware, increased purchasing will not significantly change the prices. Thus, PoS is seen as safer as well as being eco-friendlier. In a blockchain-based real estate system, a PoS network is considered to be a more viable option. This is because a PoS is regarded as a fairer solution as well as one that poses less risk as a 51% attack is not as likely. A PoS mechanism is also seen as more trustworthy, as participants stake their coins to illustrate their honesty. When coins are staked, nodes will lock a certain amount of their coins into a cryptocurrency wallet which is on the network, which represents their stake. This stake is held in a bound wallet on the network. If the node would like to stop contributing to the blockchain through validating transactions, their stake will be distributed and released back to them. These are all characteristics needed for a blockchain-based real estate solution.

4.3 The Promise of Blockchain Technology

In 2009 Satoshi Nakamoto invented the world's first cryptocurrency, Bitcoin. They used blockchain technology as the underlying technological foundation on which the cryptocurrency runs (*Section 4.2*). However, as the technology has been further studied, so its applicability in other fields is being realised. It is clearly evident that blockchain technology's capabilities span far beyond that of cryptocurrency's alone. It is believed that the technology can positively

influence and transform more than 30 industries, with health-care, supply-chain, and real estate being the biggest drivers for its implementation (Couse, 2017; Baum, 2017). As proclaimed by Paul Stevens, CEO of Just Property in an article by Property Wheel (2018, p 02).

> *"Blockchain is to Bitcoin what the Internet is to email: A big electronic system on top of which applications can be built, currency is just one."*

It is worth noting that the uncertain future of Bitcoin does not signify the end of blockchain technology nor should the potential downfall of Bitcoin be associated with the downfall of the technology enabling it. Cryptocurrencies require blockchain technology, not the other way around. With the arrival of the Internet in 1990, society was able to directly interact and exchange information with one another. Exchanges, consisting primarily of images and text, were now made faster, cheaper, and without interference. Blockchain technology is much like the Internet but instead of images and text, it allows us to transfer money and assets (Couse, 2017; Dalton, et al., 2017; Deshpande, et al., 2017).

In a world of increased business competition, ever-changing consumer demands, and a constant drive towards innovative product and service delivery, it is evident that business needs are becoming more complex. Such complexities in business paves the way for disruptive technologies such as blockchain to transform the way business processes and transactions are conducted. Currently, the technology is most prominent in the FinTech industry where an association of more than 90 companies in the United States of America are working together to bring distributed ledger technology into the global finance market (Baum, 2017; Graglia and Mellon, 2018). Consequently, blockchain technology has been defined as "the Internet of finance" (Vos, 2016). China, India, and Japan are also leading the way in blockchain adoption, with Japan having legalised Bitcoin in 2016. In South Africa the South African Reserve Bank (SARB) is researching the legalities and regulatory structures involved for the use of cryptocurrencies as a legal medium of exchange (Veuger, 2017).

Blockchain technology can enhance transactions by reducing the number of stakeholders involved. Additionally, blockchain's ledger can assist transactions with immutable record-keeping whereby the history and provenance of assets (and their ownership), such as real estate, can be maintained, recorded, and tracked. Furthermore, in a world of instant sharing and manipulation of information, blockchain technology represents an infrastructure whereby digital items can be kept scarce (PropertyWheel, 2018). Digital scarcity can be acknowledged in three ways: (1) blockchain permits single ownership by means of a private

key; (2) digital tokens can represent real-world assets that can be assigned only to their owners and cannot be copied but only transacted; and (3) cryptocurrency such as Bitcoin is limited in that there are potentially only 21 million Bitcoin on the network (Beck, et al., 2016). Possessing the characteristics of being distributed and decentralised make blockchain's ledger more transparent and efficient due to less third-party involvement and real-time access and clarification of transactions (deRidder, et al., 2016; Barbieri and Gassen, 2017; Veuger, 2017; Nasarre-Aznar, 2018).Through blockchain technology, transactional efficiency can be enhanced in the following ways:

- Reduced third-party involvement as two parties can directly engage in transactions with one another.
- Reduced transaction costs.
- Increased transaction speed.
- Concurrent delivery and transfer of assets versus delivery of payment.
- Increased security as transactional information on the blockchain is immutable.
- Increased integrity of information as all transactions are validated and approved by network participants.
- Increased transparency as all transactional information is distributed throughout the network, as well as real-time tracking of transactions and assets.
- Increased accountability through non-repudiation of network transactions.
- Enhanced smart contracts being employed which can act as escrow services and manage transactions and their metadata from start to finish.

In Bitcoin's infancy, blockchain technology only facilitated bitcoin transactions between nodes on the network. However, applications and systems have been developed whereby transactions between two parties can now be supplemented by smart contracts, specifically Ethereum[9]. Ethereum is a decentralised platform which facilitates the creation of decentralised applications that run and operate as programmed through smart contracts. Their focus lies in enabling the use of smart contracts (deRidder, et al., 2016; Kejriwal and Mahajan, 2017; Nasarre-Aznar, 2018). Smart contracts benefit transactions as they alleviate the need for intermediaries and thus lower transactions costs. In addition, smart contracts enhance transactional security and efficiency due to their automated nature of 'if this, then that', whereby funds, assets, and asset

[9] https://www.ethereum.org/

ownership can be transferred automatically and immediately upon meeting pre-programmed obligations.

Blockchain technology offers a new and innovative way of conducting transactions through a trust-less decentralised environment. Business processes and transactions are based around the need for trust and in contrast to the current method of carrying-out these transactions (third-parties managing information through paper-based database systems), blockchain technology represents a threat to anyone involved in the trust business (deRidder, et al., 2016; Vos, 2016).

Another key capability that blockchain offers are smart contracts. A smart contract can be compared to traditional paper-based contracts, except that they are digitised, with the contract contents and terms of agreement between two parties (buyer and seller) being digitally coded. Smart contracts can further be described as pieces of software which hold the rules for negotiating the terms of a contract, acting as programs that are stored on a blockchain network. One of their main advantages is that they are self-executing which means that pre-defined conditions (which were agreed upon by both parties and written as code into the contract), will be offset automatically once contractual obligations have occurred (Dalton, et al., 2017; Veuger, 2017; Maklari, Kalata and Luper, 2018; Nasarre-Aznar, 2018). Simply put, when a written condition in the contract is met, an equal and opposite activity occurs whereby the program triggers a corresponding action, which explains why these contracts are commonly known as 'if-then' contracts. Secondly, smart contracts have the potential to eliminate the need for third-party involvement in contractual negotiations, reducing both costs and the chance of human error. Through digitised coded contracts, there is less room for misunderstandings, miscommunication, and disputes.

Smart contracts have the potential to revolutionise the way in which transactions are conducted by enhancing the efficiency of and streamlining business processes. Moreover, tokenised assets (such as real estate) can be exchanged in a transparent, conflict-free manner without the need for as many third-parties (Graglia and Mellon, 2018; Gatteschi, et al., 2018). Tokenisation of assets in specific relation to real estate will be discussed further in *Chapter Six, Section 6.3*.

4.4 PropTech

The integration of property and technology is formally known as PropTech, the collaboration of real estate (and/or property) and technology, whereby technological applications and systems are employed to enhance current market practices such as real estate transactions

(Baum, 2017; Couse, 2017; Veuger, 2017). There is consensus in the literature that the real estate sector has long ignored revolutionary technologies, being slow to adopt and implement. With emerging technologies and digital transformations becoming common practice, existing business models are adjusted in order to increase efficiency in their service delivery. The complex transaction process in the real estate sector has paved the way for innovative technologies, such as blockchain, to reduce complexities and enhance processes. Currently in its third phase, PropTech 3.0 involves the integration of blockchain technology in facilitating real estate transactions.

Since the introduction of the Internet, technology began to play a role in and impact the real estate sector. PropTech 1.0 began with a focus on the consumer, by providing consumers with online portals whereby property listings could be viewed, known as 'multiple listing services' (MLS). This involved a single property portal in which multiple properties were listed and accessible to the user, expediting the search process. PropTech 1.0 occurred in response to the introduction of smart phones and the consumer's accessibility to search for anything and everything online. PropTech 1.0 required little technical knowledge for execution (Baum, 2017). A drawback of MLS was that the same information needed to be stored across multiple siloed systems, resulting in data redundancies. As a result, property information became increasingly available in paper and digital form, but information was duplicated across systems. This resulted in a lack of transparency as correct real-time information was not available, as information across multiple systems sometimes differed. In addition, there was an increased opportunity for fraud and error as false property listings were difficult to identify, resulting in consumers being embezzled into paying for properties not on the market.

However, these online portals became very competitive and so the transition into PropTech 2.0 began, whereby product and service differentiation became key. PropTech 2.0 expanded on the MLS by providing access to all property information in a manner which utilised additional tools and features (Couse, 2017). This included data analytics (tracking and monitoring consumer's social media content to adhere to and match their preferences) and virtual reality home viewings. Consequently, PropTech 2.0 required an increase in the level of technical knowledge.

Now, PropTech 3.0 is making use of blockchain technology to enhance real estate transactions and land-registry systems. Through blockchain, a digital disruption in the real estate sector is occurring – where cutting-edge technologies are employed in service delivery, providing cheaper and superior alternatives to current practices (Baum, 2017; Nasarre-Aznar, 2018). Companies such as Propy allow for real estate transactions to be conducted using

blockchain. PropTech 3.0 requires a high level of technical ability for such technologies to be integrated. Despite the challenges, once implemented, the benefits could be significant.

4.5 Opportunities for Blockchain Technology in Real Estate

Real estate transactions represent a complex business process, centred on preventing fraudulent activities and protecting titleholder ownership (truth is cardinal). Both these aspects are key features of blockchain technology. Blockchain technology has already exhibited its capabilities within the real estate sector through various start-ups who are managing real estate transactions using the technology (Compton and Schottenstein, 2017; Corluka and Lindh, 2017; Veuger, 2017). While the technology offers unique features (transparency, speed, immutability, and so on.) which can enable a more efficient real estate sector (through improved transactions and land registry systems), it is unreasonable to expect that an immediate change in the real estate industry will take place. The entire property transaction process and property recording system will not automatically adopt a blockchain system, nor will all transaction costs and stakeholders be eliminated straight away. However, through an iterative manner, the technology can be incorporated into current processes and assist in simplifying transactions. This paper analysed two different property transactional processes, property transactions in South African and international property transactions using blockchain technology.

Blockchain's involvement in the real estate sector is apparent world-wide with various nations experimenting with its use for real estate record-keeping. The United States of Arizona and Illinois are both making inroads into its adoption. The former has recently passed legislation, in March 2018, that allows smart contracts on blockchain to replace traditional methods of recording property transactions and title ownership. The latter is aiming to replace the current land registry system with that of a blockchain-based solution which will assist in transferring property titles and ownership (Vos, 2016; Karayaneva, 2017). In Europe and Asia, the Netherlands and Dubai are actively involved in developing a blockchain-based solution which can take care of property transactions and assist in the transfer of title ownership (Veuger, 2017; PropertyWheel, 2018). The leading nation in adopting blockchain technology for real estate practices is Sweden. The Swedish Land Registry (Lantmäteriet[10]) is currently in its third phase of a blockchain-based land registry system which will hold and transfer home ownership documents. In Africa, Kenya and Ghana are active role players in the PropTech sector and are both planning to implement blockchain-based solutions for managing and

[10] https://www.lantmateriet.se/sv/

transferring property records (AfricaPropertyNews, 2016; Graglia and Mellon, 2018). The commonality that exists amongst all nations involved in the PropTech 3.0 sector are their motives for doing so: the prevention of fraud via manipulation and tampering of documents, increased transaction speed, lower transaction costs and automated processes via smart contracts (Dalton, et al., 2017; Deshpande, et al., 2017; Nasarre-Aznar, 2018). The ultimate goal of this movement is to enhance the property transaction process by reducing complexity and increasing efficiency. Through the literature review, six primary opportunities for blockchain technology in the real estate sector (and transactions within) were identified. These opportunities do not exist in isolation nor will they be discussed as segregated concepts. Instead, the six opportunities identified are co-dependent on one another and the discussion of one may involve the incorporation of others and vice versa. The opportunities are as follows:

- Immutable record-keeping.
- Smart contracts.
- Costs.
- Accessibility and Speed.
- Transparency.
- Security.

4.5.1 Opportunity 1: Immutable Record-Keeping

Blockchain technology can significantly enhance the real estate sector by providing the foundation for an immutable record of real estate transaction documents and home ownership records (Veuger, 2017; Dijkstra, 2017). A blockchain-based land registry system removes current problems faced in traditional registries. Blockchain-based land registry systems have the potential to store smart contracts, which can hold title deeds representative of current owners. These smart contracts can hold digital tokens which represent the physical property (*Section 6.2*) and through smart contracts, the exchange of tokens in return for title ownership can occur.

Since 2013, 37 nations have moved to computerised systems for land registry operations, the first step towards digitisation (Graglia and Mellon, 2018). Consequently, real estate transactions have become 38% faster to complete. Moving to a blockchain-based land registry could further drive these benefits. Blockchain's digital ledger therefore represents a strong alternative to current land registry systems as it can offer process enhancements.

Through blockchain, real-time ownership is evident as it can verify who owns what, and when (Vos, 2016; Veuger, 2017).

A fundamental characteristic of blockchain is that it can act as a single source of truth in recording real-time ownership (Deshpande, et al., 2017; Lemieux, 2017). Through digitising real estate title ownership deeds and recording this ownership on the blockchain, false title claims can be prevented. This is due to the fact that the same transaction cannot be added to the chain twice. Once there is consensus on real estate owners (title ownership deeds tied to the true property owner) and there is verified truth on the network, (*single*) ownership (*digitised title deeds stored in smart contracts*) of the asset (*real estate*) is added and recorded onto the blockchain. Attempted duplicated entries or re-entries regarding this asset will not be accepted onto the chain, alleviating the problem of double-spending and record-tampering (Vos, 2016; Veuger, 2017; Nasarre-Aznar, 2018). Additionally, only asset owners can authorise transactions (involving token/title deed transfer), as the aforementioned tokens and smart contracts containing title ownership deeds are tied to their blockchain address as well as their private keys. Thus, through blockchain technology, real estate ownership is immutably recorded, protected, and secure, adding increased levels of trust and assurance during real estate transactions. Blockchain's ledger verification protocol (providing real-time proof of ownership) eliminates the need for third-party protection in the form of title insurance companies, reducing overall transaction costs and improving transaction speed (Bal, 2017; Dalton, et al., 2017).

Modernisation of land registry systems means digitising property records and transactions, thereby reducing manual human error and speeding up transaction time as stakeholders will not have to be physically present to sign as digital signatures can be employed. Blockchain's ledger maintains a full history of all prior transactions in chronological order, meaning that searches for title ownership deeds can be made more efficient and a complete audit trail of transactions is possible. This implies that it is possible to inspect all previous transactions regarding real estate and at any given point in time, a single owner can be guaranteed (Maklari, Kalata and Luper, 2018). On top of storing transactional information, blockchain can assign real estate identities which store all characteristic information pertaining to properties, thus expediting due diligence process. Information such as title ownership deeds, history of ownership, and legal information pertaining to the property could be stored on the blockchain (Vos, 2016). All blockchain information is verified, trustworthy, and secure, proving how digitised records on the blockchain can trump existing manual and paper-based systems. Finally, a distributed blockchain-based land registry system will act as a back-up of

all transactional information, preventing the loss of data and records (Vos, 2016; Bal, 2017). As a result, property title ownership could now possess increased security and be better managed through blockchain.

4.5.2 Opportunity 2: Smart Contracts

In *Section 4.3.1* the concept of smart contracts was explained. In real estate transactions, smart contracts can be used as a digital representation of agreements decided upon by the buyer and seller (Barbieri and Gassen, 2017; Compton and Schottenstein, 2017; Couse, 2017). Current real estate transactions are cumbersome as most processes involved are human intensive (both in carrying out the transaction and the creation and management of documents) but with digitisation, speed can be enhanced. Smart contracts can revolutionise real estate transactions by automating the execution of transfers once conditions are met. Smart contracts can also manage transactions by providing regular status updates as the transaction moves through its phases (Kejriwal and Mahajan, 2017).

Additionally, smart contracts can benefit real estate transactions through cost alleviation by reducing the number of stakeholders involved and fraud prevention. Transactions whereby parties can directly transact with one another, reducing the need for multiple stakeholders to be involved in the process, are plausible. This is not to say that all third parties will be eradicated overnight as legally intensive transactions, such as real estate, will still need regulatory supervision regardless of the methods employed. However, when it comes to roles of escrow services, smart contracts can fulfil this position. Here, the contracts can hold funds and assets while transactions are being carried out, and automatically distribute them when necessary. Transactions therefore become more secure with a lower risk of fraudulent activity. This is significant when considering high value asset transfers such as real estate, where trust and security are paramount (deRidder, et al., 2016).

Transactional friction can also be eased as reliance on various stakeholders for documentation can be reduced, thereby saving time (Compton and Schottenstein, 2017; Mashatan and Roberts, 2017; PropertyWheel, 2018). With fewer stakeholders involved, transactional costs will inevitably be reduced (Dijkstra, 2017; Mashatan and Roberts, 2017). Overall, smart contracts can bring noticeable advantages to real estate transactions such as cost alleviation, higher levels of security and less risk of fraud, and improved transaction speed.

4.5.3 Opportunity 3: Accessibility and Speed

Currently real estate transactions comprise various stakeholders. Each of these stakeholders utilise their own systems for managing their portion of the transaction. Here, transaction

information and documentation are stored in siloed systems which results in a situation of low inter-operability amongst all stakeholders and their data. Siloed systems not only slow down the process of moving and sharing information and data but also results in a situation of duplicated information storage. Blockchain technology has the potential to provide real estate transaction platforms in which all stakeholders can be linked, and transactions can be conducted. This allows a single transaction to be executed and managed in one place (Bal, 2017; Corluka and Lindh, 2017). Thus, the transfer of information from one stakeholder to the next is simplified, leading to increased accessibility and streamlining the processes.

Through a common transaction platform, network validation of transactional documents can occur more quickly than compared to the traditional processes currently used (Barbieri and Gassen, 2017; Mashatan and Roberts, 2017). This is because improved transparency through blockchain leads to increased accountability. Therefore, stakeholders can pinpoint at what stage a transaction is at and force participating stakeholders to fulfil their obligations when required. Such a platform can also enable smarter and quicker decision making (Barbieri and Gassen, 2017). By having real-time information available, in a secured and trusted platform, stakeholders are better equipped with the data they need during transactions (Bridge, 2017). These decisions can be further assisted by digitised documents on the blockchain which can now be searched and analysed more quickly than that of a paper-based system. Having all stakeholders operate through one platform brings about increased real-time accessibility and speeds up the transaction, expediting due diligence processes involved (Kejriwal and Mahajan, 2017; Veuger, 2017). It therefore makes sense to store all property information on the blockchain with the assistance of tokens, this was further discussed in *Section 6.2*.

It is important to remember that a blockchain represents a data model which allows for database innovation, it is an immutable ledger and its security is achieved in part by cryptography. Blockchain-based ledgers can exist without cryptocurrencies and still exhibit the same characteristics. Therefore, a real estate transaction platform which digitally stores all documents in a distributed database and the generated hash values on the blockchain, is still a plausible avenue of use despite not having a cryptocurrency or token go with it. In this scenario, the characteristics of increased speed and security are still being realised. Information is regarded as highly secure in a blockchain database due to the shared nature of the network. This means that there is no single point of failure or potential loss/manipulation of documents, which currently occurs in the paper-based system (Bal, 2017; deRidder, et al., 2016; Deshpande, et al., 2017).

4.5.4 Opportunity 4: Cost Reduction

Blockchain's distributed ledger makes it possible for participants in a network to share and access information at much quicker rates than before. Not only is speed enhanced but such data (digital assets, real estate information, fiat and virtual currency) are shared in a secure environment, which eases accessibility, reducing reliance on third-parties and therefore reducing costs (Baum, 2017; Couse, 2017; Dijkstra, 2017). Literature suggests that blockchain technology in real estate transactions can drive out the need for title insurance companies. This is because verified documents (and their hash values) are stored on an immutable blockchain ledger, allowing no room for error or fraud (Barbieri and Gassen, 2017; Karayaneva, 2017). If records are stored in a trusted blockchain-based real estate ledger, people would no longer require insurance on such documents which would eliminate that cost. By putting all relevant real estate title deeds on the blockchain, it makes these documents and their metadata (such as transaction history), publicly available at a low cost. Smart contracts are able to (and have already, as per *Chapter Five*) play the role of an escrow agent and thus transaction costs can be reduced (Compton and Schottenstein, 2017; Dalton, et al., 2017). Moreover, it simplifies the process of searching for, and analysing these documents, bringing about increased transaction turnover time and lowering costs in regard to access to information.

However, while costs may be reduced due to less stakeholders, a blockchain-based platform and what is has to offer will need to appeal to potential users. One of the reasons that the Bitcoin blockchain network is as secure and reliant as it is, is because nodes are incentivised in the process of mining through rewards. These rewards are typically in the form of cryptocurrency. If a blockchain-based transaction platform, which executes transactions with the assistance of stakeholders verifying the content, is adopted, then incentives for those managing the network will need to be established. One way that this can be done is by creating and issuing network tokens. As individuals register, interact, and use the platform, they can be rewarded with tokens that allow them to access more features and capabilities. In such a scenario, a PoW algorithm could be put in place whereby nodes who verify transaction records are rewarded with tokens from the network. Alternatively, funds arising from transfer costs, for example, could be used to pay miners as incentives to adopt and operate through the blockchain-based real estate transaction platform.

4.5.5 Opportunity 5: Transparency

As real estate is currently regarded as a very opaque sector (one in which the buyer and seller have little access to information concerning their own property transaction), blockchain offers

improved transparency to the real estate sector. Given the technological advancements today, the real estate sector expects greater levels of transparency, where secure information is accessible in real-time to the correct stakeholders (deRidder, et al., 2016; Veuger, 2017; Graglia and Mellon, 2018). A blockchain ledger is comprised of transactions dating back to the genesis block, meaning that a complete history of transactions is available. These transactions (and their metadata) are visible and available to all participants who are joined to the network, meaning participants can see who owns what and when. Through smart contracts, real estate transactions can be updated in real-time as the process moves through its relevant stages. Buyers and sellers can now access and view property records while being notified when approvals are granted and when action is needed (real-time transaction status). This allows for users of a blockchain-based real estate transaction platform to have transparency regarding their transaction, removing information asymmetry (AfricaPropertyNews, 2016; deRidder, et al., 2016).

Currently, the South African land registry and Deeds Offices permit these documents to be available to the public but due to the paper-based process there is no guarantee that documents are unique. In addition, these records are only available at a cost. Blockchain can help realise the user's right to have all deed documentation available while ensuring its individuality, accuracy, and immutability at the same time, providing transparency for all while protecting title deeds and property rights. As a result of this transparency due diligence processes can be carried out a lot faster, access to information is quicker and checks can be conducted in increased turnover time. Transparency can assist in preventing double spending (trying to sell a property twice to two different buyers) and can prevent forged real estate documents (Bal, 2017; Veuger, 2017; King, 2018).

4.5.6 Opportunity 6: Security

Real estate transactions are heavily reliant on trust (trust in ensuring stakeholders go about processes correctly and ethically). Through blockchain's structure which offers a decentralised trust-less environment, transactions are recognised as more secure. Digitisation leads to enhanced efficiency of business process. Digitally verified blockchain records allows for single digital documents (as opposed to multiple paper-based records) that can be trusted by all stakeholders.

Through digitising real estate records and storing these documents on the blockchain, information can be secured and trustworthy. This is because hash values of each record can be stored, meaning any change/manipulation of existing records, will affect the hash value and

upset the chain. Thus, changes will not go unrecognised, illustrating the security that the blockchain possesses (Barbieri and Gassen, 2017; Lemieux, 2017; Canfield, 2018). The records that can be stored on the blockchain can consist of title ownership deeds, identity documents of owners, transaction contract documents as well as financial and legal documentation. Blockchain's ledger creates a permanent record of transactions which is distributed amongst the network, almost eradicating the threat of data loss. Cryptography (which relies on advanced technical encryption techniques) also ensures the integrity of transactions and ensures that the intended stakeholders are the ones involved in said transaction. This, coupled with the consensus protocol that blockchain implements to ensure that no false entries or transactions enter the ledger, illustrates the safety mechanisms in place. As a result, falsified real estate records (such as forged title deeds and so on.) will not be verified and fraud can be reduced (Barbieri and Gassen, 2017; Maklari, Kalata and Luper, 2018). Through the tamper resistant technology, ownership clarification can be recorded and made clear to everyone on the network, and higher transparency means less risk. Records stored on the blockchain are not only immutable, verified, and secure, but these aforementioned characteristics result in a higher quality of information being used in transactions.

4.6 Challenges for Blockchain Technology in Real Estate

While blockchain technology has proven potential to augment the real estate transaction process involved, it is worth mentioning that there are obstacles which could hamper its implementation. As with all new business processes, their success depends upon the support of its users, the stakeholders. The stakeholders engaged need to fully trust the system, independent of any technical elements, in order to increase the possibilities of it being a success, in other words, it needs stakeholder buy-in. Strong support leads to adoption, and the higher the degree to which new business processes will be accepted, the higher the chances are of it succeeding. Blockchain technology posits a decentralised and trust-less environment (Deshpande, et al., 2017; Couse, 2017). However, governments and authorities of power may not be as willing to adopt such mechanisms, as it can give rise to a power shift through decentralising typically governed procedures.

The fourth industrial revolution sees emerging technologies (such as blockchain) making significant inroads into societal and business processes. These technologies come at a cost and incorporating blockchain-based solutions (of whatever nature) will require costly installation fees as well needing personnel with the correct technical skills for the development

and maintenance of such systems. Furthermore, once implemented, these technologies have the ability to reduce human resources in business processes, boosting productivity and enhancing efficiency but coming at the expense of human labour and involvement.

While a blockchain-based land registry system seems admirable, the process of obtaining the correct initial information onto the chain may prove to be a complicated task; blockchain will not solve the problem of corruption (Barbieri and Gassen, 2017; Graglia and Mellon, 2018). Moreover, real estate transactions are dependent on the country in which they occur, and with this come various national legalities, meaning that a legal framework will need to be developed which may prove to be a strenuous and an enervated endeavour. Through the literature review, the study identified five primary challenges for blockchain technology in real estate transactions:

- Adoption.
- Initial information capture.
- Human involvement.
- Legality.
- Fraud.

4.6.1 Challenge 1: Adoption

While blockchain has proved itself with respect to its involvement in Bitcoin (and other cryptocurrencies), its usage and implementation beyond that is largely experimental. The process of purchasing real estate represents a business process consisting of structured activities involving stakeholders with the end goal of delivering a product or service to customers. Integrating blockchain technology into the current practices will not only require acceptance but also implementation of new business processes and a potential restructuring of job roles. The success of a newly implemented solution is dependent on the degree to which it is accepted and adopted by all stakeholders involved in the process (deRidder, et al., 2016; Compton and Schottenstein, 2017; Couse, 2017). For blockchain technology to positively impact real estate transactions there must be full trust in the system, independent of legal and technical aspects, from all stakeholders. As a result, a strong stakeholder-buy in is imperative.

Real estate transactions today are heavily intertwined with involvement of stakeholders, something that people have become familiar with. People have become accustomed to the current business process of transacting real estate and may show resistance to new technologies such as blockchain due to the ‘fear of the unknown’. Real estate transactions represent a process

of high complexity due to the personal, legal, and financial aspects involved. Introducing new business processes to deal with this intricated chain of events and getting all stakeholders to implement and operate off it, could prove to be a difficult and lengthy process. This is because various issues will arise, namely stakeholders requiring an understanding of blockchain technology and what it means, training and skills of personnel to utilise a blockchain-based system, deciding upon uniform protocols and standards, and determining all possible methods of payment (Vos, 2016; Barbieri and Gassen, 2017; Veuger, 2017). In terms of payment schemes, a PoW algorithm with cryptocurrency pay-outs could unify the payment mechanisms through rewarding users of as they verify transactions. Taking all the above issues into account, it is possible to see why this could result in a procedure of drawn out negotiations when wanting to move to a blockchain-based transaction and land registry system.

The issue of liability also represents an area of concern. For real estate transactions which involve such high value assets, liability is crucial. Currently, state officials, registrars, and attorneys are held liable for any manipulation of land registry documents. In a business process where legal checks and financial measures are performed by automated systems, determining who can be held liable in the case of errors or mishaps is key. Blockchain technology has the power to protect physical identity, potentially blurring the lines of who to hold responsible should the case arise (Bal, 2017; Deshpande, et al., 2017). This points to the need to audit smart contracts and have a clear trace of what occurred and when.

The complexity of real estate transactions is further supported through the notion of siloed systems amongst stakeholders, as discussed in *Section 4.5.3.* Various stakeholders each operate with systems of their own, resulting in fragmented and isolated networks with minimal interoperability. Blockchain advocates use this to their advantage, stating that blockchain can help streamline processes by providing a common platform on which to operate. Initially, interoperability amongst different chain networks on the blockchain was not possible on start-up, meaning that transactions and information transfer could not occur across different blockchains (for example, Bitcoin and Ethereum). It was not possible to transfer value and data from one blockchain to the next without the assistance of intermediaries, which is rather ironic. As a result, if different stakeholders (legal, financial, and real estate professionals) decided to adopt different blockchains to store their records, we may find ourselves in a situation much like the current one, with little integration. Recently, however, has this been addressed and now cross-chain transactions and transfers are happening (in Bitcoin and Ethereum), addressing the aforementioned challenge.

4.6.2 Challenge 2: Initial Information Capture

Implementing a blockchain-based land registry system would require both governance and management. Additionally, stakeholders would need to decide upon whether the platform should run off a public blockchain (in which communities assist in maintaining) or a private blockchain. On first consideration, it could be argued that a private blockchain is too similar to the traditional systems currently in place due to lack of distribution and the ability to be hacked. However, private blockchain-based transactions are cheaper than those on a public blockchain as fewer nodes and computational power are needed for verification. In addition, these costs may not prove to be lower than current costs incurred by traditional systems. In a private blockchain system, a Proof-of-Stake algorithm may seem more applicable than a Proof-of-Work (*Section 4.2.4*). Regardless of the nature of the blockchain (public, private, or hybrid), values that remain throughout are that of cryptography, transactional history and audit trail, and immutability, leading to an increase in the quality of information (Vos, 2016; Barbieri and Gassen, 2017; Corluka and Lindh, 2017; Deshpande, et al., 2017). PropTech advocates state that the benefits provided by the technology have the potential to outweigh all challenges

Through a blockchain-based land registry system, benefits such as real-time clarification of ownership and reduced fraud through immutability can be achieved. However, once the original information of documents and records (for example, title ownership deeds) are digitised, verified, and put onto the blockchain then this information is final and immutable (unless transacted, of course). It would be futile to input incorrect records onto the blockchain that have not been verified and agreed upon by all stakeholders (Bal, 2017; Lemieux, 2017; Nasarre-Aznar, 2018). The procedure of physically collecting and importing land registration documents onto the blockchain may prove to be a tiresome and lengthy task. This issue arises because in certain nations (more so in third world and developing countries), there are often disputes regarding property ownership as ambiguities around title deed documentation and legal property rights exist. It is important to remember that the initial information capture will not be done using blockchain, nor can blockchain assist in this process. Blockchain technology cannot solve political issues, nor can it cure corruption. Consequently, the challenge resides in getting the correct initial information recorded onto the blockchain, which involves establishing a common state and foundation whereby all stakeholders involved agree upon a nationally accepted empty state of information and records. This is where the importance of the genesis block is realised, once there is a national consensus on ownership records, then the

genesis block of a blockchain-based land registry system can be populated and regarded as correct (Vos, 2016; Bal, 2017; Baum, 2017; Veuger, 2017).

The process of gaining this consensus may prove to be a daunting procedure, one that may spark unrest as well as having the potential to lead to increased corruption through manipulated documents in the hope of being recorded as the legal owner. Nevertheless, once initial information is captured, countries (including developing nations that may be corruption ridden) may benefit from a blockchain-based land registration system, as this is where the real potential of blockchain's applicability in real estate will be realised. This challenge speaks to the transition process that will need to be undertaken in moving traditionally paper-based operations onto digitised systems, which is a process that will not change overnight. It is possible that the existing land registry could act as a starting point for the genesis block.

Beyond this is the issue of protected identity which blockchain can offer. A common standard amongst all land registry systems is that homeowners, in conjunction with the property they own, must be clearly known and identified. Blockchain was built in such a way that identification and data can be protected, which may prove to be a barrier in its implementation. Electronic forms of identification could also be implemented within blockchain-based solutions so that all stakeholders can identify transacting parties, solving the problem of supplying multiple FICA paper-based documents to each authority, sometimes more than once.

4.6.3 Challenge 3: Human Involvement

Purchasing real estate is one of the biggest investments that many individuals make. Legitimacy and trustworthiness are essential for transacting parties (buyers and sellers) for such high value assets. However, many societies in the world (more so in Africa, and prominent in South Africa) are low trust societies. Due to the inherent lack of transparency surrounding real estate transactions, people tend to rely on the assurances from human third-parties (Compton and Schottenstein, 2017; Couse, 2017; Corluka and Lindh, 2017). Literature reveals that people tend to possess more confidence (as well as higher levels of security) in their transactions when said transactions are carried out and regulated by other people. It is also clear that despite third-party involvement, and the levels of so-called security it brings to transacting parties, fraud still exists in real estate transactions and within land registry systems.

A characteristic of blockchain technology is that it allows for disintermediation, meaning that the implementation of a blockchain-based solution could result in a reduction of the number of stakeholders involved. However, blockchain's integration into real estate transactions will not wipe out all stakeholders overnight. Consequently, this is, more of a long-

term threat than it is short term, as the areas currently being affected by the technology are payment and record keeping systems. Alternatively, the threat of job loss to some is seen as a shift in job description/role to others in the restructuring of tasks and activities (deRidder, et al., 2016; Kejriwal and Mahajan, 2017; Maklari, Kalata andLuper, 2018). For example, certain escrow services may be required to oversee smart contract conditions and assist in formulating contracts between the buyer and seller, but this would mean people providing the services would need the necessary technical skills to do. Also, conveyancers could provide and check electronic identification to people wishing to transact with one another. Regardless of job loss or job shift, a change in the way the process is carried out is foreseeable. As such, people may have to interact with systems when transacting real estate, something they may not be comfortable with or fully embrace.

Another potential problem is the competencies of individuals to conduct transactions on a blockchain-based system. This could, however, give rise to conveyancers becoming supervisors and representing parties involved in transactions. This would require conveyancers to now possess technical skills (over and above the legal knowledge) and capabilities to oversee such transactions, becoming specialist electronic conveyancers or e-conveyancers. Not only will specialist technical skills be needed for implementation and operation of blockchain systems, but they will also be needed throughout for maintenance and innovation. With blockchain, a complete restructure of the transaction process is necessary (Veuger, 2017). Even with third-party involvement through supervisors, the flow, speed and interchange of information will still be enhanced. By reducing reliance on stakeholders, restructuring job roles and ultimately changing the business process of transaction, the direct outcomes of a blockchain-based solution will be evident. However, these transformations will require an organisational, as well as behavioural change, from stakeholders.

4.6.4 Challenge 4: Legality

While real estate transfers represent a business process, there are many legalities to be abided by when transacting a property. As new technologies are integrated into society, we must ensure this integration is regulated and monitored. Technological turnover leads that of government regulation turnover. Literature suggests that it is a challenge for governments to keep up with changing technologies and incorporate the necessary laws. Real estate transactions are highly specific to the nation in which they occur. Every country has different conveyancing laws. Blockchain-based systems would need to be able to incorporate a variety of property regulations depending on the jurisdiction where transactions are taking place

(deRidder, et al., 2016; Barbieri and Gassen, 2017; Compton and Schottenstein, 2017; Graglia and Mellon, 2018). For blockchain technology to be integrated into real estate transactions (or any business/legal processes) a blockchain-based legal framework for transactions and record-keeping needs to exist. As there are such legal intricacies in transactions in real estate, there may in fact always be a role for trusted stakeholders.

In adopting and operating off blockchain-based solutions, people may not rely so much on attending the Deeds Office or land registry offices but rather access these records online. This represents a process shift and a potential power shift, as governments will no longer have complete control over these processes. In essence, one could say that a blockchain-based transaction platform and land registry system could open the door for the privatisation of typically governed and controlled procedures. Privatisation of assets is not particularly common in many African governments (AfricaPropertyNews, 2016; PropertyWheel, 2018). Such a shift might lead to political resistance and governments may oppose the use of such technologies.

4.6.5 Challenge 5: Fraud

While blockchain has the proven characteristics to reduce low level and less sophisticated fraud, there are situations whereby high-level fraud could occur, although these would require an adequate amount of computational and mathematical power. Transactions on the blockchain occur through cryptography (*Section 4.2.3*), which requires a private and a public key. Possessing a private key of a token or record could signify real estate ownership but problems arise if a private key is lost or stolen (Bal, 2017; Dijkstra, 2017; Graglia and Mellon, 2018). Thus, security is needed to prevent theft of wallets and their keys. Currently, there are no mechanisms in place for retaining a private key should it end up in the wrong hands, meaning that assets (digital and digitally represented) can be placed at risk. In most cases, private keys represent ownership, and this means that anyone in possession of the private key can transact the asset to which it belongs. Losing control of the private key results in losing control of the asset and potential subsequent transactions (Anderson, 2008).

The loss of private keys not only affects assets and their transactions but also affects information on the network. This means that there is a risk of bad data entering the ledger and malicious users can going unnoticed, camouflaged by the key which they possess. In addition, due to their anonymous identities, it may be hard to track down unauthorised users or participants within a network. Land registry systems require identification of people (*Section 4.6.2*), and so it would appear necessary to ensure that property ownership is tied to a real

person and not just a private key. Private keys are not enough to secure the security of such high value assets. A possible solution to this could be blockchain custodianship, which is the safeguarding of assets or securities by large firms. Just how the land registry systems (the deeds office in the case of South Africa) hold all real estate ownership and title documents, so could intermediaries store private keys in a secure authorised access manner. This, however, means employing a third-party service, illustrating that while blockchain offers disintermediation, there are still many avenues for third-party services. Alternatively, multi signature wallets could be employed. Private keys are stored in their respective wallets, which belong to the owner. Multi signature wallets require more than one key or more than one signature (from the owner) to authorise transactions, providing added security.

The decentralisation of blockchain means that information flow and financial transactions can now occur without the assistance of central authorities. However, governments may see this as a potential power shift and therefore, may be reserved in its adoption, and attempt to hold power over such networks (Bal, 2017; Baum, 2017; Graglia and Mellon, 2018; Nasarre-Aznar, 2018). The possibilities for institutions such as governments to control blockchain networks do exist, for example, a 51% attack in a PoW network. A 51% attack occurs when a central authority attempts to take over (and control) a blockchain network (*Section 4.2.4*). Due to the resources (financial and computing power) that governments possess, they hold the means to take over networks and determine what transactions are to be included and what is to be rejected, potentially resulting in situations and behaviours that are just as flawed as today. The same risk can be applied in the case of private blockchains, whereby notaries and licensed conveyancers (in a real estate system) are active participants with the possibility for an unjust collusion to take place.

4.7 Summary

This chapter provided an in-depth explanation of blockchain technology and how it is applicable to the real estate sector. An adequate examination of the literature was necessary to establish the degree to which blockchain impacts the real estate sector. Through understanding how prevalent the technology is, and what aspects of it are employed, in real estate transactions, this review assisted in the formation of the integrated model. Several technical aspects of the technology were discussed to better equip readers with knowledge of blockchain transactions, such as immutability, cryptography, smart contracts, and Proof-of-Work vs Proof-of-Stake algorithms. This was followed by a discussion on technology's involvement in the real estate

sector, known as PropTech and an outline of the opportunities and the challenges that blockchain technology will respectively provide and face in the real estate sector. It highlighted six areas of opportunity for blockchain technology in real estate transactions and five challenges. These core concepts were used as a basis for the construction of the interview questions (*Chapter Two*) as well as the integrated business process model (*Chapter Six*).

Chapter 5: Blockchain-based Real Estate Transactions

5.1 Introduction

Chapter Four presented a literature review outlining blockchain technology's involvement in the real estate sector, identifying the opportunities and challenges for the technology in real estate transactions. This chapter focuses its on real estate transactions that have been conducted using blockchain technology, adhering to the business processes involved in blockchain-based real estate transactions. A review of the various blockchain-based real estate transaction platforms will be discussed before the focus shifts to a discussion on the most prominent platform, the market leader in these types of transactions, Propy. Following this, four cases will outline where blockchain technology has assisted the real estate transaction process.

The use of blockchain technology in the real estate sector is in its infancy (Rajasekhar, 2006). Blockchain technology is currently being explored as an alternative for traditional land registry systems which are characterised by centralised databases (Voloshyn, 2017; Graglia, and Mellon, 2018). The technology is being used in the development of applications and platforms that can facilitate property transactions (Graglia, and Mellon, 2018; Baum and Saull, 2019). Countries such as Sweden and Australia are making great strides in developing a blockchain-based land registry system, with the former having conducted a three-stage trial process using ChromaWay[11], a blockchain technology platform. Sweden have already conducted their first real estate transaction, managing and storing records of the transaction on the blockchain. Blockchain-based real estate transactions which have been completed have all been performed through a real estate blockchain platforms, the most notable being Propy. Propy hosts a real estate blockchain transaction platform with a decentralised title registry. In August 2017 the first property transaction was conducted on blockchain technology when an apartment in Ukraine was purchased. Since then, Propy have carried out four more transactions on the blockchain with three occurring in the United States of America (Vermont, California, and Arizona) and the last in Seville, Spain. These transactions were executed throughout 2018 with the most recent being completed on 10 October 2018.

This study looked at four blockchain-based real estate transactions and studied them in detail. The four selected cases were the first blockchain-based real estate transaction which involved a Ukraine apartment, a deal in the American state of Vermont, a transaction conducted

[11] https://chromaway.com/

in the American state of California, and a transaction conducted in the Spanish city of Seville. These four cases were further examined at a literature level before being combined into a business process model illustrating the process.

5.2 Real Estate Blockchain-based Platforms

For real estate transactions and land registry systems to operate off blockchain technology, applications and platforms must be available. A few of the blockchain-based transaction platforms that are currently on the market (in 2019) for the real estate sector will be discussed, namely *CPROP*, *ChromaWay*, *Ubitquity*, *Rentberry*, and *Propy*.

CPROP[12] (CryptoProperties) is a decentralised real estate blockchain platform which aims to streamline the real estate transaction process. CPROP states that their goal is to focus on residential property transactions and make the activity more effective and efficient (Graglia, and Mellon, 2018). Their focus lies in providing trust and security in transactions through smart contracts, gain efficiency in the process through an online platform for all parties, reduce risk through decentralised timestamped databases, and involve all participants in a transparent manner.

ChromaWay is a blockchain technology company with their own platform. The platform facilitates the creation of smart contracts and assigns digital identities to digital assets in order to allow for asset exchange. ChromaWay aims to simplify real estate transactions with their core focus being on reducing the paper documentation required, reducing consumers costs, reducing title fraud, and increasing overall security. ChromaWay have conducted a real estate transaction through their platform and stored all records on the blockchain. The company believes that the best way to gain initial momentum is to partner (and integrate) with existing land registry, financial, and third-party systems. Sweden have stated that they strive to be one of the leading implementers of the technology in their real estate sector. ChromaWay and Sweden have partnered up in what looks to be the most advanced use of the technology at this time (Mashatan and Roberts, 2017; Graglia, and Mellon, 2018). ChromaWay have joined a consortium consisting of the official Swedish Land Registry, Swedish banks, and Swedish telecommunications providers in a project that aims to implement a blockchain-based land registry system to manage Swedish property records.

[12] https://cprop.io/

Ubitquity[13] is a blockchain-secured platform that aims to assist and manage real estate record keeping. The company is comprised of real estate and blockchain technology specialists. Ubitquity's offer to the market is that they can provide secure record keeping for property information through blockchain services. The real estate blockchain platform partners with title companies, property registry systems, and municipalities in order to provide a clean, transparent, and tamperproof record of ownership. Their platform will digitise and record property related information. Their platform offers transactional functionality, meaning that it is possible to buy and sell property through their chain. Currently, Ubitquity is working in Brazil with their official land registry in a pilot study that will attempt to move Brazil's current land registry system to a blockchain-based land registry system (Graglia, and Mellon, 2018).

Rentberry[14] addresses the market of rental negotiations between landlords and tenants. It is a rental platform which strives to streamline the process of contract negotiations between landlords and tenants. Rentberry is a decentralised platform which utilises blockchain technology to allow tenants and landlords to interact and handle all issues in one place. The transparent application will facilitate digital signatures and smart contracts which stand in place of required paper documentation (Graglia, and Mellon, 2018). The decentralised platform aims to modernise all aspects of renting property through reducing stakeholders, cutting costs, and saving time.

Propy is a blockchain-based real estate transaction platform with a decentralised title registry. This platform enables and manages property listing and facilitates online property transactions through blockchain. Propy makes use of smart contracts to accomplish property transactions (Karayaneva, 2017; Propy, 2017; Graglia, and Mellon, 2018). The end goal is to provide a foundation platform which will allow for any governments to provide country-specific rules and regulations related to their conveyancing regulations. The platform has already facilitated the buying and selling of real estate and has been involved in five property transactions (*USA and Europe*) that have taken place using blockchain technology, at the time of writing this dissertation. This platform houses a decentralised title registry which allows for the digitisation of title deeds for respective properties.

Due to the novelty of the relationship between the real estate sector (and transactions within) and blockchain technology there are currently only a handful of platforms that can facilitate such actions. This presents a clear business opportunity for all of these platforms to

[13] https://www.ubitquity.io/web/index.html

[14] https://rentberry.com/

establish themselves as market leaders in this new sector. Propy have capitalised on this chance by having already conducted five property transactions through their platform. As the sector grows and more governments and land registry systems adopt these platforms, so the competition will undoubtedly increase with more systems and applications being created. In this study, only the Propy platform and their transactions will be explored in more detail. The Propy platform is comprised of three components:

- **A property listing portal platform**
  The Propy application allows sellers to list properties and buyers to search for properties, creating a global online property registry which all parties operate on.
- **A property transaction platform**
  The platform allows all parties involved to link-up and conduct property transactions online. The platform facilitates the processing and digitising of paperwork and manages payments. Smart contracts are used to facilitate, manage and record all steps of the transaction, on the blockchain.
- **Decentralised blockchain-based title registry**
  Online transactions through Propy result in a digital transfer of title deed ad ownership, which is recorded on Propy's blockchain registry. The registry keeps track of all smart contracts, manages participant identification and stores all documents on the blockchain through hash values or the documents themselves. Propy's title registry runs on the Ethereum[15] blockchain network and therefore, all title records and property documentation are made public on the Ethereum network.

According to Graglia and Mellon (2018), Propy has two main aims: to provide technical solutions which enhance real estate transactions and to streamline all real estate transactions processes through a common platform, making the process efficient and secure. Additionally, Propy intend on reducing the number of stakeholders involved, automating manual processes through smart contracts, and improving the overall liquidity of the asset class. Initially, Propy aims to increase the efficiency of real estate transactions by adopting an online workflow through their common transaction platform. This platform is built to add increased security to transactions by storing all transactional documents and their hash values on the blockchain, creating an immutable record of events.

[15] https://www.ethereum.org/

Propy's platform not only facilitates real estate transactions but also serves as marketplace for properties. This allows prospective buyers to purchase real estate assets anywhere in the world, online. Furthermore, Propy recognises the need to partner with jurisdictional governments in terms of cross-border real estate transactions as well as blockchain technology being used to facilitate these transactions (Karayaneva, 2017; Graglia and Mellon, 2018; Cuthbertson, 2019). As will be described and seen in *Section 5.3*, Propy obtained government approval and partnership in the areas where their blockchain-based transactions were executed. Of the blockchain-based transactions that occurred, certain transactions conducted through the Propy platform were recongised as legally binding. This was done to ensure legal compliance which adhered to conveyancing legislation, despite a new technology and business process conducting the transaction.

Ultimately, Propy are striving towards a future whereby every step of a property transaction will be digitised and executed on the blockchain and managed through smart contracts. For users that make use of the Propy platform, PRO tokens can be earned. Propy's official tokens, PRO, are used to unlock smart contract functionalities such as transferring title ownership of property. These tokens are also needed to list properties for sale as well as for utilising the common platform to purchase properties. The Propy team justifies the need for these tokens being used by stating that, despite Propy's blockchain-based land registry being decentralised, some barrier to entry is needed (Graglia, and Mellon, 2018; Baum and Saull, 2019). This is because if these tokens are not employed, the network could be overloaded with illegitimate transaction records.

In order to gain acceptance both practically and legally, Propy's transaction platform will first need to demonstrate its suitability and capability to handle real estate transactions and land registry systems. This will inevitably mean that Propy's initial transactions will be conducted alongside the traditional mechanisms currently used (which still stand as official legal evidence of the transaction) (Graglia and Mellon, 2018; Lynch, 2018; Cuthbertson, 2019). This has also been described as 'mirroring' current land registry systems and will continue to be done until regulatory changes are made which permit councils to legally adopt a blockchain-based land registry system. If this shift in regulation is realised, transactions conducted via the blockchain-based platforms will be recognised as official transactions. Here, Propy's registry will be able to serve as the official ledger of records for real estate transactions and home ownership (Karayaneva, 2017; Graglia and Mellon, 2018; Cuthbertson, 2019).

If this is achieved, peer-to-peer transactions involving asset and fund transfers could be realised. In summary, Propy's two legislative routes for implementation consist of: 1) Propy

originally approaching governments and mirroring traditional systems (illustrated in *Figure 5.1*), demonstrating blockchain's capabilities and 2) governments approaching Propy and implementing official blockchain-based transaction platforms and land registry systems (Graglia and Mellon, 2018; Lynch, 2018; Cuthbertson, 2019). However, Propy recognise the fact that the real estate sector and its property purchasing process will not be revolutionised by blockchain technology overnight. This is in line with the notions put forward in S*ections 4.5* and *4.6.3.*

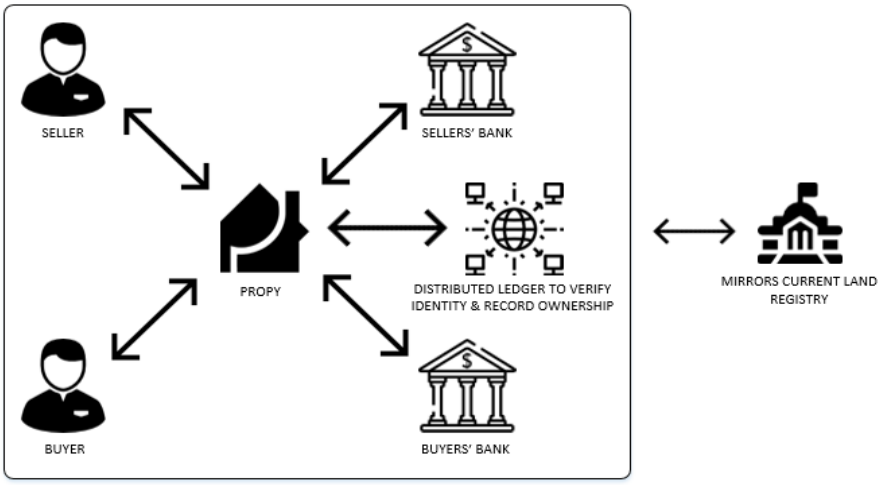


Figure 5.1: Interaction of Transaction Participants via Propy Transaction Platform

5.3 Real Estate Blockchain-based Transaction Process

The four blockchain-based real estate transactions selected for this study will now be discussed.

5.3.1 Real Estate Blockchain-based Transaction Process: Kiev, Ukraine

On 10 August 2017, the first real estate transaction was conducted using blockchain technology. It signified one of the first real assets (besides cryptocurrency) to be sold using blockchain technology. This ground-breaking operation opened the door for real estate transactions on the blockchain and as a result, more transactions have been conducted since. The first transaction involved an apartment block in Ukraine (Heaven, 2017; Voloshyn, 2017). In this transaction, the buyer was in The United States of America at the time while the seller was a Ukrainian citizen. Through the Propy platform, all parties had access to a common platform where all conveyancing documents and records were stored. These documents were stored off-chain in a distributed database amongst all stakeholders but immutably referenced to the blockchain, through hash values, for security. The Propy transaction platform connected all participants of a transaction through the use of smart contracts, illustrated in *Figure 5.2*.

5.3 Real Estate Blockchain-based Transaction Process

The process began with a buyer searching for, and selecting, a property to purchase through the Propy listing platform. In order to reserve the right to purchase, a deposit of $5000 (*equating to R75 142*) was required. This was done using fiat currency but was executed through the transaction platform. The buyer's and sellers' banks were both participants in the transaction and were included in the smart contract. The buyer then signed a power of attorney letter for a Ukrainian notary, a person licensed by the government to perform acts in legal affairs and transactions, to represent him in the deal, due to not being physically present (Heaven, 2017; Karayaneva, 2017; Voloshyn, 2017). The notary was also a participant in the transaction. This was a requirement from Ukraine but served the purpose of eliminating the need for the physical presence of the buyer.

Next, the Propy registry developed and deployed a suite of smart contracts for the transaction. These included ***a deed smart contract*** which tracks and initiates invitations of participants in the transaction (Karayaneva, 2017; Voloshyn, 2017). It also manages relevant information typically dealt with by escrow services such as property price, wallets of the parties and the smart contract wallet in which funds are held. This smart contract can receive and distribute funds, payment plans, notary details, as well as store data on the transfer of ownership. Secondly, ***a property smart contract*** was employed which contains and stores property metadata such as physical address, property description, title owner, and creates and updates property records such as current and future title ownership, based on transactions. Thirdly, ***an identity/user smart contract*** was utilised which stores multiple records with identity information for all stakeholders and participants in the transaction. The deed smart contract was developed to comply with local regulations depending on where the transaction takes place, so each country will have a different deed smart contract. The buyer and seller then logged into the transaction platform and opened the digital wallet of the deed smart contract with their private keys (the smart contract itself has a digital wallet to facilitate the transfer of funds). The buyer and seller each possessed two private keys in order to operate on the transaction platform, which were:

- **Transacting Key (wallet)**: Used for transacting with the deed smart contract. This private key is registered in the Propy identity service in advance. It is imported to the transaction platform during login and is used to access the transaction.
- **Asset Transfer Key (wallet)**: This key is registered in the deed smart contract with the transacting key and is used to transfer funds and assets once in the transaction.

> The deed smart contract wallet accepts payment from the buyer's asset wallet and transfers it to the seller's asset wallet.

These keys are used to sign off each stage of the transaction and as each stage is complete, so the deed smart contract records this. The smart contract will verify the keys throughout the process to log who the transactions and activities came from. If these keys are not authorised in the Propy identity service, the transaction will not progress. Stages of the transaction that need private key approval are the purchase agreement, the payment, and the notary approval.

Propy performs ownership verification to ensure the seller is the rightful owner of the property and that the buyer and seller are the correct parties transacting in the deal. Next, the buyer and seller signed the purchase agreement, containing details of the property and the sale. This document was generated on the transaction platform and signed electronically. Once this stage of the transaction was recorded on the smart contract, a PDF documented was created on the platform and the status of the transaction changed to 'pending' in the deed smart contract.

Once signed, the buyer received the address of the deed smart contract (and the smart contract wallet) which verified where to send the funds. In this situation 221.5 ETH (*equating to $60 000 and R901 710*) and 100 PRO tokens (Propy platform tokens) were sent to the address. The 100 PROS' was a required fee for transacting on the Propy platform. It is worth noting that as per the Propy whitepaper[16], payments can be made with various coins such as Bitcoin, Ether, Ripple, or alternatively the payment could be made in fiat currency. The notary, together with the smart contract address, then went to the land registry offices in the Ukraine to verify property ownership and physically sign a final transfer document. This step was done as of the time of writing, Propy is still mirroring official land registry procedures. The final transfer document was also generated online for the buyer and the seller to electronically sign. The document was created and stored on the platform's off-chain database in the specific transaction as a PDF document.

Next, the notary logged into the transaction platform using their private key. The notary then marked the deal as executed and the deed smart contract changed the status of the transaction to 'approved' in the Propy registry. The property ownership was then changed in Propy's decentralised title registry. As this change occurred, an electronic title deed, together with its hash value, was sent to the buyer as confirmation that the deed had their identification on it. At the same time, once all smart contract conditions had been met, the funds from the

[16] https://tokensale.propy.com/Propy-White-Paper-17-Jul-2017.pdf

deed smart contract wallet were transferred into the seller's wallet and became available for the seller to withdraw. The deal details and the smart contract address were taken to the land registry offices of Ukraine where the transaction was finalised and recorded. Property ownership had now changed in both the Propy registry and the official land registry of Ukraine (Heaven, 2017; Karayaneva, 2017). It is important to note that although the transaction was also recorded at the official registry, the physical title deed contained the smart contract address of the transaction which was conducted on the blockchain. The transaction data was now public and verified on the blockchain for all stakeholders to see.

5.3.2 Real Estate Blockchain-based Transaction Process: Vermont, USA

At the beginning of 2018, the American state of Vermont passed legislation in the form of a bill (S.269 Bill, No. 205. Act relating to blockchain business development) which recognises blockchain technology transactions as admissible in a court of law from an evidence perspective. As a result, legislation was in place to utilise blockchain technology to record real estate transactional data and documents such as title deeds. On 20 February 2018, Propy completed the first real estate transaction in The United States of America (Guitron, 2018; Hudson, 2018; Cuthbertson, 2019). Due to the legislation being passed, this transaction was supported and authorised by local governing officials. The deal was executed in this state due to the fact that Vermont is currently developing blockchain technology innovation in business and government procedures and is committed to allowing technological start-ups the opportunity to exhibit their operations in real world scenarios (Guitron, 2018; Hudson, 2018; Lynch, 2018; Wolfson, 2019).

Unlike the transaction in Ukraine, the Vermont transaction only made use of Propy's third component, the *decentralised blockchain-based title registry,* with the objective to successfully transfer ownership of a property on the blockchain as well as utilising blockchain to record and store the necessary conveyancing documents related to the transfer. This meant that aspects such as property payment were made outside Propy's platform. For the title registration, a property smart contract was created for the property being transferred. Next, the deed smart contract was created. The address of the deed smart contract was sent to the traditional land registry offices so that it too could be placed on the paper deed (Propy, 2018; Zuckerman, 2018; Ivan, 2019). Note that each transfer of rights must have its own unique deed smart contract so as to retain historical data and transfers pertaining to the property. This transaction was comprised of four smart contracts that were linked in a relational manner, illustrated in *Figure 5.2*.

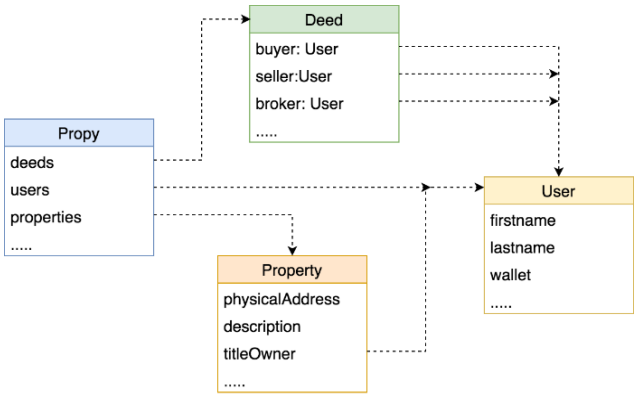


Figure 5.2: Propy Smart Contract Relationship (Propy, 2018 p.01)

After the deed smart contract was formed, the conveyancing data from the transaction was entered into this contract. In closing the registration, the deed smart contract was registered in the Propy decentralised registry and the registry fee was paid in PRO tokens (Karayaneva, 2017). The traditional paper-based deed, which is recorded at the land registry offices, also contained the smart contract address and thus cross verification occurred.

5.3.3 Real Estate Blockchain-based Transaction Process: California, USA

Propy completed a deal for the transaction of a property in California on 23 July 2018. This marked the third official real estate transaction which made use of blockchain technology (AltNews.nu, 2018; Wolfson, 2019). Every step of the conveyancing process needed for the transaction was performed on the Propy transaction platform using smart contracts, with the final payment of the sale being made in cryptocurrency (BTC, Bitcoin) (Guitron, 2018; Propy, 2018; South, 2018; Wolfson, 2019). Throughout proceedings, the buyer and seller were located in the US states of New York and California respectfully.

This property transaction involved six stakeholders altogether: buyer, buyer's broker, seller, seller's broker, escrow third party financer, and a title company. The transaction began with the buyer finding and selecting the property through Propy's property listings before submitting a reservation through the platform. Upon this reservation submission, the seller's broker received a notification of intent and invited all remaining stakeholders into the deal on the Propy transaction platform. Once the invites were accepted and all stakeholders were on the platform, the respective smart contracts were created. These smart contracts included ***property smart contract, deed smart contract,* and *an identity/user smart contract***. Next, a purchase agreement was created and signed by the buyer and seller and their brokers, using the DocuSign[17] application which is integrated into the Propy platform. This purchase agreement

[17] https://www.docusign.com

was then added to the platform through verification from all stakeholders and added to the blockchain, transparent to everyone involved. Before progressing, a deposit was required from the buyer in order to ensure their intentions of purchasing the property. This deposit was paid in BTC. The next step involved the creation and uploading of all necessary legal documentation. These documents were created and signed electronically, and included a disclosure document, a settlement agreement, and a title report (Guitron, 2018; Zuckerman, 2018). The seller was then provided with estimates on the selling price through a title company, which uploaded a title report for the buyer and seller to sign. Subsequently, once a final amount was agreed upon, the document was electronically created and signed by the stakeholders and its hash value was recorded to the blockchain. The buyer then made the payment in cryptocurrency, through Bitcoin (BTC), on the platform and as this reflected, the property smart contract recorded the Ethereum address of the new owner. The last digital document to be signed by the buyer and seller was that of the addendum, which was recorded on the blockchain. All closing documents and their hash values were then uploaded to the Ethereum blockchain (if not already so) and distributed between all nodes in the transaction. The deed smart contract was now recorded on the blockchain with the buyer as the new owner. Since Propy mirrors official land registry procedures, a paper title deed was also created and stored in the land registry offices. As with all other deals conducted using the Propy platform, the paper title deed had the address of the deed smart contract printed on it. The buyer then made a payment in PRO Tokens for the services of the Propy title registry to complete the transaction (Hudson, 2018; Wolfson, 2019).

5.3.4 Real Estate Blockchain-based Transaction Process: Seville, Spain

For the first time in the European Union (EU), a property was bought and sold using blockchain technology. The sale occurred on 10 October 2018 in Seville, Spain (Brett, 2018; Maryan, 2018; Smith, 2018). At the time of the sale, the seller was in Spain and the buyer was in France. The process began with the buyer searching for and selecting their property of choice Propy's property listings. The buyer then contacted the seller's broker, who was assigned to the property, to express their interest in the property. Before any further steps were taken, an authorised notary (a participant in the transaction) verified the seller's digital signature to ensure they were the correct and current titleholder of the property (Market Insider, 2018). The buyer then reserved the property by paying a deposit which was made in Ethereum (ETH). The seller's broker then invited all necessary stakeholders (buyer, buyers' broker, seller, and authorised notary) to the deal. Once the deal was active, the smart contracts were created. The

suite of smart contracts required for this transaction were the ***property smart contract, deed smart contract, an identity/user smart contract*** **and an** ***escrow smart contract.*** An *escrow smart contract* is a smart contract that tracks the flow of funds between parties and will be customised depending on the currency used, for example, for payments that are made in ETH the contract holds the funds until conditions are met before releasing them. Alternatively, if the payment is made in fiat currency or Bitcoin, then the transfer happens through a separate system. These smart contracts serve as a record of events proving that the transfer occurred, while holding its 'conditional' characteristic, whereby ownership will not be transferred until funds are recorded (Market Insider, 2018; Maryan, 2018; Smith, 2018). This functionality was originally covered by the deed smart contract but as the platform had developed, the escrow smart contract was introduced, allowing the deed smart contract to fully focus on the transfer of ownership. The necessary legal documents were then uploaded to the platform. These included a property registry, homeowners association fee agreement, and the title deed. These documents were then verified and digitally signed, and the hash values recorded on the Ethereum blockchain. The buyer then transferred the outstanding funds into the address of the escrow smart contract and paid a PRO tokens fee for using Propy services. The relational configuration of the smart contracts means that all smart contracts and stakeholders played a role in the transfer of ownership. Once the transaction was complete, the status of the deed smart contract changed to 'complete' and the deal is finalised. The escrow smart contract will distribute the cryptocurrency funds to the seller (in ETH) or will record that the transfer occurred using fiat currency. Lastly, the property contract will record the Ethereum address of the new owner. Smart contracts can only be executed if certain conditions are met. The notary participant recorded the deed smart contract address on the paper-based title deed, which is recorded at the Spanish Land Registry Office, finalising the transaction.

5.4 Real Estate Blockchain-based Transaction Process: Business Process Model

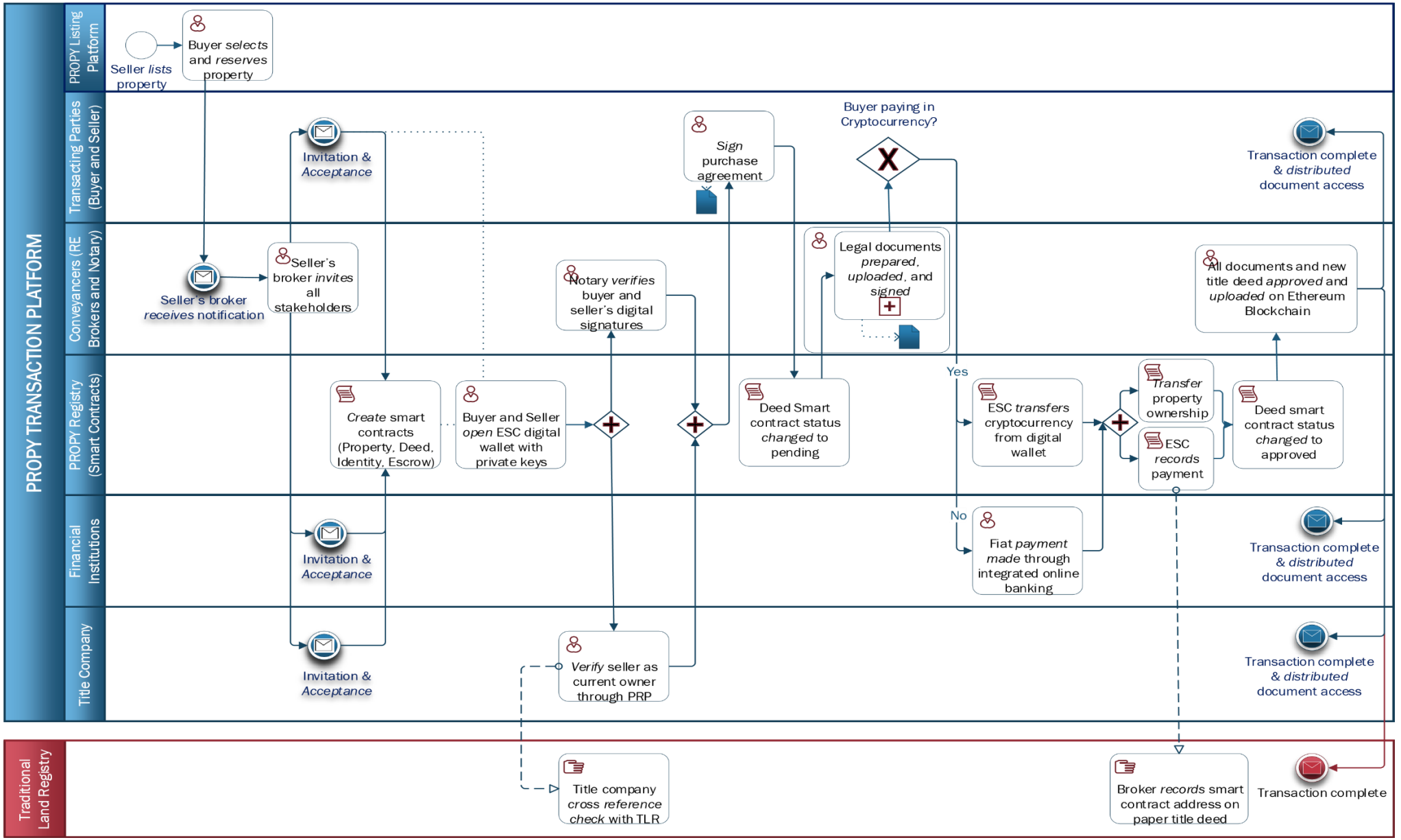


Figure 5.3: Blockchain-based Real Estate Transaction Process: Business Process Model

5.5 Real Estate Blockchain-based Transaction Process Summary

All blockchain-based transactions conducted by Propy were legally recognised and done in accordance with the relevant conveyancing regulations. To do so, Propy partnered with local governments for the jurisdictions where transactions occurred. To list some of legal amendments that were made to facilitate these transactions, a memorandum of understanding was signed by the Ukrainian Ministry of Justice which allowed Propy to carry out their transaction. Further, a bill in Vermont was passed which recognises the legality of smart contracts. A key feature of Propy's transaction platform is that it could be customised according to the conveyancing regulations of the country in which the transaction occurred. The most noticeable achievement of all of the above transactions was the combination of online and offline title deed recording. Here, the traditional paper-based title deeds had the smart contract addresses recorded on them, meaning that the transaction was able to be verified in physical form as well as on the blockchain. This permitted cross verification from two different sources. While it may be argued that a two-way verification mechanism is redundant, this is only the case while blockchain in real estate transactions is being explored and demonstrated.

The power of smart contracts was also evident as they were able to reduce the number of stakeholders involved. In the California transaction, financial institution stakeholders were not required as the deal was done using Bitcoin. Digital identities on the blockchain saved significant time and circumventing the need for numerous documents typically required. Additionally, this was apparent in the Ukrainian transaction when the smart contract played the role of the escrow service, transferring all ETH tokens from the buyer's wallet to the seller's wallet once the programmed conditions were met. Through smart contracts, all transfers of funds and title deeds were done immediately and simultaneously, solving the 'DVP' problem. The escrow functionality played by smart contracts further served to benefit in terms of protection against the double spending problem. Here, it was not possible for the property to be bought by two people in an instance whereby the seller would attempt to receive the purchase price twice. This is because the smart contract has been programmed for a direct transaction between the buyer and the seller only. Fraudulent activities are thus reduced.

All of the transactional documents were stored in an off-chain distributed database amongst all stakeholders involved. These digitised documents were then all put through a hash value generator with the hash value recorded on the blockchain. However, the digitised title deed document was stored directly in the blockchain ledger due to it being the most important document coming from the transaction. Anything stored on the Propy blockchain was

timestamped, allowing for a complete audit trail of activity. Propy do acknowledge that a level of technical knowledge is required to read data from their blockchain. In addressing this, the Propy team are working to enhance functionality for all stakeholders who utilise the platform. This will make it easier for the layman (unfamiliar with technical jargon) to interact with the platform and understand what is recorded on the blockchain.

One of the main benefits of the common transaction platform is that it managed all stakeholders in the transaction, providing them with updates and alerts at every stage of the transaction. This alleviated the pressure from conveyances who, prior to e-conveyancing and digitisation, were responsible for managing the entire process. Furthermore, data redundancy was reduced as one database of records was used as opposed to multiple siloed systems held by each stakeholder. All identification of the buyer and seller were stored and accessible to all stakeholders instead of multiple paper-based FICA documents being required at each stage of the transaction to different stakeholders. The City Clerk of Vermont stated that by using this system, higher degrees of transparency were realised as transaction speed being enhanced through electronic signatures.

5.6 Summary

This chapter provided the reader with knowledge on blockchain-based real estate transactions. The study focused on a specific blockchain-based real estate transaction platform, Propy. Four transactions that were conducted by Propy were the case studies that formed the basis of this chapter. These transactions were discussed in detail and their processes mapped out. A business process model illustrating blockchain-based real estate transactions (*Figure 5.3*) was created. Having a comprehensive understanding of both of the respective process flows (*Chapters Three* and *Five)* was vital to allow the research insight into how blockchain technology can be integrated into South African real estate transactions. In *Chapter Six*, the research will combine these two transaction processes and illustrate how blockchain technology can be integrated into South African real estate transactions.

Chapter 6: South African Real Estate Blockchain-based Transactions

6.1 Introduction

This chapter introduces the integrated business process model which shows how the various processes and stakeholder interactions for South African blockchain-based real estate transactions are conducted on one common transaction platform. This transaction platform is referred to as the South African Blockchain Land Exchange System (*SABLES*). The key components of the transaction platform will be outlined, with their applicability and inclusion in South African real estate transactions being discussed and reasoned. The transaction process of the integrated model, with its activities and flows of information, will then be delineated. The transaction process discussion will be based on the sub-process models (*Figures 6.1 and 6.2*) as well as the main business process model (*Figure 6.3*). The chapter concludes with a summary of the transaction process and the integrated model where the key components and how they adhere to existing problems are highlighted. This common transaction platform can be seen as an alternative business process (and potential replacement) to the current methods employed in South African real estate transactions. Through blockchain technology, *SABLES*' offers increased efficiency, higher levels of security, quicker transaction turnaround time, and a common transaction platform for all participants, streamlining and enhancing the process from start to finish (Bal, 2017). This model also illustrates key components that the study deems sufficient for both implementation and execution of a blockchain-based transaction platform which facilitates such transactions.

6.2 SABLES: Key Components

The *SABLES* transaction platform is categorised by three key concepts, *digital identities*, *digital assets*, and *smart contracts*.

1. **Digital Identities**

Blockchain technology allows for the creation and management of digital identities (Abraham, 2017). As the blockchain economy becomes more prominent, infrastructure has been developed which supports applications aimed at building digital identities to assist blockchain-

based transactions. Self-sovereign identity refers to the concept of being the exclusive owner of one's identity (and its metadata) (Abraham, 2017; Muhle, et al., 2018). Self-sovereign identity technology utilises blockchain and therefore allows for decentralisation when it comes to a user's identity information. Through blockchain, self-sovereign identification management (SSIDM) systems enable individuals and/or entities to manage and control their own identity and any attributes it may possess. Digital identities can be created in the form of individual intermediary identities (representing individual parties in a transaction) or value intermediary identities (representing third party entities in a transaction) (Ahmed, 2017). These value intermediaries are known as oracles. Oracles represent third party institutions who are sources of information for the creation and execution of smart contracts in blockchain-based transactions (Gatteschi, et al., 2018). Oracles collect, gather, and verify real-world information and occurrences and submit this information to the blockchain network for use in smart contracts. Stakeholders such as conveyancers, South African public services (SARS, council municipalities, and deeds registry officials) and financial institutions can act as oracles during blockchain-based South African real estate transactions (Dijkstra, 2017). Every digital identity will possess a private key meaning that public key cryptography can be used in transactions.

SABLES' offers a SSIDM system for the digital identities of all parties involved in the transaction. Stakeholders will create digital identities either on an **individual** basis (*transacting parties such as buyer and seller*) or as an **oracle** (conveyancers, SA public services, financial institutions). Adopting a SSIDM for South African real estate blockchain-based transactions means that blockchain could manage all identities and attributes associated with real estate transactions to ensure the correct parties are exchanging funds and ownership rights (Nasarre-Aznar, 2018). Security is enhanced through public key cryptography. With SSIDM systems, identities are secured from being compromised through hacks or identity theft, which has occurred on traditional identification databases. Users can also provide their identity information to whoever they choose and in whatever form they want as long as authorisation and validation of identity occurs, thus enhancing both the **security** and **privacy** of identity information. Regardless of which SSIDM system is chosen, it is suggested that both the SSIDM system and the *SABLES* transaction platform run on the same blockchain network for increased levels of interoperability. However, it is also possible for the SSIDM system to operate on a different blockchain, which would only work as long as *SABLES* can verify all stakeholder identification from the other network. Examples of SSIDM systems include Metaverse[18] and

[18] https://mvs.org

Sovrin[19]. These systems offer technological layers through blockchain technology which enable individual users and organisations to create, control, and manage their own digital identities (Ahmed, 2017). These systems allow digital identities to be created for both people and assets, such as real estate (physical property).

2. Digital Assets

Transactions conducted on blockchain involve the transfer of assets and ownership between users. Typically, assets being traded have been virtual assets or virtual currencies such as Bitcoin. However, as the blockchain economy expands and begins to facilitate the transfer of real-world assets (such as real estate), these assets also need to be digitally recognised and identified in blockchain networks. In response to this need, digital tokens were created. A digital token is used to represent an underlying physical asset and such tokens act as claims for asset ownership, being known as asset-backed tokens (Nasarre-Aznar, 2018). On the Bitcoin network these tokens are more commonly referred to as coloured coins, whereas on the Ethereum network they are referred to as Ethereum tokens. Both are used to represent real-world physical assets (Dijkstra, 2017; Nasarre-Aznar, 2018). Not only does the SSIDM system create digital identities for people but it also facilitated the creation of digital assets for properties through asset-backed tokens. Digital tokens are linked to the digital identity of their owner. Digital assets are assigned to an address and the address is assigned to a digital identity, the owner. These tokens can be embedded into smart contracts which allow them to be traded on the blockchain network (Dijkstra, 2017). Through blockchain-based transactions, these tokens can be transacted between users and ownership may be transferred.

Real estate that is transacted through the *SABLES* platform can make use of digital tokens (*Figure 6.1*) which allows for a digital representation of property on the blockchain network. The asset-backed tokens can be used to represent the physical property but more important is the metadata they hold. Digital tokens can consist of information relating to the property such as *general information* (current and previous owners), *technical information* (property maintenance and building plans), and *financial information* (property market value and outstanding debts and bonds). Along with the physical property, *SABLES* will tokenise the property title deed. This means that there will be two asset-backed tokens, one representing the property and one representing the title deed. The possibility of one token representing the property was produced, whereby the title deed could be an aspect of the token's metadata, but the study opted for two tokens, separating the physical property and the title deed. The reason

[19] https://sovrin.org

for this was twofold: (1) to digitise an asset you need it to be represented as a digital token; and (2) to legally transfer a property you need a title deed. Therefore, the property and deed tokens are the two digital tokens that are core for asset ownership to be transferred. Moreover, this adds an element of security to the transaction. All transactions will be represented on the blockchain network and the digital tokens will have a history of ownership which brings **transparency** to the process.

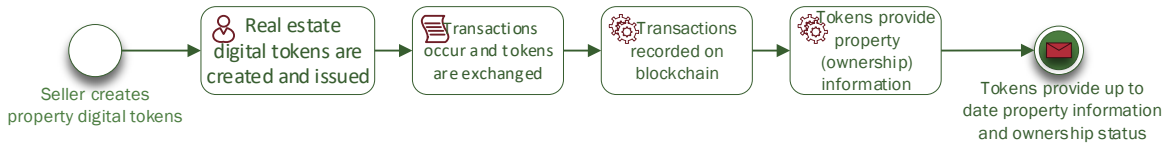


Figure 6.1: Digital Tokens on the SABLES Blockchain

3. Smart Contracts

The *SABLES* transaction platform and its transactions will utilise smart contracts. Smart contracts not only assist in digitising traditional paper-based contracts but also assist in the creation of the aforementioned digital tokens (Bal, 2017). The digital tokens, representing physical real estate, have smart contracts embedded into their architecture which allow the asset-backed tokens to be exchanged between numerous parties. Smart contracts permit traditional contracts and title deeds to become digitised and allow for blockchain-based land registration systems to be implemented, whereby ownership of real estate is stored in digitised smart contracts (Ahmed, 2017). Additionally, smart contracts play the role of escrow services as they can hold funds and assets and distribute them to the correct parties when conditions have been met.

Through *SABLES*, a new job role is identified and created (*Section 4.6.3*), a blockchain certified agent (BCCA). This job requires a mixture of technical and conveyancing knowledge and the primary role is to manage and oversee the transaction from start to finish. It is the responsibility of the BCCA to create and execute the smart contracts used in the transaction. Smart contracts play a key role in *SABLES* and their implementation is assisted by oracle identities supplying the required contractual information. These oracles feed and supply real-world data to the blockchain network which will be used and transferred in smart contracts (Swan, 2015).

6.3 SABLES: Transaction Process

The *SABLES* concepts are grouped together and are visible in the *Figure 6.3* as Group 1: Digital Identities (*left on the model*), Group 2: Digital Assets (*centre of the model*), and Group 3: Smart Contracts (*right of the model*). In BPMN, a group is a collection of activities and sub-processes that fall within the same category. Group 1 consists of activities adhering to digital identities whereby all parties involved in the transaction create digital identities and get assigned addresses on the blockchain. Digital identities offer increased security and data privacy. Group 2 consists of activities associated with digital assets whereby physical properties and title deeds are recognised as tokens on the blockchain. These activities are aimed at moving real estate records onto the blockchain. Group 3 consists of activities associated with smart contracts and are directed towards the real estate transaction once all property records are recorded on blockchain. Smart contracts assist property funds and ownership to be exchanged. Together, these concepts and their activities (sub-processes) pave the way for the transaction to occur and for a blockchain-based mechanism to come into being.

The integrated business process model in *Figure 6.3* consists of one pool which holds six swim-lanes. Of the six swim-lanes, two are nested swim-lanes, which are swim-lanes that contain additional lanes within them, known as inner swim-lanes. The pool, *SABLES*, represents the transaction platform on which transactions will be held. The six swim-lanes are as follows, reading from the top to bottom: *swim-lane 1* represents the transacting parties which are the buyer and seller, *swim-lane 2* represents conveyancers which are the transfer attorney and the bond attorney, *swim-lane 3* represents the BCCA, a created position that recognises a participant who has the necessary conveyancing knowledge but also technical knowledge of blockchain, with the role of overseeing the transaction and creating the required smart contracts, *swim-lane 4* represents the *SABLES* blockchain registry and this is a *nested swim-lane* with the inner lanes being responsible for both land records and smart contracts, *swim-lane 5* represents required South African public services and is also a *nested swim-lane,* with the inner lanes accounting for SARS, councils and municipalities and land registry officials such as deeds chief registrars, *swim-lane 6* represents financial institutions such as online banking portals. Furthermore, the business process model illustrates two additional elements, above and below the *SABLES* transaction platform. The layer above represents the SSIDM system employed for digital identities and digital assets. The layer below represents the blockchain network on which *SABLES* operates. These two are not separate entities to the *SABLES* transaction platform, but they are shown to illustrate the architecture of the transaction

platform, in other words, *SABLES* runs on blockchain technology (*the network at the bottom*) and makes use of an integrated SSIDM system (*the system at the top*).

Transaction Process: Group 1

The transaction begins with the seller accessing the *SABLES* platform and registering their property for sale (*swim-lane 1*). Upon completion of this, the BCCA will be notified of the seller's desire to sell their property (*swim-lane 3*). The process so far has been conducted through user tasks (*tasks carried out by humans but assisted with software or applications*) on a common platform which is accessible to all parties. Next, the BCCA will conduct two activities concurrently and in BPMN this is indicated by a parallel getaway (*used to synchronise and combine activities*). Firstly, the BCCA will create the escrow smart contract (*swim-lane 4, inner-lane 2*) which will hold funds and assets as well as monitor the status of the transaction. The hash of this smart contract will be recorded on the blockchain network, (*element at the bottom of the integrated business process model*), making it publicly available. Secondly, the BCCA will invite all stakeholders who are going to be involved in the transaction, to the deal. An assumption of *SABLES* is that all stakeholders will be registered on the transaction platform and have access to it at all times, because these are fixed stakeholders required in all transactions. Only transacting parties will register as they are involved in transactions. As a result, stakeholders such as conveyancers will get assigned to deals as real estate is listed for sale on the platform. Once all stakeholders are invited, digital identities (in the form of individuals or oracles) will be created with the assistance of a SSIDM system (*element at the top of the integrated business process model*). The creation of the digital assets is supported through service tasks (*a task that uses a web service or an automated application to complete an activity*) as users will enter their identification information (official ID number, tax number, and proof of residence) and the SSIDM system will generate digital identities based on the entered data. This assists in reducing traditionally required FICA paper-based documents as well as expediting due diligence processes, concluding Group 1 of the process.

Transaction Process: Group 2

The transaction now moves into Group 2, whereby real estate records are moved onto blockchain. The BCCA will request the property information from the seller and the original title deed from the transfer attorney (*swim-lane 2*). The transfer attorney will communicate (if necessary, if the required documents do not already exist on the blockchain) through the platform, with the land registry officials (*swim-lane 5, inner-lane 3*) to obtain the original title

deed. In doing so, off-chain interaction will undoubtedly occur as the traditional paper-based title deed is collected. This is inevitable, as in order to digitise documents and move towards a technologically based system, the original documents will have to be acquired (*here, the challenge of initial correct information, mentioned in Section 4.6.2, is faced*). Once the required information is collected, a deed smart contract (*swim-lane 4, inner-lane 1*) is created, which records the current owner on the blockchain-based land registry. The title deed and the property itself are then tokenised by the BCCA and represented as digital asset-backed tokens. These tokens are then linked to the current owner's digital identity address. This is done through the SSIDM system, concluding the activities of Group 2.

Transaction Process: Group 3

The transaction then moves into its final phase, which is represented by Group 3, smart contracts and exchange of funds and ownership. As property information is stored on a digital token, the information of this token is available to the users on the network. As a result, potential buyers have access, as allowed by the token access limits set forth by the seller, to the real estate information. Buyers will request the property and the transferring attorney will be notified, which will set in motion two follow-on activities. Firstly, the transfer attorney will then draft the offer to purchase document which is required as per South African conveyancing law. This will be drafted into the escrow smart contract by the BCCA and will be digitally signed by the transacting parties. Secondly, the required certificates (rates and clearance, transfer duty, and SPLUMA) will be collected from the South African public services (*swim-lane 5, inner-lane 1 and 2*) through manual user tasks. The escrow and deed smart contracts will both be updated with the relevant information as well as the transaction status. Lastly, the transfer of funds and assets occurs. When paying for the property, buyers have the following choices: **(1)** cryptocurrency whereby funds are transferred from the buyer's wallet to the escrow smart contract to the seller's wallet; **(2)** fiat currency (cash) whereby a financial institution (*swim-lane 6*) transfers the funds to the escrow smart contract which eventually transfers them to the sellers bank; **(3)** or through fiat currency (bond) which is conducted through a set of smart contracts between the transacting parties, conveyancers, and the financial institution. The bond option is represented as a collapsed sub-process in the integrated business process model (*Figure 6.3*) but the entire bond sub-process is illustrated in *Figure 6.2*.

6.3 SABLES: Transaction Process

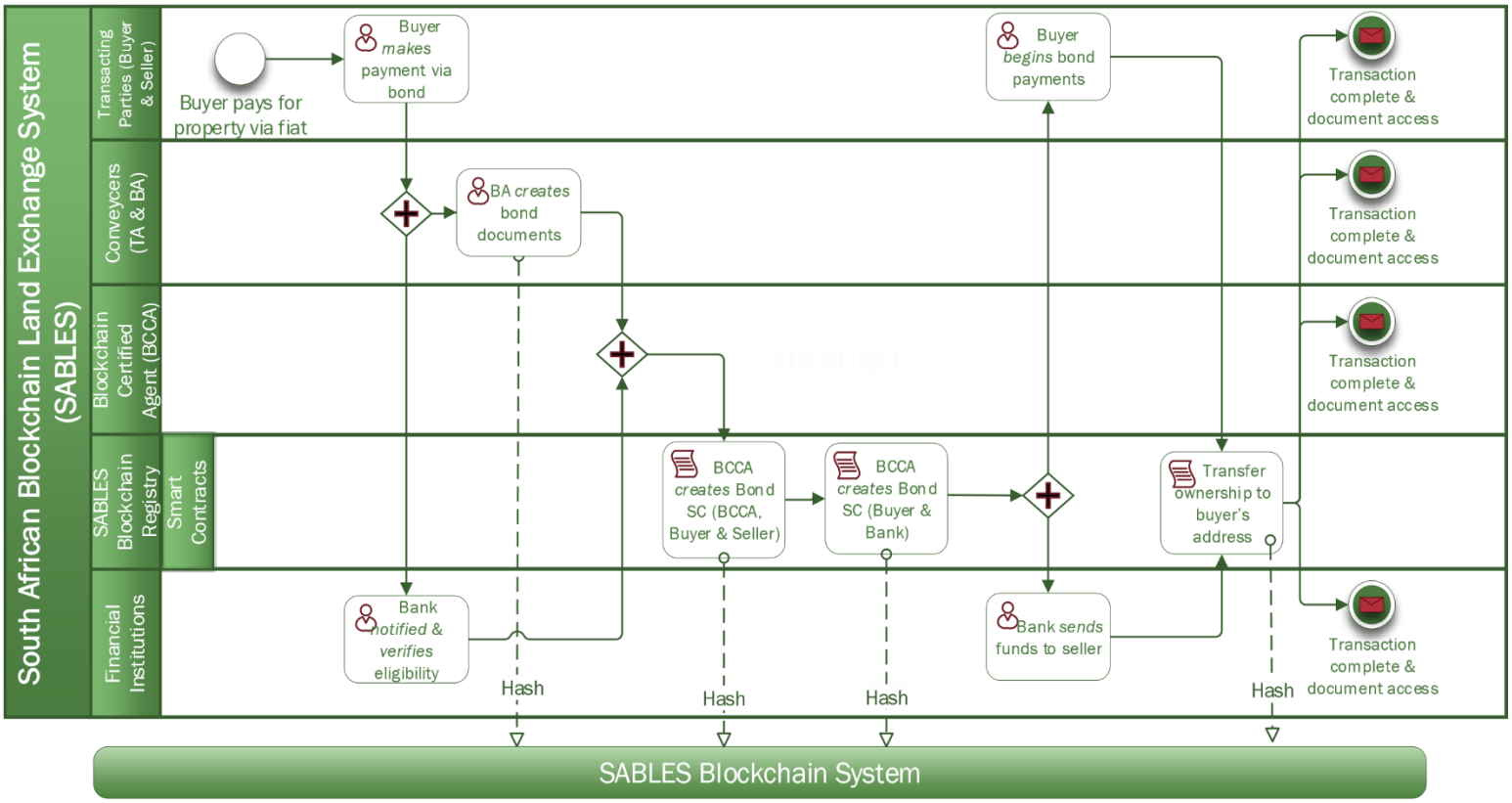


Figure 6.2: South African Real Estate Blockchain-based Transaction: Bond Process

Regardless of the payment method chosen, the escrow smart contract will record payment. As the payment is made, so the consequent transfer of ownership will occur. The deed smart contract will transfer the ownership to the buyer in the blockchain-based land registry (*swim-lane 4*, *inner-lane 1*) and the digital tokens (title deed token and property token) will be transferred to the buyer's address. The transfer of ownership is thus two-fold, allowing for extra security (Nasarre-Aznar, 2018). These transfers are executed by pre-programmed smart contracts based on all the prior conditions being met, that is, ensuring documents such as the Offer to Purchase and the Transfer Duty receipt are in place as well as ensuring the funds have been paid. Upon these conditions being met, the smart contracts will automatically update and execute the conditioned transfers. The escrow smart contract will then change the status of the transaction to complete and a notification to all stakeholders will be distributed. In closing the transaction, all digitised documents and smart contracts will be on the blockchain network and available to all stakeholders, providing a complete audit trail of the transaction process. This concludes Group 3 activities and the transaction as a whole.

6.4 SABLES: Business Process Model

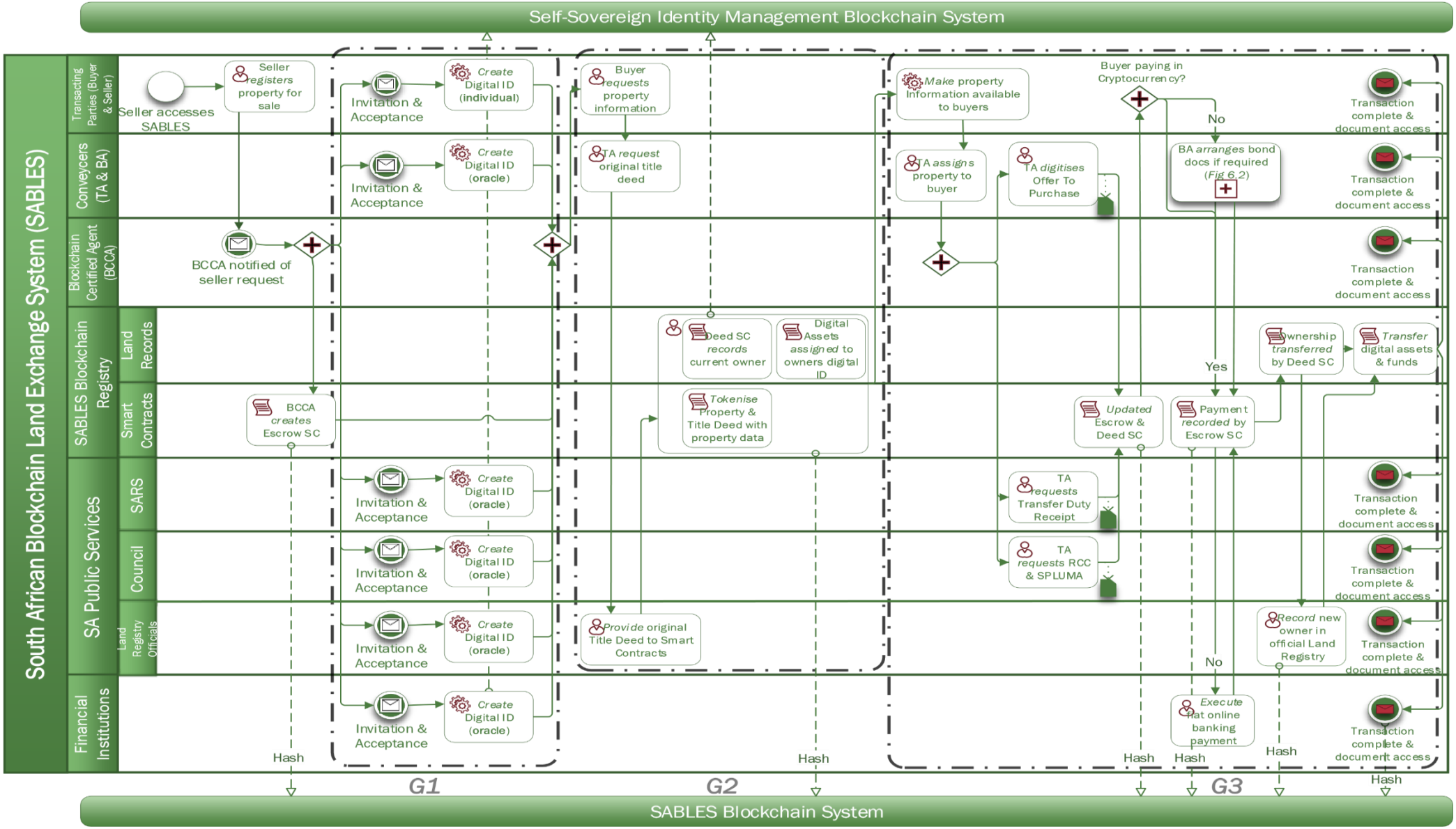


Figure 6.3: South African Real Estate Blockchain-based Transaction Process (SABLES): Integrated Business Process Model

6.5 Summary

The integrated model aims to tackle existing issues in the South African real estate transaction process by providing a blockchain-based transactional system, *SABLES*. The proposed model incorporates the necessary stakeholders and adheres to the required South African conveyancing legislation. A summary of the transaction and its key elements is *Table 6.1*.

Table 6.1: SABLES Key Components Summary

Key component	Current real estate problem	Proposed solution
Digital Identity – *Group 1*	▪ Multiple paper-based FICA documents are required. ▪ Multiple attestations of identity to various parties is requested.	▪ Digital identities through a SSIDM system means users control identity information. ▪ Paper-based documents are done away with as digitisation occurs. ▪ A common SSIDM system means identification data only has to be supplied once, for all parties to see.
Digital Tokens – *Group 2*	▪ Offline recording of property information is manual and paper-based. ▪ Accessibility to property information is difficult as information is trapped inside siloed systems. ▪ Due to siloed systems, accessibility to property information takes inordinate amounts of time.	▪ Digital tokens mean that real-world assets, such as property, can be represented on blockchain. ▪ Digital tokens mean that important documents such as title deeds can be held as a virtual token of value on blockchain. ▪ Digital tokens allow for smart contracts to be embedded into them which assists in moving property records onto blockchain as property tokens can hold smart contracts which represent title deeds, offer to purchase contracts, and so on.
Smart Contracts – *Group 3*	▪ Traditional contracts are paper-based. ▪ Traditional contracts and documents are timely due to the physical need to meet and sign. ▪ Traditional contracts that are manually created are prone to error and manipulation which can result in fraud.	▪ Smart contracts are automated contracts and will only execute once pre-defined conditions have been met, meaning that manipulation of the contract will not occur. ▪ Smart contracts solve the delivery vs payment (DVP) issue (*see Section 3.2.4*) meaning that there is concurrent transfer of ownership and of funds. ▪ Smart contracts expedite processes as digital signatures are allowed, meaning contracts from remote areas can be settled timeously. ▪ Smart contracts are verified by all necessary parties utilising the transaction meaning error and manipulation are eradicated. ▪ Smart contracts mean that the transaction status can be updated and made visible to all parties thus providing transparency

Chapter 7: Findings

7.1 Introduction

Chapter Six provided the reader with the integrated business process model, illustrating how blockchain technology could be incorporated into the process of South African real estate transactions. *Chapter Two* contained a detailed discussion regarding the data collection and data analysis processes that would occur as a result of key stakeholder interviews. *Chapter Two* stipulated that the integrated business process model would be sent out as an attachment to the interview questions, allowing the interview participants to answer the questions as well as evaluate the model. *Chapter Two* presented the interview questions and the protocol followed during the in-depth interviews. *Chapter Seven* presents the contextual background of all participant groups, providing reasoning for participant inclusion based on the skillsets they hold. This was to highlight their knowledge in their respective areas, and thus justifying their inclusion as key stakeholders. It shows the process of thematic analysis, a practical approach from phase one to phase six, as outlined by Braun and Clarke (2006). *Chapter Seven* concludes with four thematic maps, one pertaining to each participant group. A final, and more detailed, thematic map will be presented in *Chapter Eight* as it involved a level of interpretation when examining the four thematic maps in conjunction with one another. During the process of analysis, the interview transcripts were analysed. The in-depth interviews were analysed per participant group and a thematic map pertaining to each group was produced thereafter. Participant groups were initially analysed in isolation and respective themes were developed. However, once the full data corpus (involving all four participant groups) had been analysed, the four thematic maps were studied in conjunction with one another, resulting in a final and combined thematic map being produced (*Figure 8.1:* Final and Combined Thematic Map). There are instances whereby a main theme was found across multiple groups, highlighting the point of saturation around the topic regardless of the perspective (or participant group) from which the participants came.

7.2 Participant Contextual Background

7.2.1 Conveyancing Stakeholders: Participant Group One

To fully understand the current business processes and systems in play in South African real estate transactions, it was necessary to gain insights from stakeholders in the conveyancing

field. With more than 30 years of combined experience within the local real estate sector, Group One provided pinpoint views on the current state of South African real estate transactions. Three participants were interviewed on questions relating to the processes traditionally used and the applicability for innovation in their field. Group One participants have been exposed to all areas of South African conveyancing transactions, from financials such as bonds, to deeds registration operations at the Deeds Office. These three participants are all from the same attorney firm who specialise in conveyancing practices.

Participant 1A possesses more than ten years of experience and has had strong exposure to the bond registration and cancellation process in transactions. Participant 1C deals with residential real estate transactions with specific attention to deceased estates. Participant 1C is involved with document management throughout the transaction process. Significantly, participant 1B has experience relating both to the front-end of a transaction (dealing with the transacting parties and documents involved) and to the backend of the transaction (dealing with deeds examination and deeds registry at the Deeds Office). Through discussions with these participants it became clear just how complex the real estate transaction process is. While there was agreement on many of the processes being outdated and paper-based, the general response indicated that the industry is not afraid of technological disruption due to the fact that they do not think drastic changes will occur any time soon. When speaking about the movement towards electronic deeds, participant 1A stated:

> *"…when I spoke to the registrar of deeds, it was in 2008/09 when they said that the first working platform will be open for submission of deeds in 2010/11. Yet we are now in 2019 and we have not had a stitch of information on how they plan on using this system."*

There was consensus that digitisation is needed in the real estate transaction space, both for transactional and land ownership documentation. Not only would this speed up the process, but it would add an increased level of security and ease the burden on conveyancers. When speaking about the current South African processes and the intense stress placed on the conveyancer, participant 1C stated:

> *"…with the deeds office because it is a negative system – pressure and responsibility falling on the conveyancer – they literally assume that whatever is standing in the pile of attorney or purchase price is undeniably true as they don't ask to see the deed of sale*

> *to see if it is true – they assume what you have provided is true as you signed the preparation clause. So, that part is difficult for the conveyancer…"*

7.2.2 Blockchain Stakeholders: Participant Group Two

As specialists in blockchain itself, participants from Group Two provided the technical knowledge of the technology. Having all been involved in blockchain projects and implementations, these participants shared sound technical knowledge on blockchains' capabilities, applicability, limitations, and costs. Four (participants 2A–2D) of the five participants work directly for blockchain-specific companies while participant 2E is the lead stakeholder for blockchain projects within a larger organisation. The participants provided diverse views, rich in detail and explanation.

Participants 2A and 2B are both blockchain specialists who currently ply their trade at a blockchain company whose focus is on digital identities. As a result, these participants provided data relating to self-sovereign identities in digital transactions. Participant 2C comes from a pure computer science and programming background with more than 15 years' experience. By holding a position within a crypto exchange company, this participant also has five years of both cryptocurrency and blockchain experience. Having founded their own blockchain consultancy firm, participant 2D has been involved in both blockchain discussions and blockchain-based business implementations. Participant 2E comes from a large-scale consultancy firm with over ten years of experience in technological and digital payment systems. With a current focus on blockchain technology, anti-money laundering, and online payment systems, this participant provided valuable insight into blockchain applications, security related aspects and the implementation cost-analysis thereof. The general consensus gathered from this participant group is a positive one where there is a strong belief that the technology will play a definitive role in the near future. The blockchain space is now moving beyond the initial hype and into the stage of practical implementation whereby blockchain-based solutions are being tried and tested and either succeeding or failing, allowing society to see where blockchain-based processes are most applicable. The participants agreed that blockchain technology must be applicable for the case at hand, with participant 2D stating:

> *"I have turned many customers down because they are all amped about blockchain this and blockchain that, and when they tell me their blockchain use case, I realise that they*

> *don't understand blockchain and nor is it appropriate for whatever they are trying to solve."*

Due to the lack of technical knowledge, many people are still unaware of exactly how blockchain can assist and add value to business processes. Participant responses indicated that there are already a significant number of blockchain-based projects that have been executed and rolled-out both locally and globally with participants having worked on many of these projects themselves. However, it was often noted that these projects are conducted within private businesses or consortiums as implementation loops are easier to get through than with public or state-run operations. When asked about implementation of a blockchain-based solution for government operations (the deeds registry system for example), participant 2E mentioned that changing a traditional and state-run process brought its challenges:

> *"…and that is where (and I know people don't like to hear this) the consortium, hybrid, private and public blockchain solutions, tend to work better."*

7.2.3 PropTech Stakeholders: Participant Group Three

With knowledge of both the real estate sector and the blockchain space, participants from Group Three arguably represent the core participants of this study. Being involved in the PropTech sector, working with blockchain-based real estate transactions, blockchain-based land registry systems, and blockchain-based real estate record-keeping, these participants possess first-hand knowledge of the technology's capability within the real estate sector. In addition, Group Three participants are involved in an array of blockchain-based real estate ventures all around the world. This makes for interesting and comprehensive views.

Participants 3B, 3C and 3F are all involved with blockchain-based real estate transaction companies with a combined ten years of experience in the PropTech sphere. In particular, participant 3F was at the forefront of a recent pilot study in a European country where a blockchain-based land registry system was delivered and demonstrated. This study facilitated a blockchain-based transaction in a bid to further display the positives and efficiency that can be realised. Participant 3B is currently working in an African nation where they are attempting to put real estate records (pertaining to the transaction process) onto the blockchain. Participant 3D and 3E both have a high calibre of experience in blockchain-based record-keeping systems for land titles and deeds. Participant 3A works on making real estate (both

through investment and transactions) financially viable for all classes, promoting inclusion in the sector through the use of blockchain and fractional ownership and investment. Lastly, participant 3G is an internationally renowned PropTech scholar who has published multiple papers within the space. Given the novelty of PropTech 3.0 and the lack of abundance in stakeholders, this study managed to draw upon the views of a high calibre group of participants, aiding in the integrity and quality of the information gathered and presented. Despite being active role players in the PropTech space, many of the participants admitted that there has been little impact in the sector so far in terms of blockchain actually changing the way processes are carried out, with participant 3G mentioning:

> *"…there will be people who claim that they have used blockchain in a property transaction but rather, they have had to mirror the traditional property transaction process. So, the blockchain has made no contribution so far, other than to add more work to what was already happening."*

While this may seem harsh upon first inspection, one can understand the point being made. As was mentioned in *Chapter* Five, until lawfully instated as the legal means with which to conduct transactions, blockchain-based real estate transactions will still only replicate current processes in a bid to demonstrate its capabilities. Participant 3F stated:

> *"I think it is very early in the adoption cycle of blockchain and so the impact is modest but at the same time the interest and the discussions and dialogues have been quite impactful. … the questions that blockchain is asking, is having a very insightful and positive effect on the industry."*

All the participants agreed that while the current processes may work, these processes used are antiquated and in order to move to technologies such as blockchain, digitisation is needed.

7.2.4 Information and Communications Technology (ICT) Legal Stakeholders: Participant Group Four

The introduction of a new technology into business practice will involve regulation. While they did not form part of the core group of participants, a stakeholder involved in the ICT legal space was interviewed. While the blockchain space currently lacks a blockchain regulatory

framework, participant 4A stated that just as technologies are advancing, regulations may need to do the same and keep up with the times as well:

> *"…this is how this regulation is hampering the use of our technology and it should be amended or revised to accommodate this new piece of blockchain technology so that it doesn't stifle the innovative products it can provide."*

When it comes to delicate assets containing sensitive information (real estate and real estate transaction data), these transaction platforms must ensure that privacy of information and data is one of the most important factors.

7.3 Thematic Analysis: Process of Analysis

This study posits the specific details regarding the techniques that comprised the process of analysis below, as per Braun and Clarke (2006). **Phase One:** According to Braun and Clarke (2006), the principal investigator can familiarise themselves with the data through personally transcribing the interview data. Specific attention was paid to the transcription process as it represented the first instance for the research to whole-heartedly connect with the data. As each interview was transcribed, the research put together a summary of the discussion, allowing the broad notions and understandings from the data to be detected and noted. During Phase one the study formulated a list of ideas and concepts around the data, commencing the first stage of theme development.

Table 7.1: Phase Two Thematic Analysis: Data Extracts That Have Been Coded

Data extract	Code	Participant group and participant
I think it is part of the job, but I think it is getting more and more to a situation where a lot of the stakeholders try to push a lot of their responsibilities, or what they are supposed to be doing, on the conveyancer.	▪ Administration and additional duties falling on the conveyancer. ▪ Negative land registration is demanding of the conveyancer.	Conveyancing: 1C
So, in terms of the real world solutions that we have developed and implemented – it is a hybrid approach and so the blockchain is managing very specific segments of the data such as customers ID or bank account number or some unique transactional value that is at the core of the whole solution but it is not managing a lot of dense documents. You really do need off- chain data, you need a lot of off-chain data that gets referenced back to the blockchain, that's really what it is about.	▪ Blockchain is not database 2.0 for storage of large files. ▪ Linking on-chain and off-chain storage of documents.	Blockchain: 2E

Phase Two: Once an initial analysis had been accomplished, it was possible to begin coding by assigning themed codes to specific data extracts. Phase two involved critically analysing and coding each transcript, one by one, and it was conducted bearing in mind the summaries made, and initial concepts listed in phase one. According to Braun and Clarke (2006), extracts may be coded multiple times and codes may apply to multiple extracts. The transcribed data was coded for exactly what it represented and what was said, without entering into any form of interpretation. During this phase, the study found that there were codes specific to the participant group in which they were coded but also codes that occurred across participant groups, with an emphasis on the latter. This process resulted in the creation of an initial coding framework which was then further refined and amended in the subsequent phases. This is illustrated in *Table 7.1* where column two contains multiple codes for specific data extracts that are present in column one. Column three shows the participant group as well as a reference to the participant who made the quote. During phase two various data extracts were assigned to the same code. This can be seen in *Table 7.2* where the first column represents extracts from the transcriptions that have been associated with one code, which can be seen in column two. Column three represents the participant group and participant who gave the extract.

Table 7.2: Phase Two Thematic Analysis: Data Extracts That Have Been Coded Under The Same Code

Data extract	Code	Participant group and participant
▪ …this technology should be part of the conversation rather than simply seen as the be all and end all of everything – if you use blockchain it's not mutually exclusive from everything else… ▪ …it is quite an agnostic technology. We have been able to layer it into varied industries with different types of technology stacks.	Blockchain compatibility within the existing systems.	Blockchain: 2D and 2E
▪ Ironically enough I think these laws/bills being passed has had no impact at all on the profession – none at all in my personal opinion. ▪ It definitely is not effective. I think it is because, how can I put it, what the government did when I was still at the deed's office is that they hired a certain company to scan all the documents for digitisation and I believe that company failed. ▪ As time passed, I forgot about it and went on with my day to day things and	Lack of technological innovation in current real estate transactions.	Conveyancing: 1A, 1B, and 1C

now you have mentioned it again and I was only now thinking about it again for the first time. In those 8 years since I haven't heard anything about it. I started to think that maybe it just isn't going to happen and carried on with day to day jobs.		

Phase Three: Building on the first iteration of the coding framework created in Phase two, initial candidate themes were then identified, grouping codes together according to possible candidate themes. It was also possible to detect sub-themes and begin categorising the data extracts and their respective codes. As in Phase two, there were candidate themes that were relative to specific participant groups. However, through holistically analysing the data and inspecting the themes, candidate themes became evident across all of the participant groups. Four out of the five main themes (identified and included in the final thematic map) appeared across various participant groups. Phased three aimed to generate as many candidate themes as possible as these could be further refined in Phase four. To illustrate this, *Table 7.3* shows one such extract of a candidate theme together with its sub-themes as well as the codes that informed the development of this theme.

Table 7.3: Phase Three Thematic Analysis: Candidate Theme Extract

Candidate theme	Sub-theme	Code
Blockchain and Business Process Integration	▪ Blockchain Storage Capabilities. ▪ Level of Blockchain Application. ▪ Blockchain Regulatory Framework.	▪ Hybrid approach of on-chain and off-chain records. ▪ Public vs Private blockchain implementation. ▪ Legal validity of blockchain records.

Phase Four: The candidate themes were then evaluated in order to refine the coding framework. The scrutiny of the candidate themes occurred on two levels. Firstly, the data extracts that had been coded and assigned to a theme were examined to ensure that they matched the theme to which they were associated. Once all of the extracts were under their correct theme (and sub-theme), the candidate themes themselves were then assessed. This assessment was initially conducted within each participant group resulting in main theme identification. Phase four involved themes being eliminated, merged, or renamed. This can be seen in *Table 7.4* where the candidate theme and sub-themes that were presented in *Table 7.3*

have been modified and refined. Additionally, some data extracts to support this theme were included.

The same assessment process was then carried out again but now looking at all candidate themes across all participant groups, that is, candidate themes across the entire data corpus (four participant groups) were examined in conjunction with one another. This was done to inspect whether or not certain themes were necessary or whether any elements could be realigned and/or merged. This involved examining all four thematic maps that were created and resulted in the creation of the final and combined thematic map (*Figure 8.1)*. Essentially, Phase four involved a two-by-two examination approach. To aid in understanding, the study produced this concept through a visual diagram below (*Figure 7.1*). *Aspect 2.1* in *Figure 7.*1 was carried out to ensure that there was no overlap or repetition of themes in the final thematic map. If a main theme was present in more than one group, this theme was included in the final thematic map and the respective sub-themes were allocated. Further, in conducting *Aspect 2.1* of *Figure 7.1* the study was able to merge, eliminate, or rename candidate themes.

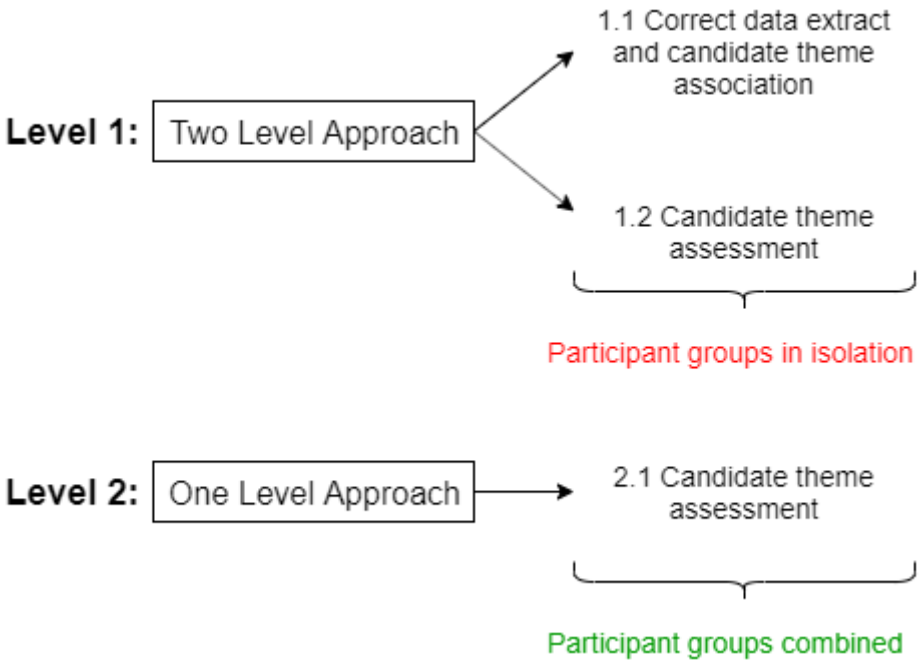


Figure 7.1: Phase Four Thematic Analysis: Two-by-Two Examination Approach

Phase Five: Phase four resulted in the completion of the coding framework whereby all candidate themes and sub-themes were identified, inspected, and either finally accepted or rejected. Each candidate theme, and its respective sub-themes, contained the correct data extracts allowing for a clear overview of the analysed data corpus. The culmination of phase

five afforded the research the opportunity to construct and develop thematic maps, one per each participant group (*Figures 7.2* to *7.5*), followed by a final combined thematic map (*Figure 8.1*).

Phase Six: The final and combined thematic map that was produced during phase five was used to guide the narrative and the discussion in *Chapter Eight*. Phase six represented the last phase of the thematic analysis process, whereby a thematic narrative was created based on the research's interpretation of the candidate themes identified (including their sub-themes and data extracts) and from whom they occurred based on the contextual background of the interview participants. The narrative was constructed in a manner that ensured that the identified themes were also discussed in relation to the research questions proposed in *Chapter One*, resulting in a discussion that is firmly aligned with the objectives of the research. Most importantly, these themes were discussed in accordance with the integrated business process model, highlighting the alignment between *Figure 8.1* and (*Figure 6.3:* South African Blockchain Real Estate Transaction (*SABLES*): Integrated Business Process Model).

Table 7.4: Phase Four Thematic Analysis: Refining Candidate and Sub-Themes With Extracts

Refined candidate theme	Sub-theme	Data extracts
Blockchain Implementation Strategies	▪ Blockchain Storage Capabilities. ▪ Blockchain Architectural Design. ▪ Blockchain Regulatory Framework.	▪ …land rights management or the real estate type of use case, if you look at the amount of information you need to keep and maintain and you really think about using the blockchain for its purpose – something like title deed or customer profile, the unique identity values, that is the core stuff that you want to be pumping through a blockchain. ▪ You don't need to store all documents on the blockchain because then you are replicating that across multiple nodes that are all on different servers that each require their own storage and so that is not an efficient way of doing things and I don't think that is the point. ▪ There are also different levels of blockchain – permission and public. A permissioned blockchain is great for a consortium in an industry where they just want to make sure that, of the people taking part in the network that they want to select, none of them have an outsized control of the network and I think that is a legitimate use case. ▪ …the next step now is to mov from interest to adoption and that is being able to (1) solve for governance and compliance…

7.4 Thematic Maps

Four thematic maps were produced: conveyancing, blockchain, PropTech, and an ICT legal. The construction of these thematic maps represents *Level 1* of *Figure 7.1* whereby participant groups were analysed in isolation from one another. Three main themes were identified and included in the conveyancing thematic map (*Figure 7.2*). Similarly, three main themes were identified and included in the blockchain thematic map (*Figure 7.3*), with one of the themes being common to *Figure 7.2* as well. Continuing from this, two main themes presented themselves in the PropTech thematic map (*Figure 7.4*) with one of these themes again appearing in the conveyancing thematic map. Lastly, two main themes became clear as shown in the ICT legal thematic map (*Figure 7.5*), both of which are present in the blockchain thematic map. These themes were then analysed holistically, renamed, merged or eliminated in order to construct the final and combined thematic map, representing *Level 2* of *Figure 7.1* and highlighting the significance of Phase four in the thematic analysis process.

7.4.1 Conveyancing Thematic Map

This thematic map was developed on analysing the interview data of conveyancing stakeholders. Three main themes were identified as can be seen in *Figure 7.2*. The thematic map was then analysed in conjunction with the other three thematic maps from the different participant groups. It was decided that '*Technological Innovation'* would become a sub-theme of '*Current Transaction Context'*, highlighting phase four of the process of analysis and resulting in two main themes in the final and combined thematic map, '*Current Transaction Context'* and '*Information Technology* (*IT) Assimilation'*.

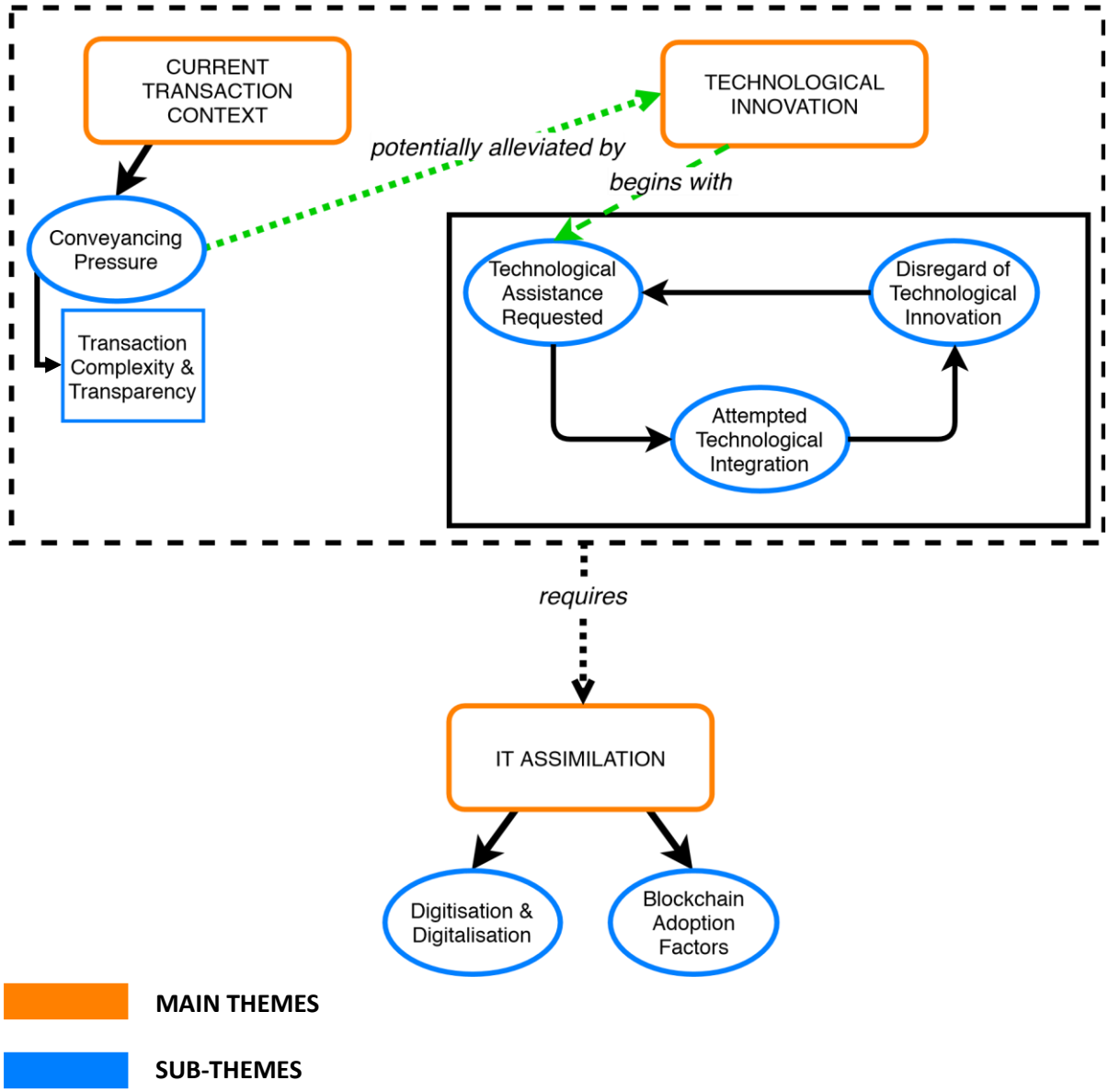


Figure 7.2: Conveyancing Thematic Map

7.4.2 Blockchain Thematic Map

This thematic map (*Figure 7.3*) was developed from interview data collected from blockchain specialists. Two new main themes are present, '*Blockchain Implementation Strategies'* and '*Business Process Applicability'*, building on those already identified in *Figure 7.2*. '*IT Assimilation'* is present amongst both thematic maps, illustrating the convergence of views and opinions across participant groups. *Chapter Eight* will clearly define and discuss these themes.

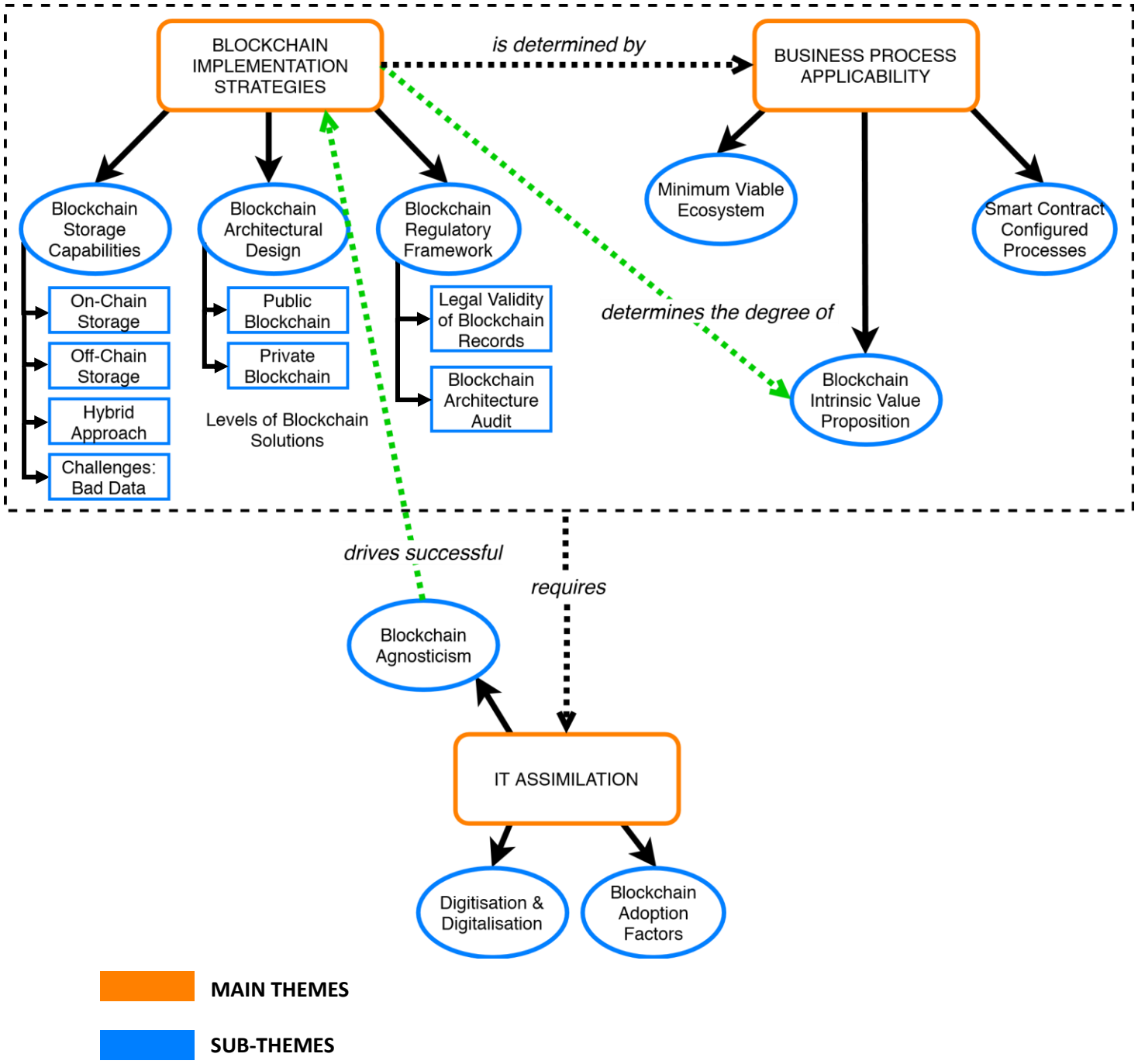


Figure 7.3: Blockchain Thematic Map

7.4.3 PropTech Thematic Map

This thematic map was constructed after analysing interview data from PropTech participants possessing both real estate and blockchain knowledge. The results showed the re-emergence of the '*Current Transaction Context'* identified in *Figure 7.2.* However, two new sub-themes were added to the main theme. Additionally, the fifth main theme presented itself in this thematic map, '*PropTech 3.0 Fundamental Success Factors'*, which outlines the process involved for blockchain's official acceptance, adoption, and use in the real estate sector,

allowing for significant impact. These themes will be clearly delineated and discussed in *Chapter Eight*.

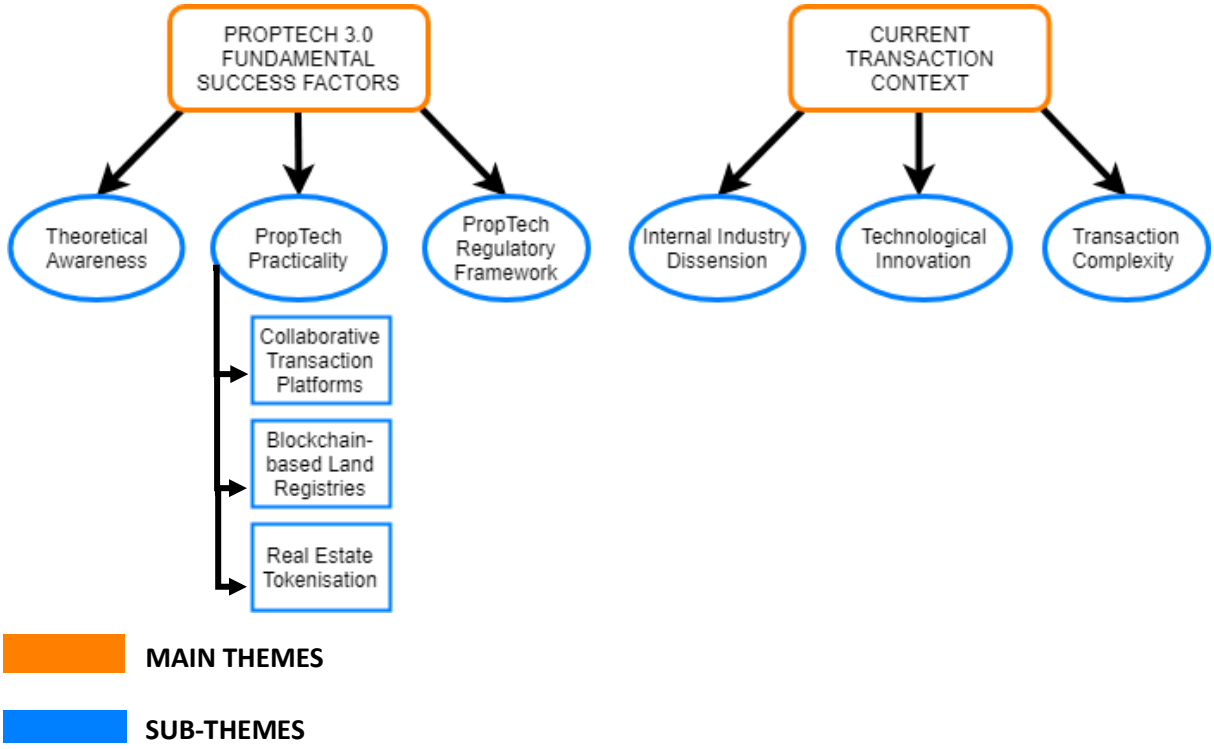


Figure 7.4: PropTech Thematic Map

7.4.4 ICT Legal Thematic Map

After analysing interview data from the Information and Communications Technology legal participant, the resultant themes were put into a thematic map (*Figure 7.5*). Both of the main themes and sub-themes identified were present in earlier maps with the exception of '*Privacy and Security Concerns'* as a sub-theme. These themes will be clearly defined and discussed in the following chapter, *Chapter Eight*.

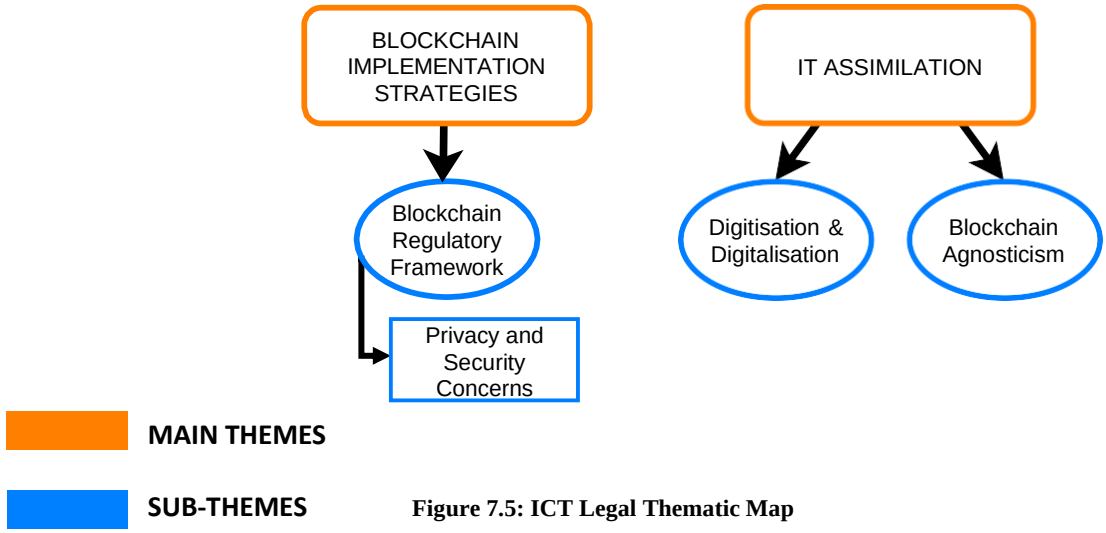


Figure 7.5: ICT Legal Thematic Map

7.5 Summary

Chapter Seven provided the reader with the results of the research. A contextual background of all research interview participants was provided in order to describe the participants and highlight their knowledge, justifying the reason for their inclusion in the study. Following this, the process of analysis was described. This chapter discussed the process of analysis from a practical point of view. Four thematic maps were provided, one for each participant group, based on the results of the collected data and these maps were presented in isolation from one another. *Chapter Eight*, will present a final combined thematic map, developed after analysing and interpreting the four thematic maps in conjunction with one another. This will be followed by a discussion of the final thematic map, paying attention to the research questions posited in *Chapter One* as well as how these themes align to the integrated business process model in *Chapter Six*.

Chapter 8 – Discussion

8.1 Introduction

Chapter Seven provided four individual thematic maps, one pertaining to each participant group. This chapter combines these individual thematic maps into a final thematic map. Following this, a detailed narrative is provided, which analyses and interprets how the findings align to the core contribution of the study, the integrated business process model (*Figure 6.3:* South African Blockchain Real Estate Transaction (*SABLES*): Integrated Business Process Model). The final thematic map (*Figure 8.1*) illustrates a combined view of all the main themes identified. This map has been placed in *Chapter Eight* as opposed to *Chapter Seven* as its development consisted of a detailed analysis and interpretation in order to depict how the main themes interact and connect with one another. When entering into the 'blockchain technology in the real estate sector' discussion, there are a number of concepts to be explored in order to reach consensus that blockchain technology can in-fact enhance real estate transactions and land registry systems. These concepts are represented by the main themes in *Figure 8.1*.

8.2 Thematic Interpretation

The discussion will involve an analysis of each of the main themes as well as the sub-themes which are associated with it. At the beginning of each discussion, a table has been provided which clarifies the meaning of the theme and its immediate sub-themes. The alignment of the themes in the final thematic map (*Figure 8.1*) with the integrated business process model (*Figure 6.3*) will guide the discussion. Most importantly, the themes and their alignment to *SABLES* will be analysed, interpreted, and discussed in a way that addresses the research questions.

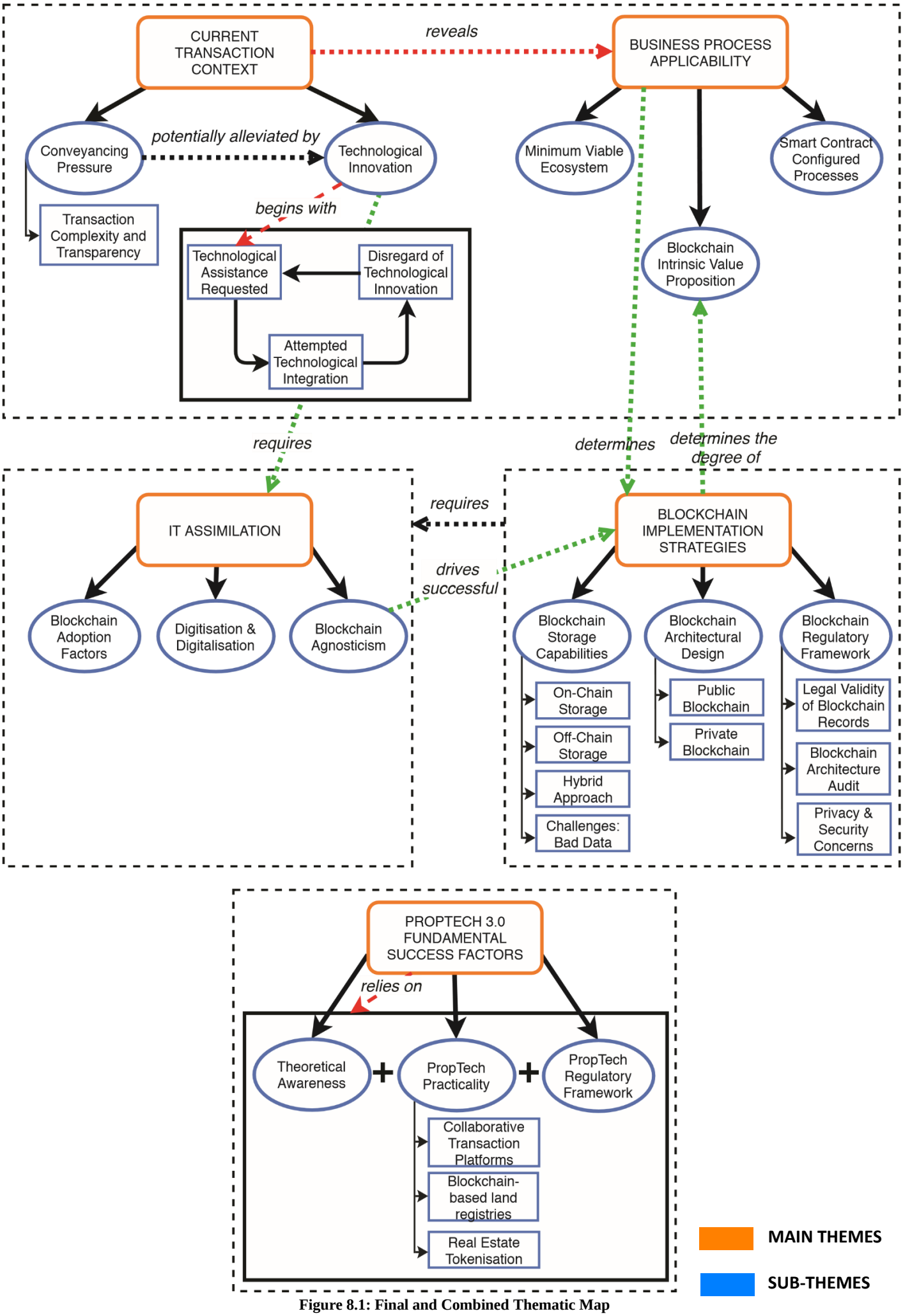


Figure 8.1: Final and Combined Thematic Map

The map shown in *Figure 8.1* was constructed after jointly analysing all four thematic maps from each respective participant group. Through joint analysis, the study identified relationships amongst the main themes. *Blockchain Implementation Strategies* is determined by *Business Process Applicability*. This is because the industry and the process which is adopting blockchain technology will determine how the technology is integrated, as in whether it is public or private, will everything be stored on chain or off chain? For example, the Bitcoin blockchain was intended to be completely decentralised and distributed but it does not follow that whoever implements the technology, will employ the same architectural structure. The strategies selected for implementation will determine the degree of *Blockchain's Intrinsic Characteristics*, such as, the business requirements and what properties they should possess, and how transparent the blockchain should be. Once blockchain's implementation strategy is determined for the business process, the next step is *Information Technology Assimilation*, the process of actually integrating the technology into current business operations. To successfully implement blockchain into business processes it is important to have *Blockchain Agnosticism*, which implies that blockchain easily slots in and connects with the other technologies in the current technology stack. *Technological Innovation* was found to be a sub-theme of *Current Transaction Context* but in order for this innovation to be realised it too needs new technology to be assimilated into businesses and organisations. Lastly, for blockchain technology to penultimately succeed in the real estate sector one needs to rely on the *PropTech 3.0 Fundamental Success Factors*: *Theoretical Awareness*, *PropTech Practicality*, and a *PropTech Regulatory Framework.*

8.3 Thematic Discussion and Alignment

8.3.1 Current Transaction Context

When determining blockchain's applicability and the integration of *SABLES* into real estate transactions, it is imperative to understand the existing processes and systems that are currently in place. Beyond the document analysis carried out in *Chapter Three*, the interview guides probed at gaining an understanding of the *Current Transaction Context* of South African real estate transactions, representing the first main theme. This theme supplemented *Chapter Three* in answering the first and second sub-question (*research question 1.1 and 1.2*).

Table 8.1: Defining Current Transaction Context as a Main Theme

Candidate Theme		Sub-Theme	
Current Transaction Context	This candidate theme presents results that speak to the current status and context of real estate transactions. Understanding the current mechanisms in place allows the research to identify bottlenecks in the process and areas for improvement.	**Conveyancing Pressure**	The South African real estate sector makes use of a 'negative registration system' which means that the responsibility of ensuring all transactional data is correct and true, falls on the conveyancer. The current processes lack technological innovation which could assist the conveyancers and alleviate certain pressures.
		Technological Innovation	Results showed that there is a call for technological assistance in the real estate transaction process from those involved in the sector. This is where *SABLES* intend to assist. However, recent attempts to integrate technology into the South African real estate transaction process have failed due to lack of sufficient attention. Furthermore, there has been significant talk of advancements towards newer technologies, but actions have not followed. These factors hindering effective integration of technology will be prevalent for any system.

Participants from both the 'Conveyancing' and 'PropTech' groups possessed knowledge on the current real estate sector in South Africa and abroad. '*Current Transaction Context*' elaborates on the archaic nature of real estate transactions and how benefits can be derived from technological assistance through a transaction platform such as *SABLES*. However, despite the call for technological assistance, due to the lag in modernisation and digitisation, participants acknowledged that current processes do work. This is further supported by literature which states that the South African deeds registration system is highly regarded and trusted as one that provides title and security to land (CS Consulting, 2013; Lombard, 2018; McIntosh, 2018). This study acknowledged the competency that current processes possess, evident through the discussion in *Chapter Three.*

Group One's participants highlighted the archaic processes used and the associated security concerns which are still prevalent in transactions. Further discussions recognised that inefficient and time-consuming transactions are a result of paper-based processes and the numerous stakeholders involved. As a result, there are still issues of security, specifically fraudulent activities, pertaining to falsified identification and title deed documents in South African land registrations. This is in line with the information documented in *Section 3.2*. It is well documented that real estate legislation has lagged behind other industries in the last two decades and it is for this reason that paper records are still required as opposed to digitised documents and contracts. These participant views coincide with the observations made by the research as mentioned in *Sections 3.2.1–3.2.3.* Participant 3C represents the only South African

PropTech individual who was available for this research. Their involvement in the PropTech 3.0 space suggests their awareness of current issues in real estate transactions and their knowledge of how technologies, such as blockchain, can alleviate current pressure points. The participant mentioned that this paper-based approach results in the South African Deeds Office wasting time searching for title deeds and transactional data, often not knowing where these files are stored. Participants concluded that while such processes may yield an individual's right to land, the systems and processes in place do not allow for streamlined transactions and such transactions are not carried out with maximum efficiency. There is consensus that current systems and processes which manage real estate transactions, do what they are supposed to albeit at a slow pace. Thus, improved systems and processes are needed, but in order to move over to a new real estate transaction and recording system, there must be significant benefit, such as enhanced speed and security of operations. These findings highlight the prime reason for why this study was undertaken, to research solutions to the problem of inefficiency in real estate transactions. This research was positioned to tackle such matters and put forward a potential solution, through *SABLES (Figures 6.2 and 6.3)*, on how current processes can be improved, enhanced, and made more efficient.

Conveyancing Pressure: The study classifies this sub-theme, '*Conveyancing Pressure*', as a latent theme. This is due to the fact that the term '*pressure'* was not directly mentioned or used in any of the interview questions but emerged upon analysis and interpretation. The South African Deeds Office uses a negative deeds registration system (Pienaar, 1986). This implies that conveyancers are responsible and accountable to ensure that all registered documents at the Deeds Office are official and correct, which holds the conveyancer liable for any wrongly registered information, as defined in *Table 8.1*. Conveyancers are also responsible for overseeing and managing the entire transaction, which requires relying on numerous stakeholders. Participants further stated that this element of accountability (as a result of the negative deeds system used) is amplified by the lack of stakeholder competency. This is due to the fact that other stakeholders involved in the transaction process either tend to push their tasks and workload onto the conveyancer or do not competently complete their tasks, leading not only to additional liability but increased frustrations felt by conveyancers. Stakeholder reliance is evident in the situation of transfer of title versus transfer of payment, a concept outlined as delivery versus payment (DVP) in *Section 3.2.4.* In this scenario, bank or bond officials may not offset the transmission of funds on the same day as the Deeds Office transfers the title deed. This not only delays the process but opens up an area of vulnerability for fraudulent activities to occur. The paper-based

operations mentioned earlier, coupled with reliance on multiple stakeholders respectively, results in:

- Inefficient and unorganised storage of documents as well as increased storage space needed.
- The situation being out of control of conveyancers at times but due to the nature of their role, they have to deal with customer frustrations.

An additional pressure point comes from buyers and sellers not understanding the transactional complexity and showing no intent to do so. Despite this lack of interest, conveyancers are still inundated with constant transaction-related questioning. Real estate transactions have the potential to be unique, with a high possibility of distinction (even if minor) occurring amongst all transactions that occur. Due to limited interest in transaction proceedings coupled with limited transparency into the transaction's progress, transacting parties (buyer and seller) often direct all their communication to the conveyancer.

Literature explored in *Section 4.5.5* suggested a lack of transparency during the transaction process, representing one of the main themes for blockchain's opportunity. However, Group One participants argued otherwise, clearly stating that conveyancers have an obligation to inform their clients of the transaction status. At every stage of the process, the conveyancer should be communicating with the buyer and seller. This implies that transparency in the process is very dependent on the conveyancing firm carrying out the transaction. A factor that contributes to this lack of transparency is a lack of thoroughness in communication amongst firms. Participants revealed that a common practice is for conveyancers to get their secretaries (who are inadequately prepared or trained in conveyancing regulation) to explain transactional documents to their client. This implies that the wrong people are carrying out an important task. Additionally, limited client interactions and meet-ups are common, which prohibits constant communication and results in clients not knowing the status of their transaction. This leads the study to conclude that while conveyancers, and conveyancing firms, need be equipped on transactional complexities, there is also a professional duty to conduct certain practices. These practices include regular client meet-ups as well as maintaining expert standards in how they are conducted. Conveyancing firms need business rules implemented stating that *only* conveyancers are to explain transactional documentation to clients. Lastly, Group One's participants stated that real-time transparency is hindered through a lack of

digitisation, because paper-based operations often result in inadequate storage and maintenance of records as well as constant loss of documentation. The administrative paper-based processes involved coupled with numerous stakeholders not fulfilling their obligations, besieged client requests, and a lack of transactional transparency, makes it clear that conveyancers bear the brunt of responsibility and required duties throughout the transaction process.

This study interprets this conveyancer reliance and complexity as an indication that real estate transactions will always need human involvement to guide the process. Technology can (and will) certainly support activities in the process, but due to conveyancing law often becoming convoluted, it begs the question of whether or not technological systems or programs, such as smart contracts, will be able to completely manage the process from start to finish. This interpretation is in-line with the *SABLES* business process model produced, which does not eradicate all professionals involved (as seen in the *five swim-lanes* in *Figure 6.2* and the *six swim-lanes* in *Figure 6.3*) but rather posits a transaction platform to aid the transaction processes. The *SABLES* integrated business process model addresses the issues raised as followed:

- *SABLES*' operates on a multi-node blockchain network, which groups all stakeholders in the process. This is apparent through the *six swim lanes* in *Figure 6.3.*
- This allows for a common transaction platform to be realised and utilised, which acts as a common point of call amongst all participating stakeholders involved in transaction processes. This is shown in through *Figure 6.2,* which illustrates how the *SABLES* transaction platform accommodates for sub-processes such as applying for, and registering, a bond. The *five swim-lanes* consist of the participating stakeholders and integrated systems which are required during the transaction. This shows how the transaction occurs within a boundary instead of across multiple isolated systems with low inter-operability.
- This transaction platform assists in transaction transparency through smart contracts managing the transaction status. In *Section 6.3* it was stated that the Deed Smart Contract (*Figure 6.3, swim-lane 4, nested swim-lane 1*) and the Escrow Smart Contract (*Figure 6.3, swim-lane 4, nested swim-lane 2)* will manage the transaction progress, notifying all stakeholders as the transaction passes through its various stages. Therefore, the transparency of *SABLES* will let the transacting parties see the status of the transaction at all times, alleviating the stress and pressure felt by the conveyancer.

- In preventing falsified identification, *SABLES*' employs a SSIDM system which facilitates and manages the digital identities of all participating stakeholders (*see the element at the top of the integrated business process model in Figure 6.3*). Digital identities represent one of three key components for *SABLES*. Here, the blockchain network (consisting of its nodes) will authorise and validate the identities on the network, as is apparent in *Group 1* of *Figure 6.3*. Furthermore, public key cryptography (*Sections 4.2.3* and *6.3*) ensures that the correct stakeholders are taking part in the transaction and funds and title deeds are put in the right hands.
- Security issues are further enhanced by all stakeholders jointly concurring and verifying all documentation utilized. Due to smart contracts making use of the verified information that they are supplied with; it can be indirectly stated that these contracts have also been verified. This was mentioned in *Section 6.3* which discussed the integrated business process model. Once verified, these documents are then stored in a distributed database amongst all stakeholder as well as being hashed to the blockchain. This safeguards their content and provides guarantees against manipulations, as any changes to the documents and their contents thereof can be detected.
- Lastly, to address the vulnerability of financial fraud occurring, *SABLES* conducts all contractual processes through smart contracts (F*igure 6.2*, *swim-lane 4* and *Figure 6.3*, *swim-lane 4*). The escrow smart contract (which replaces typical escrow services), allows for automatic and real time transfers. As can be seen in *Group 3* of *Figure 6.3*, specifically the end stages of *swim-lane 4*, as the Escrow Smart Contract records funds being paid to the seller, so the Deed Smart Contract transfers property ownership to the buyer, permitting concurrent DVP. This not only expedites the due diligence processes traditionally required but also eliminates any possibility of a mismatch between DVP.

Technological Innovation: As a result of the conveyancing pressure caused in part by transactional complexity and hindered transparency, technological innovation can significantly enhance this business process. Group One's conveyancers, coupled with opinions from PropTech specialists, stated they firmly believe the correct implementation and integration of technology can be advantageous to the conveyancer. These participants identified three specific areas that can derive benefit from technological aid.

- A collaborative platform, or integrated system, which allows all stakeholders to

connect, communicate and transact, resulting in complete exposure and transparency to the process. There is currently nothing with such capabilities. This is what the *SABLES* transaction platform intends to achieve. As can be seen in *Figure 6.3* there are six swim-lanes all within one pool, meaning that all stakeholders can conduct a transaction through a common transaction platform. Participant 1A commented on this aspect in regard to the *SABLES* integrated business process model, which was presented to them, by stating:

> *"Now, if you do use the conveyancing system, SABLES, to the fullest then that would mean that clients could get notified [on various aspect, such as] to where they are on their loans, whereas with the traditional mechanisms now, they only get them [notifications] once every 6 months from the bank. But if you can get those role players involved then the client can see what their exposure is and what asset they have in terms of how much of the capital/asset is repaid."*

- Digitisation of documents allowing for increased speed through digital signatures and the ability to sign without having to be physically present. Digitisation also allows for documents to be submitted in an easier manner. Further, safety and security of information becomes enhanced in that it prevents loss of documentation or manipulation of paper-based records. This is evident in the *SABLES* model in *Group 2, swim-lane 5, nested swim-lane 3* whereby the title deed is digitised and can move between stakeholders at a faster pace. This is further seen in the integrated model in *Group 3, swim-lane 2* whereby the offer to purchase is a digital document which is digitally signed. Lastly, digitised documents are employed in *Group 3, swim-lane 5, nested swim-lane 1 and 2* represented by the transfer duty receipt, rates and clearance certificate, and the SPLUMA certificate. Digitisation of data permits for a seamless flow of information, enhancing transaction speed. Following the process flow from each of the above-mentioned digitised documents shows that this information acts as an input for smart contracts. This displays the movement from digitised data to digitalised data as the digital information is now deemed to be official and original. This concept will be further discussed in *Section 8.3.4*. This aspect can also be noticed in the sub-process of applying for a bond if required, see *Group 3*, *swim-lane 2*. This sub-process is illustrated in detail in *Figure 6.2*, in *swim-lane* 2 where the bond

documentation is digitally drafted and created. In both *Figure 6.2* and *6.3*, all transactional documentation and data is made available to the relevant stakeholders in a digital manner.

- The benefit digital and distributed storage of transactional documents. *SABLES* is underpinned by blockchain technology and represents a peer-to-peer platform. This coupled with the digitisation of data and documentation means that distributed storage is possible in the *SABLES* off-chain network database. This allows for ease of access and consequently expedites processes as well as reduces the duplication of information. This is evident at the end of each swim-lane in *Figures 6.2* and *6.3* whereby all transactional data is stored in the *SABLES* database and distributed amongst all stakeholders. Further, this data is all hashed onto the blockchain making it secure and immutable.

In South African real estate, several projects which have attempted to integrate technologies into the current process with the goal of alleviating the burden that current stakeholders carry. Group One's participants mentioned that these have seen both successful implementations as well as failed endeavors. For those that have been successfully integrated, there are both advantages and disadvantages to their systems. For example, Nedbank's bond originator platform, South African Receiver of Revenue Service's (SARS) e-filing system, and Lexis Convey Contract Management software. These software solutions have aided the process in their respective areas, obtaining finance, obtaining transfer duty receipts, and developing contracts. However, they are not system agnostic in that they exist in isolation and do not connect with each other, hence the continued call for a collaborative transaction platform amongst all stakeholders. As can be seen in *Figure 6.2*, *SABLES'* integrates the bond application process into the transaction platform which allows all sub-processes to be conducted in the same place where the transaction is occurring, grouping all related activities. Further, in *swim-lane 5*, *nested swim-lane 1* and *2* of *Figure 6.3*, the *SABLES* platform integrates with the SARS systems and municipal systems, which allows transfer duty receipts and rates and clearance certificates to be obtained directly through the *SABLES* platform, again, grouping all activities. This illustrates that *SABLES* is a blockchain agnostic system. This will be further discussed in *Section 8.3.4*. The existing systems mentioned do, however, have their drawbacks. For example, Nedbank's bond originator platform is bank-specific and while Lexis Convey assists in drawing up contracts, they still need to be printed in paper-form and manually executed. Participants concluded that when the correct technology is effectively integrated into

current processes, significant benefit is derived, and automation is achieved.

There have also been situations where technological assistance was attempted but ultimately failed. In 2017 the e-DRS bill was passed allowing for electronic lodgment of deeds with the goal of tracking the deed registration process as it passes through levels of examination. This began with a failed attempt to digitise over 100 000 title deeds at one of South Africa's Deeds Offices in 2008. This was attributed to poor implementation and not digitally backing-up these deeds. The proposed e-DRS was a one-sided development project with only one practicing conveyancer present to the conversation. The majority of the decisions were made solely by IT and government personnel. This illustrates a lack of alignment in requirements between all the stakeholders involved (business, IT, and governments), which is something fundamental to the development and deployment of an information system. Moreover, since 2008, conveyancers and Deeds Office personnel have not been informed as to how e-DRS will work and what it will entail, representing 11 years of no advances beyond the initial conversation and integration. Municipal systems have also been developed to assist conveyancers in obtaining RCC and SPLUMA documentation *(Section 3.5.4), however,* conveyancers have been less than impressed with these systems, stating that their functionality is limited, as they are frequently offline.

In this study, technological assistance has been requested from existing conveyancing stakeholders. In what proved to be very honest, straightforward and open interviews, with South African conveyancers, it is clear they have witnessed several failed attempts at implementing various technological systems. Ultimately, these projects have failed due to poor implementation and a disregard of innovation. On top of this, they have lacked the sufficient attention that is required when integrating technology into business and governmental processes. This cycle is illustrated in the bottom left corner of the final thematic map *(Figure 8.1).* In lieu of this, the research acknowledges that all systems and transaction platforms, including *SABLES*, will be subject to integration obstacles. However, once successfully integrated, this research believes that there is room for *SABLES* and blockchain technology to not only enter the South African real estate transaction process but to significantly elevate it, enhancing efficiency and security. *SABLES'* provides a collaborative transaction platform, digitised documents, smart contracts, and distributed digital storage to all stakeholders involved and intends to provide the technological innovation requested.

8.3.2 Business Process Applicability

When integrating blockchain technology into a business process, it is vital to ensure that the need to do so exists, knowing and understanding where and how value can be added. This gives rise to *Business Process Applicability*, representing the second main theme. *Section 8.3.1* describes a first-hand account of South African real estate transactions, demonstrating their inefficiency and how they can benefit from technological intervention. This section aims to illustrate *why* the real estate sector represents an ideal use case for blockchain technology. This discussion will aid in answering the first sub-question (*research question 1.1*). Further, the discussion will also provide insight into *how* South African real estate transactions can leverage off *SABLES* by utilising smart contracts. This assists in answering, both the fourth sub-question (*research question 1.4*) and *main research question*. Both *Chapter Three* and *Section 8.3.1* indicate that South African real estate transactions are inefficient. These inefficiencies form the basis of the problem statement identified in *Chapter One*. From the literature review (*Chapter Four)* the research was led to believe that the real estate sector signifies one of the prime environments that could utilise, and receive benefits from, blockchain technology. In order to fully realise these benefits, an understanding of all sub-themes in *Table 8.2* must be obtained.

Table 8.2: Defining Business Process Applicability as a Main Theme

Candidate Theme		Sub-Theme	
Business Process Applicability	There are various use-cases where blockchain technology is applicable. Results concluded that real estate transactions and land registry systems represent a fitting use-case for the technology.	**Minimum Viable Ecosystem**	Before incorporating a new technology into business processes, it is important to understand the current processes and the stakeholders involved. Once understood, this should be modelled against blockchain-based solutions to see if any harmony exists amongst the processes, the people, and the technology, creating a sound information system underpinned by blockchain technology.
		Blockchain Intrinsic Value Proposition	The degree of blockchain's intrinsic characteristics (immutability, transparency, and so on.) will be determined by the business process environment in which blockchain is integrated.
		Smart Contract Configured Processes	Smart contract technology can assist business processes and business transactions, allowing for traditional contracts to become digitised.

Research question 1.1 asks *why* South Africa should make use of blockchain technology in real estate transactions. In this regard, the literature review identified opportunities for blockchain technology in the real estate sector. Here, participants agreed on the following two key areas:

- Contractual processes: Where there are contractual transactions (comprising of transactions which involve the transfer of assets and/or funds) involving multiple stakeholders who cannot be fully trusted, smart contracts which operate through blockchain represent a viable alternative.
- Ledger-based record-keeping processes: these provide immutable provenance of assets (such as a title deed which represents ownership to a property), traceability of the asset's ownership, and transparent trust through blockchain.

Minimum Viable Eco-system: In response to the *SABLES* model presented, participants spoke about the importance of understanding the minimum viable eco-system, what are the current process involved, who are the key stakeholders, what are the current problems, and what will the new processes be with the incorporation of new technology. The study obtained knowledge about the current process and its stakeholders in *Chapter Three,* which illustrated the current state of South African real estate transactions (*Figure 3.9:* South African Real Estate Transaction Process: Business Process Model). *Chapter Five* showed the same process but with regards to blockchain-based transactions (*Figure 5.3:* Blockchain-based Real Estate Transaction Process: Business Process Model). Given the intricate nature of real estate transactions, participant views stated that knowledge of the stakeholders involved in the process is crucial. Further, given the regulatory nature of real estate transactions, it is important to ensure the inclusion of government official regulators (such as Deeds Office personnel) in the processes. The *SABLES* integrated business process model took this into consideration. This can be seen in *swim-lane 5* which specifically accounts for '*South African Public Services*' and includes three *nested swim-lanes* which account for '*South African Revenue Services (SARS)*', '*Councils*' and/or '*Municipalities*', and '*Land Registry Officials*'. Through a comprehensive understanding of these two processes, the study was able to gauge the minimum viable eco-system required for the *SABLES* integrated business process model (*Figure 6.3*). This involved identifying the required stakeholders and integrated systems which would participate or need to be present in the transaction, illustrated by the *six swim-lanes* in *Figure 6.3.* It also involved recognising and mapping out the processes that will be required to conduct a blockchain-based real estate transaction – illustrated by the process flow between the *six swim-lanes*, the grouped activities from *Group 1* to *Group 3*, and the nature of each task (user task or script task for example). A detailed understanding of the necessary processes and their

functionality is evident in *Figure 6.2* which illustrates the bond application sub process in *Figure 6.3, Group 3*. The *five swim-lanes* in *Figure 6.2* depict the stakeholders and systems required to carry out the process of obtaining finance for a transaction. Throughout these *five swim-lanes*, a combination of user tasks and script tasks illustrate the process flow for completing the activity of obtaining a bond.

Understanding the minimum viable eco-system provides a holistic view of the business processes that are currently in place and allows for discovery of where new technology can add value. This leads to a clear awareness and distinction of what the research defines as 'business workflow' versus 'technical workflow'. Understanding the processes involved in a transaction, provides knowledge regarding where data come from and whether that data can be trusted. This represents the business workflow. A strong knowledge of the business workflow is important to populate the blockchain ledger, and associated smart contracts within, with the correct data. Technical workflow, on the other hand, relates to simply taking the information from the data sources to which it is programmed. So, while technical workflow simply utilises the information in the blockchain database, the business workflow ensures that this information is correct. This cohesion amongst the two factors comes down to fully understanding the minimum viable eco-system.

SABLES' consists of *six swim-lanes*, representing the stakeholders involved in the transaction. This illustrates that this transaction platform (operating on blockchain technology) does not completely eradicate all stakeholders and their traditional workflow. Rather, it integrates blockchain technology in a way that lets technology significantly assist the process, acting as an additional layer of credibility for transaction data, evident in *Figures 6.2* and *6.3* by the element at the bottom of the business process models. This further illustrates how this technology is not mutually exclusive from all other technologies but can operate in tandem with them, implying that blockchain is an agnostic technology. The concept of blockchain agnosticism will be discussed in *Section 8.3.4*. As a result, *SABLES'* still permits stakeholders to conduct their workflow, just through more efficient processes such as user tasks script and service tasks, which can all be conducted through a transaction platform that is underpinned by blockchain technology.

Blockchain Intrinsic Value Proposition: Blockchain embodies the following characteristics: transparency, distribution, decentralisation, immutability, and timestamping – representing the intrinsic value that the technology offers. Participants all agreed that through blockchain's adoption and the employment of said features, overall efficiency and trust can be enhanced in transactions. As mentioned at the beginning of this section, ledger-based record

keeping, and document management systems can significantly benefit from blockchain technology. Through blockchain's intrinsic value, data, transactions, and transaction meta-data is guaranteed. Therefore, document tampering, and fraudulent activities can be eliminated, and an audit trail of the ledger's contents is possible. The *SABLES* transaction platform embraces these characteristics. Transaction data can be distributed amongst all the stakeholders involved, as can be seen in Group 3 at the end of each *swim-lane*. This data, along with all smart contracts and their meta-data is stored in a blockchain ledger and hashed onto the *SABLES blockchain system* which is illustrated at the bottom of *Figure 6.3*. This exhibits immutability of real estate transaction data, giving increased trust to those involved in the process. As mentioned in *Section 8.3.1*, the *Escrow* and *Deed Smart Contract* manage the transaction progress, notifying stakeholders of what stage the transaction is at as certain conditions are met. This provides transparency amongst the network, letting stakeholders have visibility as to which processes are needing to be completed and by whom. This aids in public witness and accountability, leaving no room for incompetent role players and ensures that each stakeholder performs their designated tasks.

The study acknowledged that while blockchain technology offers these capabilities, this does not mean that every blockchain-based solution will employ them to the same degree. For example, the Bitcoin blockchain, operates on complete decentralisation. This is because the purpose of this cryptocurrency was to move away from conventional norms of fiat money and financial banking systems. However, that is not to say that every forthcoming implementation will be the same, as it would be dependent on the problem being solved within a specific business scenario. It is for this reason that the final thematic map shows a connection whereby '*Blockchain Implementation Strategies*' will determine the degree of '*Blockchain Intrinsic Value Proposition*' that will ultimately be realised. Depending on the business process to which blockchain will be applied, the degree of the innate characteristics of the technology will be decided. When deciding on implementation strategies for a specific business process, this will determine the degree of blockchain's intrinsic value that is achieved.

The business process will need to certain questions such as: is the focus on speed, efficiency, decentralisation, or a combination of all of these? Should the application be completely public or private? The study acknowledges that there should be *different* blockchain solutions implemented to solve *different* business problems across various sectors. Within the array of solutions, trade-offs will emerge based on specific business requirements. However, in terms of *SABLES*, the focus is on enhanced transaction speed, transparency, safety, and security. To achieve increased speed, *SABLES'* adopts a digitised approach of all transaction

data. This allows for the ease of transmission as well as digital signatures used in *Group 3, swim-lane 2* whereby the offer purchase is digitally signed. Transparency is accomplished through a collaborative transaction platform which groups all stakeholders together instead of operating through multiple siloed systems. Further, smart contracts track the status of the transaction. Safeguarding of all transaction information is achieved through joint consensus and verifiability of transaction data amongst all stakeholders as well as this data being stored and hashed in an immutable blockchain ledger. Self-automating smart contracts ensure that there is complete security when transferring property funds and ownership, which can be seen throughout *swim-lane 4* in *Figure 6.3* as well as *swim-lane 4* in *Figure 6.2*. Security is further enhanced through the use of a SSIDM system (*see element at the top of Figure 6.3*). Here, identities are validated and verified on the blockchain to ensure the correct parties are taking part in the transaction. This lowers the risk of falsified paper-based identification records. Moreover, when it comes to recording property ownership (once the *Deed Smart Contract* has transferred property ownership), this is done through a dual recording system. As depicted in *Group 3, swim-lane 4, nested swim-lane 1*, the *Deed Smart Contract* transfers property ownership and this transaction is stored and hashed onto the *SABLES* blockchain. Secondly, property ownership is recorded by the South African land registry officials in their traditional database, but this is still linked to the *SABLES* blockchain whereby this digitised record becomes hashed; this is illustrated in *Group 3, swim-lane 5, nested swim-lane 3*. This must be done because real estate transactions are still heavily regulated and such data is still stored in government repositories. Lastly, decentralisation and distribution amongst the nodes in the network is necessary but this will not extend beyond those involved. The study did not envision a scenario where everyone has open access to all documentation, such as title deeds, pertaining to various real estate transactions. Rather, there will be certain stakeholders who have permanent access to the system, such as public service officials (for example, municipal, SARS, and land registry personnel), mentioned in *swim-lane 5* of *Figure 6.3*. In contrast to this will be users who are invited to join the network to conduct their transaction. This will be users such as transacting parties who will have restricted access to view certain transactional data, only pertaining to their transaction, mentioned in *swim-lane 1*. As a result, these characteristics will present themselves within the closed network on which *SABLES* operates, representing higher applicability towards a private consortium-based blockchain (this will be further described in *Section 8.3.3*).

To further demonstrate these characteristics in relation to the *SABLES* transaction platform, as the seller registers the property for sale on the platform (*Figure 6.3, swim-lane 1*),

a block will be embedded within the transactional flow by virtue of its origin or province being recorded in real time. Additionally, as this contract, document, or asset moves along during the transaction status, this can now be recorded in parallel in a digital landscape. This would occur as the transaction moves from stage to stage, for example, as the property is tokenised (*Figure 6.3, Group 2, swim-lane 4, nested swim-lane 2*) and the buyer requests to purchase the property (*Figure 6.3, Group 3, swim-lane 2*). This means that stakeholders no longer need to be physically present or go through various due diligence processes, such as making phone calls to determine whether certain steps have been taken, and whether contracts have been approved. This information is then recorded and automatically made available on *SABLES*. This collaborative platform ensures that documents and records are verified, validated, and signed off by an independent body, the participating stakeholders on the *SABLES* transaction platform, and then added to the blockchain ledger in real time. Ultimately, this would speed up elements of the process and digitise and automate traditionally manual processes. Again, this illustrates how stakeholders can add increased value in more important areas of the transaction.

When interpreting the opinions that advocate for blockchain technology's use in real estate transactions it was natural to hear these views come from PropTech personnel. Given that their current profession is in the space this illustrates their constant involvement in various PropTech 3.0 projects. However, what the research found insightful was that all of the *blockchain specialists* also called for blockchain's integration into real estate transactions and all were as equally optimistic as to its prospects. This showed that blockchain specialists, individuals believed to have a more comprehensive grasp of the technology's competency (assumed by the research) than those in the PropTech sector, are confident of the success of PropTech 3.0. These '*technicians*' believe that blockchain can aid real estate transactions through record-keeping systems which maintain transactional documents and title deeds. This further supports not only why this research is being conducted but also the notion that blockchain technology will disrupt current real estate practices.

Smart Contracts: Real estate transactions are heavily contract-based. Whether one looks at contracts between the transacting parties themselves (buyer and seller) or contracts between financial institutions and transacting parties (bond contracts), a single transaction can consist of multiple contracts. In the digital world, and with the assistance of blockchain technology, smart contracts can be employed. This discussion allows for the main research question and the fourth sub-question (research question 1.4) to be partially answered. The discussions in *Sections 8.3.3–8.3.5* will fully answer these questions. Before utilising digital technologies, real estate transactions need to digitise their current processes (and contracts).

Digitised contracts immediately assist the transaction process with enhanced speed of transmission and signing as the physical presence of signatories is no longer required. In *Figure 6.3, Group 2, swim-lane 5, nested swim-lane 3,* title deeds are digitised. Further, *Group 3, swim-lane 2* illustrates a digital offer to purchase contract. This means that documents can now be requested, searched for, and distributed between stakeholders much more quickly. Digitisation, and *SABLES*' use thereof will be fully described in *Section 8.3.4.* Digitisation is beneficial in that it provides digital inputs for the smart contracts that will be utilised.

In *Chapter Four,* smart contracts were defined as self-executing, digitised contracts with the potential to not only replace paper-based contracts but to enhance contractual processes. Smart contracts can assist in reducing the number of stakeholders involved as they can fulfil the role of escrow services, as seen in the transactions outlined in *Chapter Five*. Here, smart contracts can have everything from funds to title deeds and signatures locked in, waiting to be executed and transferred. Not only does this reduce reliance on various stakeholders but it expedites the process and offers increased security and trust as automation ensures that contracts are executed only on certain conditions being met. With programmed and self-executing capabilities, smart contracts can store inputs and automatically produce outputs based on conditions being met. Speed is enhanced as various scenarios are pre-programmed and will automatically offset when appropriate. This means that security and trust will be significantly improved as an instantaneous transfer of funds versus title deeds will occur, eradicating any suspicion of 'DVP' fraud that could arise.

In interpreting the benefits that smart contracts provide; the study identified a two-fold beneficiary layer. The first is the speed and security derived from the immediate transfer identified above. Beyond this, there is also the value-added security in how smart contracts operate on top of the blockchain and interact with blockchain's data. Inevitably, smart contracts rely on the information stored in the blockchain ledger. It can be viewed as follows: smart contracts run on the application layer of a system, allowing transacting parties to interact with them and sign them off. However, these contracts speak to the database layer, the blockchain, from where they collect their information. So, if blockchain's database consists of secure and immutable data (which, by definition, it should), which is guaranteed to be correct by the nodes in the network, and smart contracts pull this data and information into their contractual conditions, then in theory, smart contracts represent one of the safest approaches to contractual transactions. This approach can instill confidence and trust in those utilising smart contracts.

The automation of processes means less reliance and trust in humans and more trust in mathematically programmed contracts, a result of the evolutionary process with respect to

technology and how it is advancing in today's digital landscape. As a result, society and business processes within may start to embrace the shift towards technologically executing transactional contracts, thus relegating certain human ability and status. This will unavoidably further promote how technical capabilities outweigh human activity and offer increased efficiency and trust. This then begs the question: to what degree will society let technology to replace and conduct operations traditionally carried out by humans? *SABLES'* recognises the importance of these stakeholders and their profession, as illustrated by the *five swim-lanes* in *Figure 6.2* and *six swim-lanes* in *Figure 6.3*. The functionality of smart contracts (self-executing capabilities upon pre-determined conditions being met) led participants from Group One to become reserved in what the research interpreted as 'the fear of the unknown' and the potential of driving out the need for their job role. However, as the information in the smart contract comes from the blockchain, this means the due diligence procedures can be significantly enhanced. The automation of these processes can then give rise to conveyancers developing their skills in more value-added areas. While smart contracts do expedite the process, they will not replace all individuals in the profession, especially not those as specialised as conveyancers. Real estate transactions are too intricate to not require these legal stakeholders and as can be seen in *swim-lane 2* of *Figure 6.3*, *SABLES'* still accommodates for these stakeholders. Participant 2D shared an enlightened view with regards to this aspect, whereby they stated that the job description and role of current stakeholders will not be eliminated. Rather, the participant anticipated that these roles will be restructured and modified, sharing the same views as this study (*Section 4.6.3)*. In addition, *SABLES'* created the role of a BCCA (see *Figure 6.3, swim-lane 3*), which would be a stakeholder possessing both technical and conveyancing knowledge and responsible for the creation of the smart contracts. Therefore, allowing these stakeholders to add more value in areas they perhaps were not traditionally able to, due to time constraints. Participant 2D stated:

> *"I think there are really skilled individuals whose time is being wasted with redundant tasks and it's for reasons of trust. When we find a technology that can alleviate the trust argument then those people can get on with more value adding activities. They don't not have a job, but it means they can now do other things better."*

Smart contracts represent one of the three key components for *SABLES* (*Section 6.2*). *SABLES'* makes use of three smart contracts, a Deed Smart Contract, an Escrow Smart Contract, and a Bond Smart Contract. These contracts are programmed to ensure that the transactions are

compliant with South African conveyancing's regulations. This is evident in *Figure 6.3, Group 3*, *swim-lane 2* and *swim-lane 5*, where the Escrow and Deed Smart Contracts included the transfer duty receipt, rates and clearance and SPLUMA certificates, offer to purchase contract, and the property title deed, which are all key components needed in South African real estate transactions. The efficiency of the smart contract, coupled with the fact that these contracts having jurisdictional conveyancing regulation coded within, permits *SABLES* to offers a revolutionised mechanism for real estate transactions. On top of the Escrow Smart Contract holding the funds and title deed, it will manage the status of the transaction, providing transparency regarding the different stages the transaction goes through. This guides all stakeholders through the transaction from start to finish as a stage begins; while it is in process; and when it is completed. In *Figure 6.2*, *swim-lane 4*, the bond smart contract manages the mortgage and bond process of obtaining finance between the buyer and the banks. Here, smart contracts will ensure that unless guarantees are provided, allocated funds will not be distributed. Further, the bond smart contract will manage the pay-back aspect, alerting stakeholders on the platform as to the performance of their bond. The *Deed Smart Contract* ensures the completion process is executed in terms of confirming all documents are present, all funds are available, and all conditions have been met before finalising the transaction. Consequently, the transfer of the land title deed and funds is automated. It is clear that these smart contracts can also reduce escrow costs that are typically added to conveyancing fees, because these contracts now manage the payment and distribution process instead of being managed by a third-party conveyancer.

8.3.3 Blockchain Implementation Strategies

Section 8.3.2 clarified the suitability and applicability of real estate transactions for blockchain technology's use. However, the technicalities behind blockchain technology mean that there are various *Blockchain Implementation Strategies*, representing the third main theme. The business process into which blockchain technology is integrated will determine the degree of '*Blockchain's Intrinsic Value Proposition*' upon implementation, in other words, is it public or private and/or how transparent the network should be, etc. This section of the discussion will deliver an interpreted explanation regarding how *SABLES* has implemented blockchain technology, compared and contrasted to the views of the interview participants. The discussion will be centered on the architectural design (public or private) and the storage capabilities (on-chain, off-chain, or hybrid). Once implemented, blockchain solutions will need regulatory acceptance and compliance, which will be briefly discussed. The following discussion will

assist in answering the main research question as well as the fourth sub-question (*research question 1.4*).

Table 8.3: Defining Blockchain Implementation Strategies as a Main Theme

Candidate Theme		Sub-Theme	
Blokchain Implementation Strategies	This candidate theme examines how blockchain-based solutions can be integrated into business practices. There exist numerous techniques which could be applied when incorporating blockchain technology into a business process.	**Blockchain Architectural Design**	There are public and private blockchain's. Based on the specific use-case, the degree of public-witness or privacy stemming from the blockchain, must be decided.
		Blockchain Storage Capabilities	Determining what data and information gets stored on-chain against what is stored off-chain should be known prior to implementation. A common strategy is a hybrid approach, linking on-chain and off-chain data. However, ensuring that the correct data is migrated onto the blockchain represents a challenge.
		Blockchain Regulatory Framework	With new technologies come new regulations. The legality and regulation around the use of blockchain technology in business practice hinders mass adoption.

There are intricate technicalities behind blockchain technology meaning that its integration into a business process can be done in various ways, depending on the specific business requirements. When developing and implementing a blockchain-based solution, the following questions need to be answered:

- Will this blockchain network be public or private?
- How will this blockchain network achieve consensus?
- Is a crypto-currency incentive scheme necessary for every blockchain solution?
- Will the network's data be stored on-chain, off-chain, or will a hybrid approach be used?

Blockchain Architectural Design: When integrating a blockchain-based solution it is important to determine the nature of the blockchain network. Will the network be a public network or a private-permissioned network? The answer to this question is determined by the use-case. Bitcoin, for example, represents a completely public and decentralised blockchain network due to its motive of providing a global digital currency. The Bitcoin white paper[20] demonstrated a public blockchain, illustrating the most idealistic form of blockchain's capabilities, as discussed above in *Section 8.3.2*. As *Figure 6.3* depicts, the *SABLES* transaction

[20] https://bitcoin.org/bitcoin.pdf

platform consists of *six main swim-lanes,* and the sub-process in *Figure 6.2* depicts *five main swim-lanes*. These swim-lanes represent the stakeholders (or integrated systems) that are involved in the transaction process and part of the *SABLES* network. Here, the stakeholders involved represent the nodes. Therefore, through the business process model it can be seen that the *SABLES* network depicts a transaction platform operating on a blockchain system that is *public to those within the permissioned and private network,* representing a consortium blockchain network.

Consortium Blockchain: According to the Merriam-Webster (2011) online dictionary, a consortium is an association of individuals, entities, or organisations. Therefore, a consortium includes a select number of stakeholders with the objective of participating in a common process or activity (a South African real estate transaction) and achieving a common goal (successfully completing a South African real estate transaction by transferring real estate ownership and funds). A consortium-based blockchain represents a hybrid approach between a public and a private network. A consortium-based blockchain is primarily used for business operations, and this is no different from what *SABLES* intends to provide, a blockchain-based transaction platform which can conduct the necessary business processes needed to complete real estate transactions. Consortium-based blockchain solutions adopt a hybrid network approach whereby the network is public and open amongst pre-defined nodes within a specific, and private network. The pre-defined nodes of *SABLES* are evident in the various swim-lanes in *Figures 6.2* and *6.3*. These stakeholders will be present throughout the transaction, and constantly kept up to date. Further, the openness and public nature of the blockchain system amongst the nodes, within the private network, can be seen at the end of each swim-lane in *Figure 6.2* and *Figure 6.3* whereby all final transactional documents are distributed to all participating stakeholders.

While real estate transactions represent a business process, they do not represent a completely private business process, one which can be curated for by a single private institution. Such a private entity is currently not able to provide the guarantee of a title deed, as this is something that only national systems offer. Instead, these transactions involve numerous stakeholders and entities from both the private and public sector, thus proving the collaborative nature of real estate transactions. It is for this reason that *SABLES'* employs a hybrid consortium-based blockchain approach. This approach permits for transparency and accountability within the network. Here, stakeholders are able to identify the stage of the transaction and to whom the transaction is currently reliant upon for information. This prohibits any single entity or stakeholder gaining complete control and influencing or manipulating the

processes involved. Participant responses concurred with the architectural design of *SABLES*, stating that a consortium-based approach is common when implementing blockchain to tackle business process problems. Participants also stated that consortium-based blockchain solutions work better due to the following reasons:

- These implementations tackle business processes that are internally more manageable by a collective group of stakeholders.
- Consortiums possess more control over the compliance and regulation and can ensure that processes are carried out accordingly.
- A consortium-based approach allows for a more controlled environment when managing a business process on the blockchain as a permissioned blockchain means that only trusted stakeholders/nodes are allowed to validate transactions and add blocks. These trusted stakeholders consist of the pre-determined stakeholders involved in the respective swim-lanes in *Figure 6.3* and through distributed consensus, will approve transactions and blocks.
- Such use-cases (smart contracts or digital record-keeping of transactional data) do not pose the threats to national governments that the Bitcoin blockchain does.

SABLES' represents a platform on which to conduct a specific business process between a select number of stakeholders, a hybrid consortium (public and private) corporate process. The contents within a specific transaction being conducted on the platform will not be made publicly available to those outside the network. This implies that complete decentralisation and distribution beyond the identified stakeholders is not likely. *SABLES* is also not a completely private blockchain granted to a single entity. Instead, *SABLES'* offers a blockchain-based solution suited to serving the needs of and enhancing the transaction for relevant stakeholders in the ecosystem (*Section 8.3.2*). These nodes will represent the stakeholders necessary for South African real estate transactions. To highlight the above points, Participant 2C stated:

> *"A permissioned blockchain is great for a consortium in an industry where they just want to make sure that, of the people taking part in the network that they want to select, none of them have an outsized control of the network and I think that is a legitimate use case."*

Consortium Blockchain Reward Structure: Once the architectural design of *SABLES* has been clarified, the study investigated the need, or lack thereof, for a crypto-currency economic incentive scheme. When it came to cryptocurrency reward schemes, participants stated that these are more applicable to public blockchains. Such incentive schemes and reward structures are crucial to highly decentralised and distributed networks, where nodes are actively mining. In private or consortium blockchain networks, the mass mining aspect falls away. Does *SABLES* need a cryptocurrency to reward its users? The answer to this question is no, at least at the current stage of this research. This is because the purpose and the use-case of blockchain's utilisation has now changed. Blockchain and crypto-currency are not co-dependent on one another, blockchain can and does exist without crypto-currency, as mentioned in *Section 4.5.3*. *SABLES'* represents a transaction platform for an enhanced business process that provides clients with a service: an alternative and more efficient platform on which to conduct South African real estate transactions. Consensus in this blockchain network is not reached through the process of mining, wherein nodes are rewarded with cryptocurrency. Rather, the incentive is in conducting better business processes with the reward being enhanced transaction efficiency and security, leading to increased transaction turnover time and thus, higher revenue. This was reiterated by participant 2E who works as a blockchain consultant for an internationally recognised organisation. Their experience with blockchain-based solutions has shown that reward comes from more efficient business processes, as blockchain attempts to better the service being delivered, rather than gain some form of cryptocurrency reward for customers or clients. Through blockchain, the stakeholders will reap the rewards of blockchain's characteristics, as discussed in *Section 8.3.2*. What the stakeholders in the network will get is:

- Blockchain as a secure database which acts as a layer of credibility, providing a guarantee that their data is cryptographically secure. This can be seen by the *SABLES* blockchain system at the bottom of *Figure 6.3*.
- The certainty that their hashed data is immutably stored or represented on the blockchain. This provides public witness, meaning that there is transparent accountability which could prevent tampering and manipulation of documents and records. This entails data being hashed to the *SABLES* blockchain. For example, the Escrow Smart Contract and subsets of the contract in *swim-lane 4*, *nested swim-lane 2*, are hashed onto the blockchain.

- The ease of transactional documentation being made available through distributed off-chain database storage amongst all nodes.
- The security of automated smart contracts that can ensure concurrent delivery versus payment. This is illustrated by the use of the *Escrow* and *Deed Smart Contract* in *Group 3*, at the end of *swim-lane 4*, *nested swim-lane 1* and *2*, which deliver concurrent actions (title deed being automatically transferred as funds are paid).

Table 8.4: Public Blockchain vs SABLES Blockchain

	Bitcoin Blockchain	***SABLES Blockchain***
Incentive Scheme	• Nodes are incentivised to mine as there are rewards that they can receive.	• Nodes are incentivised to transact through SABLES, as business processes can be conducted in a simpler manner with enhanced capabilities.
Reward Structure	• Miners are rewarded in cryptocurrency.	• Nodes are rewarded through more efficient business transactions. Businesses and stakeholders utilising *SABLES* are conducting business processes more efficiently, thus resulting in increased turnover time.

All of these benefits result in an increased level of trust amongst stakeholders and enhanced efficiency of the transactions. Real estate transactions will continue to be conducted with or without blockchain technology, but the study concluded that with blockchain's integration, this business process can be significantly improved. The consortium network will consist of stakeholders in a business transaction whose goal is not to earn cryptocurrency but to utilise blockchain technology to aid their business processes, resulting in no need for a crypto-economic incentive scheme.

Achieving Network Consensus: As mentioned in *Chapter Six*, the *SABLES* network approves transactions and data through distributed consensus amongst the stakeholders (*Figure 6.3, swim-lane 1–6*) whereby there must be joint verification and agreement regarding the blockchain's data. A distributed consensus mechanism implies that nodes will receive a message of a transaction or a block of data prior to the data being added to the blockchain. Together with the prior information (which is verified and approved on the blockchain), stakeholders will determine the legitimacy of potential new information. This is done so that each node can then make a decision on whether or not the data should be accepted. Each decision is then shared amongst the network of stakeholders where joint consensus is needed. Participants also recognised the potential issue of a lack of active contribution and participation from the nodes in the system, who may not act in the best interests of the transaction when

participating. The study concluded that the value of the service which that will be derived (transparency, security, and efficiency) justifies the use of the approach and consequently the blockchain ledger will be adequately maintained. The study believes that in a consortium blockchain, group consensus amongst all stakeholders must occur before documents or their hash values are added to the database or blockchain respectively. Participant 3F stated this approach enhances transaction security and transparency, qualities vital to *SABLES*. This joint and distributed approach, whereby independent verifiers must come to an agreement on validity was chosen because:

- The advantage of having various stakeholders who can approve a block is that the transaction platform and processes within will be more transparent.
- By giving control to approve the block to those who are contributing and participating in the transaction, the transaction platform will ensure a high level of integrity.

Chapter Four, *Section 4.2.4*, stated that a Proof-of-Stake (PoS) consensus mechanism could be adopted for a blockchain-based real estate transaction platform. This is because PoS utilises '*validators'* and not '*miners'*, is more energy efficient than Proof-of-Work (PoW), is more decentralised than PoW, and is less expensive due to not requiring computational equipment. However, when using a PoS consensus protocol, nodes will deposit cryptocurrency as their '*stake*' to the network. Once the chosen node approves the block, they will be rewarded with the transaction fees from that block. Earlier in this discussion it was stated that *SABLES* will not employ a cryptocurrency economic incentive scheme. Therefore, the study chose the option of distributed consensus, whereby the principle functionality of consensus will be employed by the blockchain. Should cryptocurrency be introduced to a platform like *SABLES* in the future, then a PoS represents a fitting consensus algorithm for a consortium-based blockchain.

Participant's further stated how Proof of Authority could act as an appropriate consensus mechanism, which delivers and approves transactions based on nodes' identities as a stake. Certain nodes can possess certain transaction rights and either act as controllers of the network, users of the network, or observers on the network. However, the study decided against this approach due to the fact that it centralises trust and decisions, a concept that this study is attempting to move away from. Such a consensus algorithm, and the study of various others, represents another area that can be examined in future research.

Blockchain Storage Capabilities: Blockchain is a ledger which stores transactions.

However, these transactions consist of many subsets of data (contracts, offer to purchase, transfer duty receipts, and so on). Therefore, when implementing blockchain-based solutions, the storage of data needs to be determined. The storage options which emerged were on-chain storage, off-chain storage, or a hybrid approach to storage that involves both options and links them together.

On-Chain Storage: A common misconception regarding the architecture of blockchain is that blockchain can act as traditional databases do, storing large amounts of data in the form of documentation, then combined with the benefits of blockchain's security. However, Blockchain and PropTech participants made it clear that the blockchain ledger's main purpose to store lists of transactions as well as references to transactional meta-data (such as a hash value of a digital transaction document) rather than housing gigabytes of actual documents themselves. These opinions led the research to interpret the following.

- Blockchain is not 'database 2.0' in that it is not meant (nor created) for housing and storing large amounts of documentation. A blockchain ledger is typically not capable of such storage as well as applying enhanced levels of security to this volume of data. As a result, a mass database migration to a blockchain ledger is not recommended.
- On-chain storage of all documentation is inefficient as it is expensive (with regard to storage fees).
- On-chain storage of all documentation can lead to transparent exposure of sensitive information (such as ID numbers) amongst a distributed network.
- However, as transactions consist of numerous important and vital documents and contracts, simply storing an on-chain record of the transaction alone introduces a problem with blockchain as a ledger, in that there is a lack of complete information and transparency.

On-chain storage is ideal for storing unique identity values or specific segments (subsets) of information, such as digital signatures, digital identities, and hash values of documents. Therefore, in terms of real estate transactions and the data collected throughout these transactions, it is be recommended to store hashes of the digital documentation (and/or contracts) on the blockchain. Further, if documents and/or contracts are broken down, then the blockchain ledger can also store subsets of this data, as these subsets will likely be a lot smaller in size. This offers immutability of the generated hash values, which in turn adds increased

security to the referenced documents. Blockchain is preferred for its capability in storing a reference to a transaction or a document. This reference can provide a timestamped record which can prove that a transaction occurred, as well as prove (through a hash value assigned to a blockchain transaction) that documentation was added to transaction. Therefore, storing hash values, which are connected to transactions on-chain is a more efficient and applicable approach to utilising blockchain. This approach still provides benefits of immutability and security. This approach can be seen in *Figure 6.2* and *Figure 6.3* whereby digitised and digitalised documents, smart contracts, and closing transactional data, are all hashed onto the *SABLES* blockchain. A more detailed discussion on hash value storage will be provided further on in this section.

Off-Chain Storage: A commonly recommended strategy is that transactional documentation (consisting of gigabytes of data) is stored off-chain. This can occur using traditional databases, either public or private. These databases can then be connected and linked to a blockchain system where a reference of this documentation is stored on the blockchain, through a hash value, and linked to the real estate transaction to which it pertains. However, traditional databases are centralised and controlled. One of the drawbacks in the current real estate transaction process is the speed with which data is transmitted between stakeholders. This is hampered due to paper-based documents being stored in centralised databases, as evident at the end of *swim-lane 5* in *Figure 3.9*. In addition, paper-based documents do not allow for digital signatures and require physical presence on signing. Therefore, linking a blockchain system to a traditional database will not completely solve the problem of 'speed' that this research posed. Documentation needs to be stored in a manner that is accessible to all stakeholders in a transaction. To address this, participants proposed that off-chain data could be stored in distributed databases such as InterPlanetary File System (IPFS)[21] or Filecoin[22] whereby documents and 'bigger-sized' data is redundantly stored in one repository across all nodes. Here, distributed storage amongst selected stakeholders is permitted amongst all nodes in the *SABLES* network. This is shown in *Figure 6.3, Group 3*, at the end of the *swim-lanes*, showing that all stakeholders on the transaction platform are granted access to transactional data.

Hybrid Storage Strategy: In order to store a hash value of a document on the blockchain there must be a link to the database where that document or data is housed. The two

[21] https://ipfs.io/

[22] https://filecoin.io/

systems will have to be connected and linked to one another, which gives rise to a hybrid approach to storage, where the hash value is stored on-chain, the document is stored off-chain and the hash value ID is also stored as a verification record in the off-chain database. This is a recommended appropriate approach for utilising blockchain technology in record-keeping, linking and connecting data sets to a blockchain through an on-chain reference. The generation of hash values can determine whether the data residing in a database matches the hash value that is stored on-chain. In interpreting the participants views towards a hybrid approach to storage, it was summarised that:

- Blockchain is not yet fully capable of acting as the primary database of all information and documentation.
- A hybrid approach is therefore a good practice when adopting blockchain technology to assist with record-keeping of transactional data.
- A hybrid approach is also deemed affordable.
- In terms of implementation and integration, a hybrid approach is manageable and rudimentary to set-up.

Blockchain can now store and manage very specific aspects of the data, key data points where veracity and verifiability are of paramount importance. As noted earlier, this is done through generating a unique identifier, a hash value, which provides a representation of said data. Blockchain storing this hash value, offers increased security. In a scenario where the blockchain may be linked to a private database, the generated hash value can be published to a public blockchain, allowing for public witness by all nodes in a network. This means that private data can still be publicly exposed as the correct data. As a result of the public hash value, malicious or tamper-based activities cannot go unnoticed. This gives rise to the concept of ‘trust without access’, a term coined by the study.

Hash Value Storage: As mentioned in *Section 4.2.3,* a hash value is a unique identifier (and output) that is generated from a given input. It is essential to note that *it is the hash value that is being stored on the blockchain which is immutable and tamper resistant, not the document from which the hash value was generated*. Documents that are stored off-chain, in a centralised or distributed database, may still be susceptible to tampering (depending on the characteristics and capabilities of the storage systems) and immutability of the document is not guaranteed, nor is its eternal existence. Thus, if the document that is linked to this hash value

undergoes tampering or manipulation, this hash value stored on-chain will not change, as blockchain is immutable. However, safety can still be achieved because when a new hash value, *for the same document*, is requested and generated (through a SHA256 hash generator for example), it will be possible to determine whether *the prior hash value matches the new hash value*. If there is a mismatch between the two hash values, it can be concluded that the contents of the documents have been altered, alerting the stakeholders. A hash value is a one-way relationship, meaning that it is possible to generate a hash value from a document, but it is not possible to determine what document a certain hash value pertains to, further enhancing privacy and security. There is benefit in storing on-chain hash values amongst a distributed network in the same way that there is benefit in redundantly storing off-chain data across stakeholders, the higher the level of distribution, the higher the level of trust and the reduced danger of records and documents disappearing. When various stakeholders have access to documents or verification of said documents, trust in those files will grow and stakeholders can be confident that transaction data is authentic.

However, this gives rise to a concern that was raised by participant 3F: what if the original document itself is erased from the off-chain database, what good will a hash value be in recovering the contents of the document? If this were to happen with a title deed, as seen in *Figure 6.3, Group 2, swim-lane 5,* then it becomes difficult to prove ownership based on the hash value because its value alone is of little significance. The document itself cannot be re-generated or determined from a hash value due to hash values being irreversible. In interpreting this challenge, the research states that this can be addressed by:

- ***Storing subsets of documentation data along with the hash value on-chain.***
  It is possible to store subsets of digital documents or data along with the hash value that is stored on-chain. These two references would be stored in conjunction with another, which would be linked to the same transaction. Here, a digital signature and the hash value could be linked to the rightful address of the property owner, the rightful entity to whom the title document belongs. If the original document were to be erased, at least the signature could tie the hash value back to an individual, assisting in determining what and who the hash value represented. On this point careful consideration needs to be taken in deciding what critical subsets of data, or important identification information will be stored in the blockchain ledger with the hash value. This concept, as well those relating to the hybrid approach, is visually depicted in *Figure 8.2*.

A hybrid approach means that the documents themselves are stored either in centralised or distributed databases. To realise the benefits of blockchain, hash values must be stored on-chain as this requires less storage space. Depending on the storage mechanism employed, there may not be complete decentralisation and transparency of the original documents and data. However (and in conjunction with addressing the issue of 'erased documents/data'), to achieve a certain degree of benefit relating to decentralisation and transparency of original documents, subsets of the data can also be stored on-chain and be publicly available to the network. This approach (as can be seen in *Figure 8.2)* means that unique data can be stored on-chain without requiring large storage space.

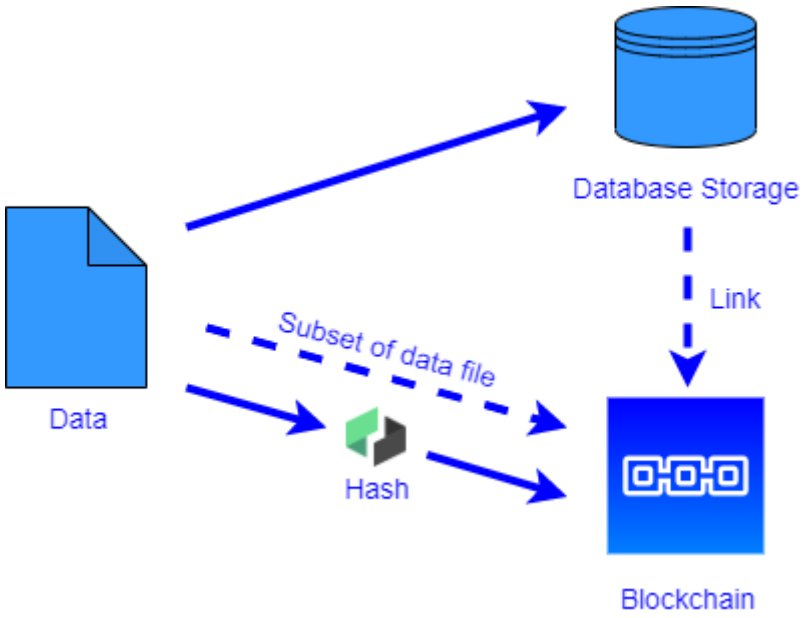


Figure 8.2: Storing Subsets and Hash Values of Data On-Chain

- ***Utilising public key cryptography with hash values.***

  A recorded hash value will also employ public key cryptography, meaning that the public key of the rightful owner will be assigned to the hash value on-chain, while the owner possesses their private key. If a title document is subsequently erased from its database, it would still be possible to identify the public key assigned to the hash value. This is over and above the subsets of data mentioned previously. This allows for the provenance of the owner to still be realised, identifying the rightful owner. If the original subsets of data and the public and private keys are trusted, then this approach can act as a unique selling point for always being able to provide provenance of an asset

on the blockchain. This data becomes trusted because it was verified as correct on the blockchain network by all the stakeholders in the ecosystem.

- ***Distributed file storage and access.***
  Storing documentation in a private database comes with risks, if erased, there are no other points of access. Alternatively, this data can be stored in a manner that permits distributed storage and access and eliminates centralisation. This can be achieved through a distributed file storage system which is linked to the blockchain. The study does not posit complete decentralisation and distribution of real estate transaction data but rather, distributed access to all stakeholders.

Through the illustration in *Figure 6.3* it is clear that the *SABLES* transaction platform adopts a hybrid approach to storage. This is evident through two scenarios. Firstly, for enhanced security purposes, all transaction contracts and documentation are immutably hashed to the blockchain and linked to the transaction to which they occur. Although not specifically present in *Figure 6.3*, these hash values are stored alongside unique (and smaller) subsets of data files pertaining to the transaction. This implies on-chain storage of unique information. This is shown in *Group 2, swim-lane 5* whereby the digitised original title deed is added to the Deed Smart Contract and then hashed onto the blockchain. This is further seen in *Group 3, swim-lane 2* whereby an Offer to Purchase contract is created and its hash value is stored on-chain. Secondly, at the end of each swim-lane in *Group 3*, all transactional data and documentation is distributed and accessible across all nodes on the *SABLES* transaction platform, indicating distributed off-chain database storage. Therefore, it can be concluded that *SABLES'* has its own off-chain distributed database. This hybrid approach is further evident and applied in the *SABLES* model in *Group 3*, *swim-lane 5, nested swim-lane 3*, and relates to the '*Land Registry Official*' stakeholder. Here, property ownership from the official, and current, Deeds Office (and therefore, their traditional and centralised database) is hashed to the *SABLES* blockchain. The reason for this was explicitly stated in *Section 8.3.2*, when discussing blockchain's intrinsic value proposition. Adding to this, interpretation of participant responses gave rise to the concept of 'transparent trust'. This applies to government level databases and record-keeping systems where transparency is imperative. The centralised systems and databases that currently house real estate transactional data, such as the Deeds Office, is conceivably an area where transparency is needed most. This is because when it comes to an asset as vital as property, citizens should be provided with an undisputed record of land ownership. This alone proves why a blockchain-based land registry is attractive. Participant views stretched beyond simply acknowledging the

record-keeping applicability to the positive impact that this method of real estate record-keeping can have, which allows for storing and tracking transactional data and title deeds either directly on the blockchain or through a hashed reference which is stored on the blockchain.

Taking into account the comments and opinions with respect to on-chain storage above, the study recognised that a hybrid approach is more effective. The *SABLES* network employs a distributed file storage database, improving on the centralisation and control of traditional databases. A hybrid approach to storage maximises storage efficiency and costs. *However, the hybrid approach has one key issue: it creates two sources of truth.* By storing transactional references in a blockchain ledger and also storing transactional data and documentation in a database, this means that transactional records now exist in two places (see left-hand side of *Figure 8.3* below). Ultimately, blockchain is intended to prove that information and data is correct and has not been tampered with. Therefore, in an ideal scenario, a blockchain should have direct access (complete on-chain storage) to all of this data and if possible, this approach of 'complete storage' should be implemented. However, based on discussions above, this is currently not plausible nor is it scalable. For this reason, the *SABLES* transaction platform adopted a consortium database as its distributed database for off-chain storage while. A consortium database also allows for all transaction records (in a hybrid approach) to be stored in one place as the blockchain ledger is integrated and stored inside the database (*right-hand side* of *Figure 8.3*), illustrating (what the research believes to be) the best currently available solution to the issue above. Participant 3F, a front-runner in the PropTech sphere having worked on some of the most recent developments in blockchain-based transactions, supported the notion of a consortium database by stating that it brings data and 'truth' to one place. At the time of writing, there was only one consortium database system which permitted the integrated storage of the blockchain ledger in the database, namely Postchain[23]. Postchain represents what is termed 'a consortium database', possessing the capabilities of both a database management system as well as the integrated security of blockchain technology in combination. *Figure 8.3* was adapted from the conversation with participant 3F as well as documents put forward by Postchain. While not specifically stated in *Chapter Six, Figure 6.3* coupled with references to *SABLES'* storage techniques above, show that *SABLES'* employs a consortium database. As a result, the *SABLES* hybrid approach to storage in *Figure 8.3* can be summarised as:

- A consortium database is used for distributed off-chain storage of digitised transaction

[23] https://chromaway.com/products/postchain/

documentation amongst all stakeholders.

- However, a consortium database also permits for the *SABLES'* blockchain ledger and its data to be stored inside the *SABLES'* consortium database itself which links the two together and provides one source of data and truth. Therefore, the state of the blockchain and the database can never deviate from one another which provides enhanced security, immutability, and integrity of data.
- Hash values and subsets of data files are stored in the blockchain ledger. The hash value ID will be added as a record to a transaction in the off-chain database.
- When off-chain data are published, the original data will be stored in the distributed peer-to-peer file sharing database and a blockchain transaction will be created which contains that data's hash value.
- To retrieve off-chain data, the immutable hash value will be extracted from the blockchain and used to fetch the content it is linked to from the database. Verification between the blockchain hash value and the hash ID stored in the database will occur to ensure validity of transaction information.

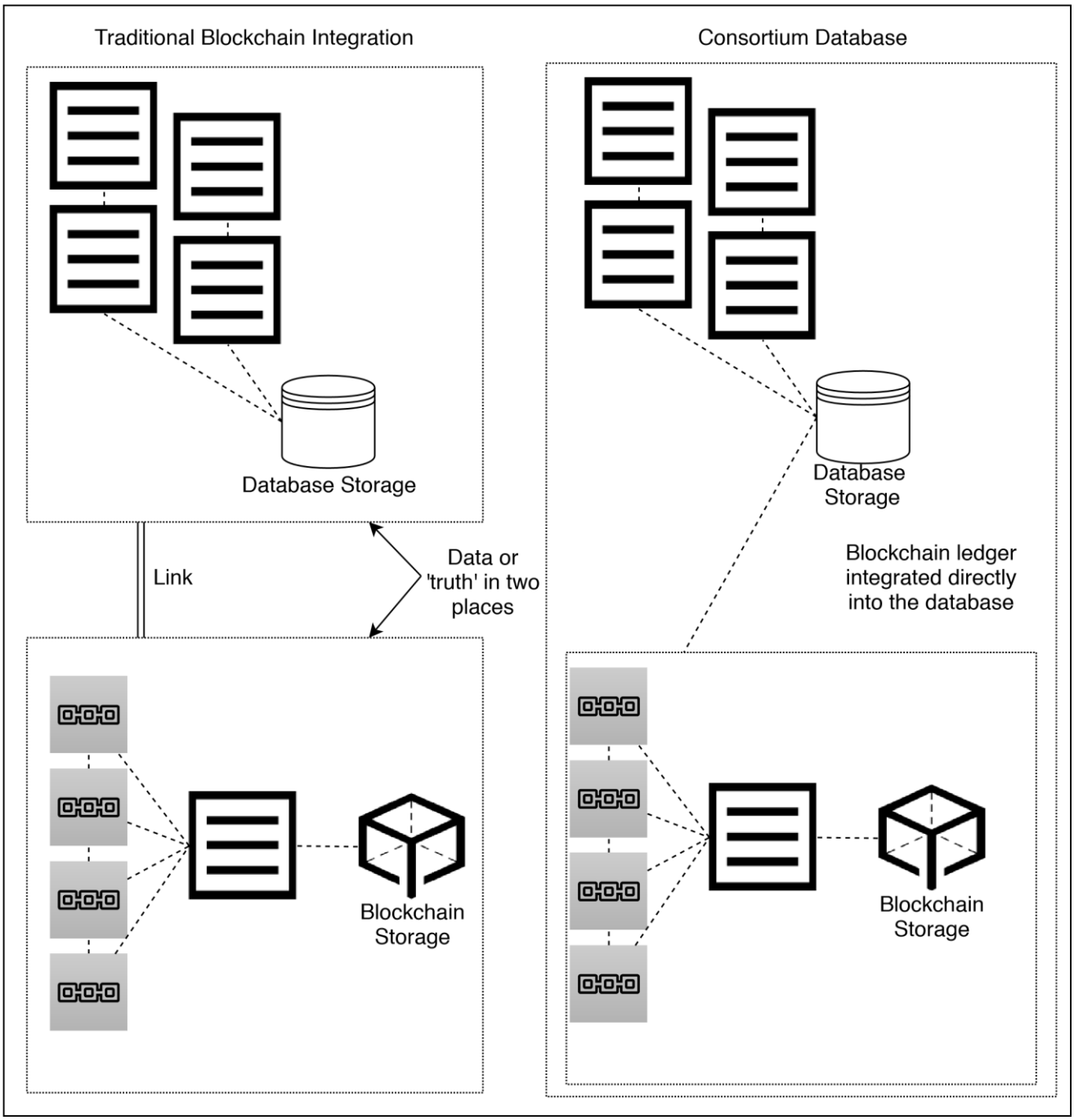


Figure 8.3: Hybrid Consortium Database Storage Mechanism

Storage Challenges: Blockchain technology can be described as a verification system. The ledger will perform as it is programmed, immutably storing the information and data that it is fed. Inputted data into a blockchain ledger will be verified, validated, and recorded as correct on-chain. However, this does not guarantee that the initial information is true. It is vital to ensure that the data being migrated to the blockchain is accurate and correct and corresponds to real world information. The limitations of blockchain's data, such as unique hash values, is that they can be generated off bad data. This issue was discussed in *Section 4.6.2*, stating that

the initial information which is captured to the blockchain needs to be correct, preventing corrupt data being stored in an immutable ledger. A base and starting point needs to be achieved, where all stakeholders reach consensus on what information is correct and incorrect. Interpretation of this aspect led the study to develop two terms: technical workflow and business workflow. Blockchain will abide by the technical workflow, immutably storing the data that it is fed. Business workflow, on the other hand, is perhaps more important as it aims to ascertain where this initial information comes from, ensuring that the correct processes are in place. If a trusted business workflow exists, with trusted information stored in its databases, then the information that business processes will produce will not be disputed. In turn, this will lead to an increased trust in the technical workflow. The data entering *SABLES* will be verified and validated by the nodes involved in the transaction. The study identified this approach as one of the selling points of correct and protected data due to the fact that the blockchain ledger must be approved by various nodes, making collusion unlikely.

This allowed the study to posit that a blockchain-based system is only as strong as the people using it. A blockchain ledger is: (1) as strong as the information that it is fed; and (2) as strong as the nodes in the network who validate its information. Nodes commit time and resources to blockchain and the network survives on this joint participation, whereby entries to the ledger are either verified or rejected. While the blockchain operates through trusted mathematical and programmed algorithms, it is the nodes who reach consensus amongst one another. Therefore, the more a blockchain is maintained and interacted with, the more trust the network, and the nodes within, will gain. Essentially, this depicts how the blockchain is actually a social network.

Blockchain Regulatory Framework: In *Section 4.6.4* the issue of legality was mentioned. Until blockchain-based transactions and records are deemed lawfully acceptable and admissible in a court of law, there will be resistance in conducting such operations. Such a framework could assist in solving issues around blockchain governance and compliance. While this represents a key concern, legal implications are beyond the study's scope.

8.3.4 Information Technology Assimilation

The processes discussed in this chapter have revealed the business process applicability of real estate transactions as the most suitable implementation strategies. However, to integrate blockchain technology into this business process involves *Information Technology (IT) Assimilation*, representing the fourth main theme.

Table 8.5: Defining Information Technology Assimilation as a Main Themes

Candidate Theme		Sub-Theme	
IT Assimilation	Technology assimilation refers to the process whereby businesses move from initial awareness of the technological benefits to formal and full-scale adoption of new technologies. Here, organisations will incorporate these new technologies into their business processes. Assimilation of technology affords organisations the chance to enhance key business processes, resulting in more efficient business practice and conduct (Setial, et al., 2011).	**Blockchain Agnosticism**	To be system agnostic means that a specific system, or technology, can function within, and alongside, different technological environments. Blockchain technology is not mutually exclusive and can be incorporated alongside other systems and software.
		Digitisation and Digitalisation	Technological advancements have meant digital documents and records of transactions can be maintained. Digitisation refers to the process of converting paper-based records into a scanned, digital soft copy. However, this is just to provide a digital back-up of the original document. Digitalisation refers to the creation of digital documents which can be interpreted and automated by computer programs as well as stand as original electronic documents (Baum, 2019).
		Blockchain Adoption Factors	When incorporating new technology into business processes and transactional methods there will be both adoption drivers and adoption hindrances.

Blockchain Agnosticism: When integrating technology into an organisation's current business practices, it is important for this integration to occur in a seamless manner. Furthermore, it is equally important to ensure that new technology is not mutually exclusive from everything else but that different technologies can work in tandem with one another. This illustrates the connection that *'Blockchain Implementation Strategies'* and *'Business Process Applicability'* have with *'IT Assimilation'* in the final thematic map. Participants stressed how blockchain technology should not be mutually exclusive from every other system in a business process but rather, be able to connect to off-chain systems as well. The more agnostic (and integrable) blockchain technology is, the more successful its implementation will be, thus illustrating the connection between the two aspects, *Blockchain Agnosticism* and *Blockchain Implementation Strategies*, in the final thematic map (*Figure 8.1*). Blockchain simply acts as another layer of technology in a business, a layer of credibility that guarantees data to be correct. This can be seen in the *SABLES* model in *swim-lane 5*. *Swim-lane 5* illustrates three stakeholders and their respective systems, South African Revenue Services, municipalities and councils, and land registry officials. These stakeholders and their respective systems have successfully integrated into the *SABLES* blockchain system, allowing for all stakeholders to interact on one transaction platform.

Digitisation and Digitalisation: Blockchain represents a *digital* technology that stores *digital* transactions in a *digital* ledger. Therefore, in order to utilise blockchain to its full potential, current processes must first become digitised. The following discussion answers the

main research question as well as the fourth sub-question (*research question 1.4*). Blockchain has the capability to reference these digital records and documents (through hash values) and store this reference on the blockchain itself (*Section 8.3.3)*. Real estate transactions involve multiple contracts and documents which require record-keeping. The majority of these processes are currently manual, and paper based. Paper-based processes bring with them various challenges, including time-consuming transactions due to waiting on physical documents, mistakes through human error, fraud through document manipulation, storage concerns due to warehousing of physical files, and associated risks that come with the storage of physical files, such as natural disaster or fire. Group One participants concluded that the storage of mass paper-based documentation has detrimental effects in real estate transactions due to loss of documentation and possible inability to quickly find and allocate files. Participant 2B also stated that paper does not allow for features such as push-notifications, something that smart contracts can offer. Conveyancers have called for technological innovation, but for this to happen, digitisation is needed – illustrating the relationship that is visible on the final thematic map. '*Technological Innovation*' requires '*Information Technology Assimilation*' and requires the digitisation and digitalisation of transactional data. It illogical to consider moving towards 'fourth industrial revolution' type technologies, such as blockchain, without first escaping the archaic paper-based processes that the sector is trapped in. Thus, the first goal is for these processes to become present in the digital world.

Digitisation, as defined in *Table 8.4*, represents a digital copy of a paper-based original. However, final documentation at the South African Deeds Office needs to consist of the original hardcopies, actual printed out pieces of paper. Digitisation of documentation means that there is now a digital back-up, and documents, albeit not the originals, are more easily accessible. Particsipants also stated that fraudulent and corrupt activities can be reduced through digitisation of documents. However, digitisation doesn't permit for functionalities such as digital signatures, arriving at one of its shortcomings. Further, it does not assist in the streamlined transmission of original and authentic transactional documentation.

The study recommends systems should strive for complete original digital activity whereby business process can leverage digital data and information to enhance efficiency. Once digitisation has occurred, this data and information should be formatted in such a way that allows technological systems, programs, and contracts to understand and read this data which leads to automation and increased efficiency, representing digitalisation. Ulitmately, digitalisation should see blockchain-based records, documents, smart contracts, and transactions as not only digital processes and documentation but original, official, and legal

digital sources. This concurred with 13 of the 16 interview participants, who envisaged the scenario of relying solely on digital records, admitting that the key objective should be digitalisation and the recognition of blockchain-based records as legally binding. While the term 'digitisation' was mentioned in the interview questions for Group One (comprised of three participants), there was no direct mention of either of these terms in any of the questions for the remaining groups. Therefore, the other 10 participants recommended digitisation on their own accord, leading the study to posit this theme as the second latent theme. Due to prior unfamiliarity with the term 'digitalisation', the research attempted to discover its prevalence (or lack thereof) amongst literature. The concept of digitalisation appears to be as novel as blockchain's involvement in real estate. Baum (2019, p.05) defines digitalisation as:

> *"Digitalised data enables computer programs to automatically execute tasks without the need for human intervention. In practice, this means completing forms online to enable software processes to act upon the machine-readable, 'intelligent' information."*

Digitisation is noticeable in two instances in the *SABLES* model. Firstly, in *Group 2, swim-lane 5, nested swim-lane 3,* the original paper-based title deed is scanned and added to the transaction platform and hashed to the blockchain system. Further, *nested swim-lane 1* and *2* from the same group and swim-lane, show the transfer duty receipt and the RCC and SPLUMA certificates. These documents have simply been scanned and added to the platform. However, both of the above scenarios eventually result in digitalisation. When these digitised documents are added to their respective smart contracts, they become digitalised. This is because smart contracts represent one of the key components of the transaction and through these contracts, transaction finality occurs. Therefore, it is the smart contracts and their contents which illustrate a registered and legal transaction, and therefore digitalisation. On transaction completion, all official documentation is made available to all stakeholders, which can be seen at the end of each *swim-lane* in *Figures 6.2* and *6.3*. This closing data is digitalised.

It can be said that digitisation does not assist with automation of traditionally manual processes, but the study postulates a scenario where these two objectives (digitisation and digitalisation) are met and achieved at the same time. A phase beyond the mere digitisation of data is necessary to achieve significant efficiency. As such, the information and data that real estate transactions will leverage off must be digitalised. Through *SABLES*, documents are digitalised directly to be incorporated with blockchain, allowing *SABLES* the opportunity to

'digitally leap-frog' decades of technologies and bring forth digitalisation for South African real estate transactions. This can be seen in *Figure 6.3, Group 3, swim-lane 2* whereby the Offer to Purchase contract is created on-chain. This provides for digital signatures. Not only can documentation be digitised, the actual real estate itself. This is evident in Group 2, swim-lane 4, nested swim-lane 2 where the real estate property is tokenised. Participant 3G elaborated on this stating how these tokens can act as digital property passports that possess all necessary information related to the property. In interpreting participant's views towards digitalisation, the study deduced that digitalisation is a concept that: ***(a)*** should be achieved; ***(b)*** given the digital age, is expected by transactional parties; ***(c)*** the professionals within the real estate sector would like to embrace; and ***(d)*** the professionals within the real estate sector are pushing for.

Blockchain Adoption Factors: With new technology being incorporated into business processes, there will be both adoption drivers and adoption hindrances. The study noticed that a significant number of the reservations towards blockchain came from those who are unfamiliar with the technology and who lack an understanding of its capabilities. It is possible that while those working in the blockchain space continue to share and spread their passion for the adoption of blockchain, they too are aware of the hindrances that its potential integration may encounter. Areas of concern are a lack of blockchain regulation, education and training necessary for those utilising new blockchain systems, stakeholder buy-in and the willingness to adopt different business processes, and the potential business lost due to personal touch and connection being incrementally decreased through digitised processes. In contrast to this, adoption drivers were also discussed, for example, blockchain's intrinsic value is that it is capable of offering enhanced speed through digitisation and a common transaction platform assisting distributed transparency and availability of data amongst nodes.

8.3.5 PropTech 3.0 Fundamental Success Factors

PropTech 3.0 is defined as the use of emerging and disruptive technologies such as blockchain, in the real estate sector. This was introduced and defined in *Section 4.4.* The study identified three factors needed for blockchain's ultimate success in real estate transactions Theoretical Awareness, PropTech Practicality, and PropTech Regulation. This three-phase approach follows vertical alignment, meaning that in order for the next phase to occur, the previous phase must be completed.

Table 8.6: Defining PropTech 3.0 Fundamental Success Factors as a Main Theme

Candidate Theme		Sub-Theme	
PropTech 3.0 Fundamental Success Factors	For PropTech 3.0 (involving the integration of disruptive technologies such as blockchain) to succeed in the real estate sector, three factors must be attained. These factors represent the fundamental success factors for PropTech 3.0's acceptance and integration into real estate transactions and land registry systems.	**Theoretical Awareness**	Equally as important as practical implementation is the discussion and interest around blockchain's involvement and applicability in real estate transactions.
		PropTech Practicality	Blockchain technology is now moving beyond the hype and discussion and into a phase of practical implementations. These projects, whereby the technology is tried and tested in specific environments, will allow for a greater understanding of where blockchain is best suited and what it is capable of.
		PropTech Regulatory Framework	Until blockchain transactions and smart contracts are declared legally binding, complete stakeholder buy-in and adoption of the technology will be hindered. This is why all blockchain-based transactions that have so far occurred, are still being carried out in the traditional manner. This is because there is yet to exist a PropTech Regulatory Framework which deems blockchain-based real estate transactions and recordings as lawfully acceptable and admissible.

As outlined in *Chapter Four* and *Chapter Five*, the study posits that blockchain technology has made a noticeable impact on real estate transactions and has thus achieved a level of success. However, PropTech participants explained that the success so far has been minimal. While these participants promote blockchain and advocate for its inclusion in real estate transactions, they brought with them a realistic mind-set, describing the different stages of success. This study concludes that true success will consist of blockchain technology changing the way that real estate transactions are executed. The joint accomplishment of the three factors identified in *Table 8.6* will bring ultimate success to PropTech 3.0. While the term 'impact' was used in interview questions (when discussing the current state of blockchain technology in real estate transactions) there was no mention of this incremental approach or the three steps that need to be carried out. Consequently, this theme (and the sub-themes) emerged from interpretation of the data, representing the third and final, latent theme.

Theoretical Awareness: When discussing the current impact of blockchain, participants stated that the success so far lies in the conversations that have occurred and the literature that has been written. By definition, to have an impact means to *effect* or *influence*, in this case, a real estate transaction process. As mentioned in *Chapter Five*, all of the blockchain-based transactions that have occurred, mirror the traditional process of transactions. This is because these are only demonstrations, to prove what the technology is capable of.

8.3 Thematic Discussion and Alignment

Current transactions are still conducted in the traditional manner and processes have not changed. Where current success does lie is in the ongoing dialogue which intends to educate organisations on blockchain, allowing them to develop an understanding of and appreciation for what it could do. The questions that are being posed and answered are:

- What does the technology do and how does it operate?
- What are the technology's capabilities and limitations?
- How can the technology assist real estate transactions?
- How can the technology be integrated into the process in a feasible manner?

This will undoubtedly lead to an increased education on blockchain and from this, knowledge will be constructed. Potential lies in this knowledge being correctly and effectively leveraged. This study represents theoretical awareness, adding to the body of knowledge of how blockchain can assist real estate transaction processes. From this knowledge, organisations can begin putting practical implementations in place, which is what start-ups and pilot projects are doing, leading to *PropTech Practicality*.

PropTech Practicality: In *Section 5.2* the study discussed various blockchain-based real estate platforms. PropTech practicality speaks to the practical works and projects that are currently in place. Three areas where blockchain can assist the real estate sector are:

- Blockchain-based transaction platforms.
- Blockchain-based land registry systems.
- Real estate tokenisation (more applicable to commercial real estate investments where multiple parties can invest and own property).

In terms of areas 1 and 2 above, PropTech participants specified that blockchain should be used for what it was originally intended for, which is managing transactional data and records in its ledger. This is what *SABLES* intends to do and is illustrated in *Figure 6.3*. While *SABLES'* represents a transaction platform, conceptual in nature (one that has not been created nor used in blockchain-based real estate transactions), it aligns with PropTech practicality. This is because the *SABLES* transaction platform represents a platform that could facilitate such transactions and land registry record-keeping. In line with the *Blockchain Architecture* discussed in *Section 8.3.3* these participants stated that there is no need for a crypto-economic

incentive, but the incentive instead lies in improved document management and improved transaction processes. Practical success is yet to be fully achieved in the PropTech 3.0 arena. This is because current real estate transaction processes have not changed to formally adopting blockchain solutions and transactions. Instead, blockchain-based transaction platforms (such as Propy) simply 'mirror' the current process. However, this approach (initially mirroring current transactions) is necessary for the following reasons:

1. Blockchain technology is still an emerging technology that comes with its certainties and its uncertainties.
2. Therefore, regulation that accommodates for blockchain technology in real estate is still minimal.
3. As a result, blockchain technology in real estate transactions is not yet deemed to be the official process in which to conduct transactions.
4. So, blockchain technology must act in parallel to the current process until such a time as it becomes the official method for transactions.
5. This is done to demonstrate its capabilities and to show those professionals in the real estate and the legal sector what it can offer and how it can enhance transactions.

The end goal is for blockchain-based real estate transactions to act as the single source of truth and be legally accepted. To achieve this, there should be a shift in regulation for blockchain technology in business processes and also a shift in conveyancing regulation to permit for blockchain-based transactions, leading to the eventual and proposed development of a PropTech Regulatory Framework.

PropTech Regulatory Framework: Similar to the discussion at the end of *Section 8.3.3*, for blockchain to impact real estate transactions there must be enforced and embraced regulation that allows it to do so. All participants agreed that this is the most important aspect to be addressed in the PropTech 3.0 environment. Participants stated that given the regulation around real estate transactions, blockchain technology would need to fit in with the current conveyancing legislation. Contrary to this, certain participants stated that regulation can, and should be amended for the incorporation of new technologies if these technologies bring major benefits. The findings of this study concur with this viewpoint. If the technical capabilities demonstrate significant positive change which can be measured through value adding activities, then regulation should be altered. This will make room for technical innovation in real estate transactions as opposed to outdated regulation which hampers the productive use of

an innovative and revolutionary technology. The *SABLES* integrated business process model was developed to take into consideration all aspects of real estate transactions. This study was conducted in iterations, moving from the current process to potential solutions. As a result, a holistic understanding of South African real estate transactions was developed. This allowed the research to identify the stakeholders involved, the processes in place, and the documents and data imperative to these transactions. This all-inclusive understanding was taken into account when constructing *Figure 6.3.* Therefore, the research concludes that a legal PropTech framework could easily be developed around *SABLES.*

8.4 SABLES Reflection

- *SABLES'* provides a common transaction platform for all stakeholders which improves transparency and speed for all stakeholders throughout the transaction process.
- *SABLES'* operates through a consortium-based blockchain system which is managed by all nodes in the network, the key stakeholders in the eco-system. Although a consortium approach does not permit complete decentralisation, decentralisation amongst the stakeholders is possible. The justification for a consortium-based blockchain approach was outlined in *Section 8.3.3.*
- *SABLES'* achieves consensus through a distributed and joint consensus algorithm where the stakeholders (nodes) in the network must approve and verify data that is added to the blockchain.
- All documentation (except the original title deed which is stored at the Deeds Office) is digitalised, and contractual processes are run by smart contract, thereby enhancing security and efficiency.
- Once data and documentation leading up to the title deed are verified and approved by all nodes in the network, a hash value is then generated for these documents and this unique hash value is stored on-chain (providing security and immutability of blockchain data). Subsets of the data files are also stored on-chain (*Figure 8.2*). Further, public-key cryptography is employed which links hash values of real estate data to the private key of real estate owners to which that data pertains. The hash values and subsets of data are linked to the same transaction. *SABLES'* goes beyond simply storing hash values and stores important and smaller subsets of data which do not hamper on-chain storage capabilities. This is recognised as one of the unique selling points.

- The documents themselves are stored in *SABLES* consortium off-chain distributed database and are accessible by all stakeholders.
- The *SABLES* blockchain ledger (containing hash values and subsets of data), together with the transactional documentation and data is stored in the *SABLES*' consortium database meaning that the state of the ledger and the database will never deviate from one another. This is known as a hybrid storage mechanism. This concept is described in *Section 8.3.3* and illustrated in *Figure 8.3*.
- This configuration now allows for a storage mechanism which provides one point of storage and 'truth' instead of two. This allows for a real-time view of correct and trusted information.
- Once a transaction is complete, the title deed is then generated and verified by the nodes, adhering to *Step 3* above. Once approved, this title deed is sent through to the Deeds Office where a digital title deed is recorded and stored in their online system as well as physically recorded. This method of storage is still a centralised system run by government officials due to legal requirements. This will be linked to the *SABLES* blockchain system whereby the hash value of the title deed will be stored blockchain's ledger, resulting in a dual recording system.
- A copy of the title deed will also be added to *SABLES* consortium database and distributed amongst the stakeholders involved in the transaction. This title deed will also be put through a hash generator which will be stored on-chain.

The proposed transaction platform will provide an efficient, secure, and transparent service for any set of stakeholders who conduct transactions on it. The benefits will be realised by those stakeholders who register and utilise *SABLES*. In utilising such a system, the start of the movement towards blockchain-based transaction platforms and land registry systems will begin. As the transaction platform and business processes become more widely adopted and accepted, so it will gain more ground in becoming the official means of conducting real estate transactions. Here, the original title would be digitalised and stored in the *SABLES* database and referenced to the blockchain, providing a more efficient method of transacting real estate.

It is worth noting that the purpose of this study was to investigate an enhanced business process solution, utilising innovative technology to improve South African real estate transactions. In analysing the collected data, various sociological, legal, and political factors presented themselves. There will always be human issues around trust and adoption, social factors around legalities, usage, and consensus, and political factors around transparency.

These factors represent intractable sociological issues, which cannot be controlled or solved through computational elements or technical solutions. Blockchain technology will not solve all of these issues and completely eliminate corruption in record-keeping. These issues are beyond the scope of this study. Rather, this research delineated and provided a discussion on the technicalities of the technology, putting forward a technical solution.

8.5 Summary

Chapter Eight presented the final and combined thematic map. This chapter elaborated on the candidate themes identified, identifying and outlining the latent themes. The discussion focused on aligning the thematic map and its concepts to the *SABLES* integrated business process model, while answering the research questions. The chapter concluded with a final reflection on the *SABLES* transaction platform and its functionality. The following chapter will conclude the study by revisiting the research questions and clearly outlining the study's contribution.

Chapter 9: Conclusion

9.1 Introduction

Chapter Eight provided a definition and explanation of each of the main themes and their associated sub-themes. The discussion was centred on the integrated model while also answering the study's research questions and addressing the problem statement, both of which were outlined in *Chapter One*. All five themes present in the final and combined thematic map contributed to the discussion and were elaborated on in detail. However, the sub-themes of '*Blockchain Adoption Factors*', '*Blockchain Regulatory Framework*', '*PropTech Regulatory Framework*', as well as the block beneath the sub-theme, '*Technological Innovation*' were not discussed in great length. This was because this study was positioned to provide a discussion on the potential benefits that blockchain technology could offer to South African real estate transactions once implemented and did not explore the political and regulatory factors to adoption in precise detail. However, these topics represent areas of importance for future research. The discussion in *Chapter Eight* was centred on the integrated business process model and concluded by providing a final interpretation on the *SABLES* integrated model based on the views and inputs given by the interview participants. This chapter provides a summary of the study, outlining how the questions were answered, and showing how the South African Blockchain Land Exchange System (*SABLES*) integrated business process model represents the core contribution of this study. *Chapter One* identified a problem statement, setting forth the issue that this study intended to investigate. From there, the research questions that this study planned on answering were developed. This chapter shows how the research questions were addressed and answered by revisiting each question. This will be followed by a discussion on the contributions made as well as the limitations faced. The areas of future research for this topic will then be highlighted. The chapter will conclude a retrospective of the study.

9.2 Research Questions Revisited

This study consisted of one main research question and four research sub-questions. In answering the main research question, it was imperative that the research had a complete understanding of the two transaction processes in isolation, namely South African real estate transactions and blockchain-based real estate transactions.

> ***Main Research Question:*** *How can blockchain technology be integrated into the process of real estate transactions in South Africa?*

Answering this question required an all-inclusive understanding of South African transactions, blockchain-based transactions, and the capabilities of blockchain technology. It was determined that current South African real estate transactions illustrate an ideal business process and use-case for blockchain technology. This allowed for the main themes of '*Current Transaction Context*' (as well as *Chapter Three*) to depict current South African transactions; '*PropTech 3.0 Fundamental Success Factors*' (as well as *Chapter Five*) to depict blockchain-based transactions; and '*Business Process Applicability*' to illustrate how real estate transactions are appropriate for the employment of blockchain. Once these areas were all determined, the above question could be answered in terms of the technicalities and approaches to integration of blockchain technology into the South African real estate transaction process. The main theme of '*Blockchain Implementation Strategies*' in the final thematic map (*Figure 8.1:* Final and Combined Thematic Map) helped to answer the main research question. From this theme came two important sub-themes: '*Blockchain Architectural Design*' and '*Blockchain Storage Capabilities*'. It was determined that the architecture of the *SABLES* blockchain would be a consortium-based blockchain solution. This will comprise all stakeholders in the transaction process and provide an equal and joint verification mechanism from all of the nodes in the network. It was declared that distributed and joint consensus must be in place, whereby group consensus amongst stakeholders must occur before subsets of documents and their hash values are added to the blockchain. Further, *SABLES'* hybrid approach to storage was delineated whereby hash values are stored on-chain and digitalised documents are stored in the *SABLES'* off-chain database. Decentralisation of off-chain stored data was also achieved through a consortium file-sharing database, accessible by all stakeholders. In addition, the *SABLES* consortium database was designed to permit for all data and 'truth' to be stored in one place, while still adopting a hybrid storage mechanism. The *SABLES'* consortium database would embed and integrate the storage of the blockchain ledger into the database itself (*Figure 8.3*). Blockchain is not mutually exclusive from existing technologies in a business process but rather, acts as an additional layer in the current technological architecture. Ultimately, this question is answered through the integrated business process model (*Figure 6.3:* South African Real Estate Blockchain-based Transaction Process (SABLES): Integrated Business Process Model) itself, which illustrates how this integration can occur and depicts the processes involved.

> ***Sub-question one:*** *Why should South African real estate transactions make use of blockchain technology?*

Answering this question presupposes that there must be a problem in the current transaction process. *Chapter One* outlined the problem statement and *Chapter Three* elaborated on this, listing the inefficiencies of South African real estate transactions and the subsequent land registry systems. From this, the research conducted a literature review in *Chapter Four* which illustrated what blockchain technology is capable of and how it can assist in addressing the problem statement. This was made evident in *Section 4.5*, where the research listed the six opportunities that blockchain has in real estate transactions: **(1)** *immutable record-keeping of transaction data*; **(2)** *smart contracts to reduce transaction stakeholders*; **(3)** *accessibility and speed through a common transaction platform and smart contracts*; **(4)** *reduced costs through fewer stakeholders involved and distributed access to data*; **(5)** *transparency, and* **(6)** *enhanced security*. Participant views reinforced the findings shown in *Chapter Four.* Two key themes in answering this question were '*Business Process Applicability*' and '*IT Assimilation*', illustrated in *Figure 8.1*. Participant insights reflected that any business process which is characterised by contractual obligations as well as trust amongst various stakeholders, represents a prime use for blockchain technology. Discussions on the sub-themes, '*Smart Contracts*' and '*Blockchain's Intrinsic Value Proposition*' further solidified why South African real estate transactions should look to blockchain-based solutions. Smart contracts ensure the simultaneous deliverance of funds to the seller versus delivery of ownership to the buyer, addressing the '*DVP*' issue mentioned in *Chapter Three,* as well as reducing escrow costs typically paid to conveyancers. Blockchain's characteristic of immutability means that transaction documents can be referenced on-chain for audit and authentication purposes, guaranteeing the correctness of information. Utilising blockchain technology will also see the digitisation of transaction processes, giving rise to the sub-theme of '*Digitisation and Digitalisation*', which can significantly enhance transaction speed. This aspect was called for by participants from all groups, illustrating its relevance and importance.

> ***Sub-question two:*** *What are the existing business processes in South African real estate transactions?*

There was agreement amongst the participants from Groups One and Three (conveyancing and PropTech professionals) on the inefficiencies that plague real estate transactions. These

opinions were in line with the study's initial interpretation and diagnosis of the current state of South African real estate transactions, documented in *Chapter Three*. *Chapter Three* depicts how the study collected secondary data on South African real estate transactions through document analysis. Here, three Business Modelling Language (BML) models were produced, namely, '*What'*, '*Who'*, and '*Which'*. This culminated in the production of a BPMN-based model illustrating the process (*Figure 3.9:* South African Real Estate Transaction Process: Business Process Model). Document analysis revealed that an individual transaction can involve between 12–17 stakeholders, 25–35 paper-based documents, and between 11–18 different costs, resulting in a single transaction taking, on average, three months. This is in contrast to the reduced stakeholders and digitised documents in the *SABLES* transaction platform. After data analysis, the study was able to use the primary data collected from interview participants. As depicted in the final and combined thematic map (*Figure 8.1*) one of the main themes that assisted in answering this question was *Current Transaction Context.* Participants from Group One concurred on the paper-based nature of transactions and land registry systems, mentioning that this hinders transaction speed. Group Three participants added to this by stating that the lack of digitised processes results in inefficient transactions. It was further concluded that transaction complexities are caused by a large number of stakeholders being involved in the process, as well as certain stakeholders lacking the necessary competencies. Therefore, transaction transparency is subject to the competency of the conveyancer and assisting stakeholders. There is no common transaction platform in current processes, meaning that the various systems currently utilised in transactions, exist in isolation from one another. The study inferred that there is a significant amount of pressure on the conveyancer, developing the '*Conveyancing Pressure*' sub-theme. It was further revealed that to fully understand a business process, knowledge of all the stakeholders and sub-processes involved is crucial. This is where the sub-theme, '*Minimum Viable Eco-system*' stemmed from, illustrating how a holistic view is needed before integrating blockchain into the process. Concurring with the knowledge documented in *Chapter Three*, the lag in technological modernisation was reiterated, giving rise to '*Technological Innovation*', another sub-theme. Here, participants expressed their desire for technology to assist transaction processes where possible. However, previous implementations have failed due to poor planning and execution. There has been significant discussion within the South African real estate sector on how technologies can and will be implemented, such as discussions on the e-DRS that was proposed in 2005. However, little implementation and practical output has amounted from this, leading

to the inference that there either is a disregard towards innovation or a lack of capacity to deliver in the sector, likely the former.

> ***Sub-question three:*** *What are the existing business processes for blockchain-based real estate transactions?*

While these transactions were conducted using blockchain technology, they were still conducted in the traditional manner as well. This is because blockchain-based real estate transactions have not yet gained legal acceptance. As a result, these transactions act as demonstrations to portray the capabilities that blockchain has and how this technology can positively impact real estate transactions. Document analysis was carried out for South African real estate transactions (*Chapter Three*) and for blockchain-based transactions (*Chapter Five).* The study investigated a variety of blockchain-based transaction platforms that permit such transactions. The study focused on one of these platforms, Propy, and four transactions which they have carried out. These were done on a transaction platform to which all of the stakeholders had access, allowing for complete transparency at each stage of the process. Digitisation of the process permitted for digital signatures, speeding up the time in which transactions were completed. All contractual processes were managed and run by smart contracts which added increased security to transactions. Smart contracts ensured concurrent delivery of title to the new owner versus payment of funds to the seller, leaving no room for fraudulent activities. In addition, smart contracts managed the transaction as a whole, notifying all stakeholders as the transaction moved through its phases. Ultimately, this question was answered through the BPMN-based model which depicted the real estate blockchain-based transaction process (Figure 5.3: Real Estate Blockchain-based Transaction Process: Business Process Model). Participants from Group Three stated that smart contracts have assisted in reducing the number of stakeholders involved in a transaction. These views were present under the '*Smart Contract*' sub-theme within the main theme of '*Business Process Applicability*', whereby blockchain technology's relevance in real estate transactions was discussed and approved. Through the discussion of these themes in *Chapter Eight*, together with the opportunities identified in *Section 4.5*, it was made clear that these concepts were incorporated into the integrated business process model. Additionally, the findings in *Chapter Five* showed that a smart contract can replace the role of an escrow agent, thus reducing conveyancing fees and automating transfer of ownership upon payment of funds. A significant addition was the referenced recording (through hash values) and storage of transactional documentation on the

blockchain and in the respective database. Propy also adopted a hybrid approach, however, stored one document on-chain, a copy of the finalised title deed which contained the address of the smart contract that executed the transaction on the blockchain. All other transaction documentation was stored in a Propy database which was distributed amongst all stakeholders in the transaction. These documents were referenced on-chain via generated hash values. Interview data from participant Group Three further mentioned the aspects above and discussed numerous other blockchain-based real estate transactions and projects that have occurred. This is reflected in the sub-theme '*PropTech Practicality*' which falls under the main theme of '*PropTech 3.0 Fundamental Success Factors*'.

> ***Sub-question four:*** *How would the business processes for real estate transactions and recording property titles in South Africa change if blockchain technology was integrated into the current transaction process?*

The primary aim of this study was to produce an integrated business process model which would answer this question, illustrating the process flow for blockchain-based real estate transactions in South Africa. This model is one of the core contributions of the study. In developing this model, the research drew from various aspects that emerged from the document analysis, documented in *Chapters Three* and *Five*. The study identified the elements that are imperative in current transactions, coupled with applicable blockchain-based processes. This resulted in an integrated business process which illustrates how the various process and stakeholder interactions for South African blockchain-based real estate transactions are conducted on a common transaction platform. This integrated business process model, together with the interview questions, was given to the interview participants for their recommendations and critiques. After these interviews were complete, and the transcribed data was analysed, the study collected data on '*Blockchain Implementation Strategies*', one of the main themes in *Figure 8.1*. This theme provided the study with supplementary insights on how blockchain can be integrated into the business process of real estate transactions. '*Smart Contract Configured Processes*' illustrated how these transactions can use more efficient contractual processes which utilise digitised data. Therefore, along with '*Blockchain Implementation Strategies*', the main themes of '*Business Process Applicability'* and '*IT Assimilation*' assisted in answering this question. The technicalities of the *SABLES* transaction platform were re-addressed at the beginning of this section when answering the main research question.

9.3 Contribution

To answer the research questions, the study required knowledge of two individual real estate transaction processes: South African transactions and blockchain-based transactions. This involved collecting secondary data through document analysis which culminated in the development of two business process models (*Figures 3.9* and *5.3*), constructed using BPMN. While these processes have been outlined in prior research, they have not been depicted or modelled in the manner in which this research portrayed, and as a result, represent the first contribution of the study. From these models, the study developed a combined and integrated business process model, *SABLES* (*Figure 6.3*). This integrated business process model depicts how blockchain technology could be integrated into South African real estate transactions. This stands as the core contribution of the research. Furthermore, the Business Modelling Language (BML) models, adhering to the 'W5' approach mentioned in *Section 3.4.1*, were developed as prerequisites to the business process model illustrating the current process (*Figure 3.9*). These prior models also represent a contribution of business process models for South African real estate transactions. The structured method of arriving at the business process models offers an alternative approach when carrying out document and thematic analysis, allowing a comprehensive understanding of the present state of business processes before modelling proposed and enhanced solutions to business processes. Through in-depth interviews, the study collected additional data pertaining to the integrated business process model. Along with specific questions on blockchain technology in the real estate sector, the integrated model was evaluated by specialists with conveyancing, blockchain, PropTech, and ICT legal backgrounds. Through thematic analysis, the study developed a final combined thematic map (*Figure 8.1*). This thematic map involved concepts derived from all participant interview groups to create the final integrated model. While this thematic map operated in the context of real estate transactions, these concepts can be adjusted accordingly to apply to a general context. For example, '*Current Transaction Context'* implies understanding the current state of the business process, regardless of the industry in which it occurs. Therefore, this thematic map can be seen as the start of a '*Blockchain Implementation Framework'* for business processes. It provides a basic framework for understanding and conceptualising relevant facets and technicalities that need to be taken into account when implementing business processes on the blockchain. The '*Blockchain Implementation Framework',* together with the integrated business process model can act as direct inputs for projects that are attempting to provide blockchain-based solutions.

9.4 Limitations

In conclusion, it is necessary to list some of the limitations that the study faced. Firstly, the study compared the South African and blockchain-based real estate transaction process respectively. Transactions pertaining to the latter process have only occurred in an international context. Current PropTech 3.0 projects are largely conducted overseas. This limited the study in terms of direct access and observation of these transactions, access to the personnel and institutions conducting the transactions, and the ability to generalise to the South African context. Economic limitations were also apparent as the principal investigator was unable to attend international PropTech summits and conferences where the use of blockchain in real estate transactions was discussed. All but one of the PropTech participants from Group 3 were international participants. However, this international limitation was overcome by studying the local transaction context. This resulted in this study's interpretation merging the findings from these two areas as to how blockchain can be integrated into South African real estate transactions. This approach, however, was a prime contribution of the research, namely the fusing of international knowledge with current transaction understanding.

9.5 Methodology Review

Upon reflection of the methodological approach and the research design chosen, it can be argued that case study methodology may not have been the correct fit. Case study methodology studies social units in a deep and thorough manner across a wide range of time (Yin, 2011). While the four international blockchain-based transactions do each represent a case on their own, their investigation in this research resulted in a summary of the processes involve which were derived from literature reports. It can further be argued that *Chapter Three*, which examined South African real estate transactions, was more applicable to the case study approach. This is due *Chapter Three* producing a deep and thorough examination of this process (and the social unit involved) over the transaction's period of time from start to finish.

9.6 Future Research

During the study, it became evident that there are areas for future research. Due to the novelty of the topic, this study represents more than just a starting point for blockchain technology in South African real estate and provides business process models illustrating the required processes. Future studies could expand on the proposed transaction platform by using this business process model as an input for practical-based research whereby a prototype

transaction platform could be programmed and developed. From this, functioning business processes that the model put forward could be highlighted, while business processes that need attention and restructuring could be remodelled. This would allow an iterative approach to modelling and producing a working platform. In addition, further studies could focus on aspects on the integrated business process model for development, such as smart contracts. An escrow smart contract which holds *funds* and *title documents* between various stakeholders could be coded, allowing greater clarity on the practical functionality of smart contracts. Future research could explore how the transaction platform is paid for (whether or not transaction fees can pay for the transaction platform), the on-chain governance, and stakeholder responsibility as well as stakeholder payment fees (such as conveyancing fees). Moreover, in terms of technological implementations which can assist South African real estate transactions, the barriers to innovation illustrate an area for future research. This was evident as the block beneath the sub-theme, '*Technological Innovation*', was not discussed in great length nor was a solution put forward. This block is isolated which represents an infinite loop with no resolution. Here, future research can elaborate on why these 'attempted' technological integrations have failed and investigate the element of 'disregard' towards innovation that this study noticed. This can assist in reducing the barriers to innovation in real estate transactions.

When discussing '*Blockchain's Storage Capabilities'* the study proposed that the primary use of blockchain is not to replace traditional databases and house gigabytes of data. Blockchain's potential lies in safeguarding data through storing a reference to a transaction or document. To combat the issue of centralised databases, distributed, peer-to-peer storage systems such as 'IPFS' and 'Filecoin' were mentioned as primary databases that could link to a blockchain system. Future work could attempt to determine an appropriate balance of on-chain versus off-chain storage while still maintain efficiency.

Throughout the data collection process, interview participants mentioned the concept of real estate tokenisation whereby property investment or ownership is fractionalised. Tokens, which run on a blockchain, can be divided into many parts, which opens the door for fractional investment or ownership. This can allow individuals who traditionally would not hold enough funds or capital, to invest part shares in property. Based on the reach that this concept gained during the in-depth interviews, tokenisation is as relevant as blockchain technology in real estate transactions and land registry systems. A qualitative study could compare traditional real estate investment and ownership opportunities with new age possibilities through tokenisation.

As mentioned in *Section 9.3*, the final and combined thematic map could be applied in a different context as it illustrates a '*Blockchain Implementation Framework*'. These concepts

could be utilised in different industries or sectors where blockchain technology solutions are being considered. Through these studies, this framework could be modified and/or added to. Lastly, it was stated in *Chapter Eight* that this research did not intend to address sociological, socioeconomic, or sociolegal issues pertaining to the implementation of blockchain technology. While these concepts were beyond the scope of this study, they remain important. As a result, studies that intend to tackle and overcome these concerns will significantly aid in the process of integrating blockchain technology into current business and governmental processes.

9.7 Conclusion

This dissertation has provided a comprehensive and coherent overview of the current state of real estate transactions in South Africa as well as putting forward an enhanced solution, through process modelling, regarding these transactions. To begin with, the inefficiencies of current transaction processes were made explicit. This study then provided sufficient knowledge of the technicalities of blockchain technology and how blockchain can enhance real estate transactions. This was done through employing qualitative research techniques whereby document analysis, literature reviews, and in-depth interviews provided the research with the necessary data, ensuring a wide range of insights. The research then provided an integrated business process modelled solution to the inefficiencies currently faced in South African real estate transactions. This was done through the construction of a BPMN-based model which represents a transaction platform named the South African Blockchain Land Exchange System (*SABLES*). Discussions on the integrated business process model highlighted how blockchain technology can assist the real estate transaction process in South Africa.

Blockchain technology is an emerging and revolutionary technology, which is still being explored and examined. This technology is assisting in driving the fourth industrial revolution. However, technology does not exist in isolation nor can it significantly enhance society on its own. Successful technological integration arrives through an alignment of sociological, socioeconomic, and socio-legal factors. This study holistically examined the current and potential (technologically advanced) business process of South African real estate transactions. This was done by acquiring knowledge on the stakeholders involved, the processes conducted, and the information technology employed, illustrating the three core pillars of an information system. Through acquiring knowledge of the combined set of components involved, the study could stand as a bridge between technological implementations

and the people and processes which would bear the fruits of this integration, and did so in a manner that adhered to all three pillars of an information system.

References

Abraham, A., 2017. *Self-Sovereign Identity.* Austria: E-Government Innovation Szentrum. Available at: https://www.egiz.gv.at/files/download/Self-Sovereign-Identity-Whitepaper.pdf [Accessed 22 October 2018].

Africa Property News, 2016. *Blockchain Technology could alter Real Estate Industry deals.* [Online] Available at: http://www.africapropertynews.com/investing/3246-blockchain-and-bitcoin-technology-could-alter-real-estate-deals.html [Accessed 02 March 2018].

Ahmed, O.H., 2017. *Metaverse Digital Identity White Paper.* Metaverse. Available at: http://newmetaverse.org/white-paper/Metaverse-digital-identity-white-paper-v1.0-EN.pdf [Accessed 05 January 2019].

Al Ahmad, M.A., Al-Saleh, A. and Al Masoud, F.A., 2018. Comparison between PoW and PoS Systems Of Cryptocurrency. *Indonesian Journal of Electrical Engineering and Computer Science,* 10 (3), pp.1251.

AltNews.nu, 2018. *Propy Blockchain Real Estate Platform Sees California's First-Ever Property Sale.* [Online]. Available at: http://www.altnews.nu/propy-blockchain-real-estate-platform-sees-californias-first-ever-property-sale/ [Accessed 19 October 2018].

Amadi-Echendu, A., 2013. *An Analysis of Conveyancing Business Processes in South Africa.* Master of Commerce. University of South Africa.

Amadi-Echendu, A., 2016. *Towards a Framework for the Integration of Data and Data Sources in the Automation and Dematerialisation of Land Administration Systems*. PhD. University of Pretoria.

Anderson, R., 2008. *Security engineering: A Guide to Building Dependable Distributed Systems*. 2nd ed. Chichester, United Kingdom: John Wiley and Sons Ltd.

Azad, B., and Faraj, S., 2008. E-Government institutionalising practices of a land registration mapping system. *Government Information Quarterly*, 26 (2009), 5-14.

Bajaj, A., and Ram, S. 1996. A Content Specification for Business Process Models. *Australasian Journal of Information Systems*, *4*(1), pp. 22-31.

Bal, M., 2017. *Securing Property Rights in India through Distributed Ledger Technology.* [Pdf] New Dehli: Observer Research Foundation. Available at: https://ideas.repec.org/p/ess/wpaper/id11567.html [Accessed 15 December 2018].

Barbieri, M. and Gassen, D., 2017. Blockchain - can this new technology really revolutionise the land registry system? In: Responsible Land Governance: Towards an Evidence Based Approach, Annual World Bank Conference on Land and Poverty. Washington, America, 20-24 March 2017. Washington DC: Responsible Land Governance: Towards an Evidence Based Approach.

Baum, A., 2017. *PropTech 3.0: The Future of Real Estate.* [Pdf] Oxford: SAID Business School. Available at: https://www.sbs.ox.ac.uk/sites/default/files/2018-07/PropTech3.0.pdf [Accessed 04 February 2018].

Baum, A., and Saull, A., 2019. *University of Oxford Research: The Future of Real Estate Transactions.* [Pdf]. University of Oxford Said Business School: Oxford Future of Real Estate Initiative. Available at: https://www.sbs.ox.ac.uk/sites/default/files/2019-03/FoRET-ReportFull_1.pdf [Accessed on 04 May 2018].

Baxter, P. and Jack, S., 2008. Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers. *The Qualitative Report,* 13(4), pp.544-559.

Beck, R., Czepluch, J.S., Lollike, N. and Malone, S., 2016. Blockchain – The Gateway to Trust-Free Cryptographic Transactions. In: AIS Electronic Library, Twenty-Fourth European Conference on Information Systems. Istanbul, Turkey, 12-15 June 2016. Istanbul: Association for Information Systems.

Benedichte Meyer, C., 2001. A Case in Case Study Methodology. *Field Methods SAGE Journal,* 13(4), pp.329-352.

Bowen, G.A., 2009. Document Analysis as a Qualitative Research Method. *Qualitative Research Journal,* 9(2), pp.27-40.

Boyatzis, R.E., 1998. *Thematic Analysis and Code Development: Transforming Qualitative Information*. London: SAGE Publications.

Braun, V. and Clarke, V., 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology,* 3(2), pp.77-101.

Brett, C., 2018. *Propy sells Sevilla property via blockchain: a first in the EU?* [Online]. Available at: https://www.enterprisetimes.co.uk/2018/10/10/propy-sells-sevilla-property-via-blockchain-a-first-in-the-eu/ [Accessed 12 December 2018].

Bridge, C., 2017. *Blockchain's Impact in Residential and Commercial Real Estate: Executive Summary.* [Online] Available at: https://investmentbank.com/blockchain-real-estate/ [Accessed 12 August 2018].

Bryzek, P., 2018. *How Blockchain can eliminate the need for Real Estate Agents, Brokers, Title & Escrow.* [Online] Available at: https://medium.com/@bryzek/how-blockchain-can-eliminate-the-need-for-real-estate-agents-brokers-title-escrow-291db5d7ad6 [Accessed 13 February 2018].

Canfield, A., 2018. *Distributed Ledger Technology Use Cases in the Real Estate Ecosystem.* [Online] Available at: https://blockchainplusthelaw.com/2018/01/22/distributed-ledger-technology-use-cases-in-the-real-estate-ecosystem/ [Accessed 24 May 2018].

Castleberry, A. and Nolen, A., 2018. Thematic analysis of qualitative research data: Is it as easy as it sounds? *Elsevier: Currents in Pharmacy Teaching and Learning*, pp.1-9.

Chas Everitt International Property Group, 2017. *A Guide to Property Transfer in South Africa*. [Online]. Available at: https://www.chaseveritt.co.za/conveyancing/ [Accessed on 16 July 2018].

Chas Everitt., 2018. *Conveyancing - A Guide to Property Transfer in South Africa.* [Online]. Available at: https://www.chaseveritt.co.za/conveyancing/ [Accessed 13 April 2018]

Compton, S. and Schottenstein, D., 2017. Blockchain Technology and its Applicability to the Practice of Real Estate Law. *Commercial Insight*, [pdf] Available at: https://store.lexisnexis.com/products/blockchain-technology-and-its-applicability-to-

the-practice-of-real-estate-law-by-sh-spencer-compton-and-diane-schottenstein-skusku0324201701/details [Accessed 22 January 2019].

Conboy, K., Fitzgerald, G. and Mathiassen, L., 2012. Qualitative methods research in Information Systems: motivations, themes, and contributions. *European Journal of Information Systems,* 21(2), pp.113-118.

Corluka, D. and Lindh, U., 2017. *Blockchain: A Technology that will Transform the Real Estate Market.* Master of Science. KTH Royal Institute of Technology. Available at: https://kth.diva-portal.org/smash/get/diva2:1124675/FULLTEXT01.pdf [Accessed 03 August 2018].

Couse, A., 2017. *Clicks and Mortar: The Growing Influence of Proptech.* [Pdf] Asia Pacific: JLL: Jones Lang LaSalle. Available at: http://www.ap.jll.com/asia-pacific/en-gb/research/950/proptech-2018-refreshed-with-new-insights-apr2018 [Accessed 25 August 2018].

Creswell, J. and Plano Clark, V., 2007. *Designing and conducting mixed methods research,* 2nd ed. California, Thousand Oaks: SAGE Publications.

Creswell, J.W., 1994. *Research Design: Qualitative and Quantitative Approaches*. California: SAGE Publications.

Crotty, M., 1998. *The Foundations of Social Research: Meaning and Perspective in the Research Process.* California, Thousand Oaks: SAGE Publications.

Cuthbertson, A., 2017. *Blockchain used to sell Real Estate for the first time*. [Online]. Available at: https://www.newsweek.com/blockchain-sell-real-estate-first-time-ethereum-682982 [Accessed 03 March 2018]

Cuthberston, A., 2019. *South Burlington in Vermont to Use Propy's Technology*. [Online] Available at: https://blog.propy.com/2019/04/south-burlington-in-vermont-to-use-propys-technology/ [Accessed 10 March 2019].

Dalton, D., Kehoe, L., Leonowicz, C. and Hallahan, J., 2017. *Future-proofing real estate: An insight into the potential use of blockchain in real estate funds*. [Pdf] Dublin: Deloitte

Performance Magazine. Available at: https://www2.deloitte.com/content/dam/Deloitte/ie/Documents/FinancialServices/investmentmanagement/IE_2017_future-proofing-real-estate-Deloitte_Ireland.pdf [Accessed 19 April 2018].

Davids, A., 1992. *Practical Information Engineering: The Management Challenge*. California, Thousand Oaks: SAGE Publications.

Davis, K., 1995. The Phenomenology of Research: The Construction of Meaning in Composition Research. *JAC*, 15(1), pp.121-129.

deRidder, C.A., Tunstall, M.K., Grosser, J.M. and Holtan, N., 2016. *Blockchain: The Impact on the Real Estate Industry.* [Pdf] California: Pillsbury Winthrop Shaw Pittman LLP. Available at: https://www.pillsburylaw.com/images/content/1/0/v2/104784/AlertDecember2016RealEstateBlockchainTheImpact.pdf [Accessed 26 August 2018].

Deshpande, A., Stewart, K., Lepetit, L. and Gunashekar, S., 2017. *Understanding the Landscape of Distributed Ledger Technologies/Blockchain: Challenges, Opportunities, and the Prospects for Standards.* [Pdf] Cambridge: RAND Corporation. Available at: https://www.rand.org/pubs/research_reports/RR2223.html [Accessed 10 February 2019].

Dijkstra, M., 2017. *Blockchain: Towards Disruption in the Real Estate Sector.* Master of Track Management in the Built Environment. Delft University of Technology. Available at: https://repository.tudelft.nl/islandora/object/uuid%3Ab6ec7ece-e879-4ae3-8232-d8144ac2642d [Accessed 12 May 2018].

Gatteschi, V., Lamberti, F., Demartini, C., Pranteda, C. and Santamaría, V., 2018. Blockchain and Smart Contracts for Insurance: Is the Technology Mature Enough? *Future Internet*, [e-journal] 10 (2), pp.1-16. 10.3390/fi10020020.

Graglia, J.M. and Mellon, C., 2018. Blockchain and Property in 2018: At the End of the Beginning. In: Land Governance in an Interconnected World, Annual World Bank Conference on Land and Poverty. Washington DC, 19-23 March 2018. Washington DC: MIT Press.

Guitron, M, 2018. *Propy Announces the First California Property Sale on the Blockchain.* [Online]. California: Business Wire. Available at: https://www.businesswire.com/news/home/20180723005199/en/Propy-Announces-California-Property-Sale-Blockchain [Accessed 25 August 2018].

Harder, H., 2012. *Encyclopaedia of Case Study Research: Explanatory Case Study. California*, Thousand Oaks: SAGE Publications.

Hayes, B.K., Heit, E. and Swendsen, H., 2010. Inductive reasoning. *Wiley Interdisciplinary Reviews: Cognitive science,* 1(2), pp.278-291.

Heaven, D., 2017. *A house has been bought on the blockchain for the first time.* [Online]. Available at: https://www.newscientist.com/article/mg23631474-500-a-house-has-been-bought-on-the-blockchain-for-the-first-time/ [Accessed10 February 2018].

Hofstee, E., 2006. *Constructing a good dissertation: A Practical Guide to Finishing a Masters, MBA or PhD on Schedule.* Sandton, South Africa: Exactica.

Hudson, M., 2018. *Vermont county and Silicon Valley startup close historic RE deal using blockchain.* [Online]. Available at: https://therealdeal.com/2018/03/25/vermont-county-and-silicon-valley-startup-close-historic-re-deal-using-blockchain/ [Accessed 02 June 2018].

Hyett, N., Kenny, A. and Dickson-Swift, V., 2014. Methodology or method? A critical review of qualitative case study reports. *International Journal of Qualitative Studies on Health and Well-being,* 9(1), pp.1-12.

Ivan, K.V., 2019. *Propy to Become Global Solution for Real Estate Transactions*. [Online]. Available at: https://blog.propy.com/2019/04/propy-to-become-global-solution-for-real-estate-transactions/ [Accessed 18 January 2019].

Ivan, K.V., 2019. *Vermont Goes Blokchain because of Propy*. [Online]. Available at: https://blog.propy.com/2019/03/vermont-goes-blockchain-because-of-propy/ [Accessed 25 May 2019].

Johansson, R., ed. 2003. Case Study Methodology. In: Housing Research, *Proceedings of the International Conference Methodologies in Housing Research.* Stockholm, 22-24 January 2003. Stockholm: Open House International Association.

Joubert Galpin Searle, 2017. Conveyancing – The Process of Transferring a Property Explained. [Online]. Available at: http://www.jgs.co.za/index.php/property/conveyancing-the-process-of-transfering-a-property-explained [Accessed on 28 May 2018].

Karayaneva, N., 2017. *How A Smart Contract replaced An Escrow Company in a $60k deal.* [Online]. Available at: https://hackernoon.com/how-a-smart-contract-replaced-an-escrow-company-in-a-60k-deal-551ff7839044 [Accessed 25 January 2018].

Kejriwal, S. and Mahajan, S., 2017. *Blockchain in commercial real estate: The future is here.* [Pdf] United States: Deloitte Center for Financial Services. Available at: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/financial-services/us-dcfs-blockchain-in-cre-the-future-is-here.pdf [Accessed 15 July 2018].

Keramati, A., Reza Golian, H., and Afshari-Mofrad, M. 2011. Improving business processes with business process modelling notation and business process execution language: an action research approach. *International Journal of Business Information Systems*. Vol. 7, No. 4, pp.458–476.

King, S., 2018. *How Blockchain Technology Is Allowing For A Reinvention Of The Real Estate Ecosystem.* [Online] Available at: https://www.forbes.com/sites/forbesrealestatecouncil/2018/03/13/how-blockchain-technology-is-allowing-for-a-reinvention-of-the-real-estate-ecosystem/ [Accessed 10 June 2018].

Klein, H.K. and Myers, M.D., 1999. A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *MIS Quarterly*, 23(1), pp.67-94.

Law Society of South Africa, 2019. *Conveyancing Fees Guidelines*. [Pdf]. Johannesburg: GhostDigest. Available at: http://www.ghostdigest.com/articles/conveyancing-fees-june-2019/55746 [Accessed on 17 April 2019].

Lemieux, V.L., 2017. Blockchain and Distributed Ledgers as Trusted Recordkeeping Systems: An Archival Theoretic Evaluation Framework. In: The University of British Columbia, Future Technologies Conference. Vancouver, Canada, 29-30 November 2017. Vancouver: The Science and Information (SAI) Organisation.

LexisNexis, 2018. *Table of Costs for Conveyancing*. As from 01 June 2018. Johannesburg: GhostDigest.

López-Pintado, O., García-Bañuelos, L., Dumas, M., and Weber., 2017. Caterpillar: A Blockchain-Based Business Process Management System. In: Proceedings of the BPM Demo Track and BPM Dissertation Award, 15th International Conference on Business Process Modeling (BPM 2017). Barcelona, Spain, September 13, 2017. Barcelona. CEUR Workshop Proceedings.

Louise Tonkin Inc, 2013. *Property Transfer Guide: Meeting Your Unique Needs*. [Pdf]. Roodepoort: Louise Tonkin Inc. Available at: http://ltinc.co.za/wp-content/uploads/2015/06/LTIncPropertyGuide.pdf [Accessed on 20 April 2018].

Lynch, D., 2018. *Propy records country's first blockchain-only real estate deal just north of LA County*. [Online]. Available at: https://therealdeal.com/la/2018/07/30/propy-records-first-us-real-estate-sale-on-blockchain/ [Accessed 24 August 2018].

Maklari, S., Kalata, C. and Luper, A., 2018. *Blockchain 2.0 Cryptocurrencies are only the beginning: Blockchain a real estate game changer*. [Pdf] Singapore: Credit Suisse: Equity Research Technology. Available at: https://www.blockchaindailynews.com/attachment/967068/ [Accessed 13 September 2018].

Malviya, H., 2017. *Blockchain for Real Estate.* [Pdf]. Social Science Research Network. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2922695 [Accessed 15 March 2018]

Market Insider, 2018. *Blockchain Used to Sell Real Estate for the First Time in the EU.* [Online]. Available at: https://markets.businessinsider.com/news/stocks/blockchain-used-to-sell-real-estate-for-the-first-time-in-the-eu-1027598772 [Accessed 12 September 2018].

Marrella, A., Mecella, M., Russo, A., Steinau, S., Andrews, K. and Reichert, M., 2015. *A Survey on Handling Data in Business Process Models.* [Pdf] Germany: Ulm University Institute of Databases and Information Systems. Available at: https://pdfs.semanticscholar.org/958c/b387b92d49f036af0319220bd6025036a217.pdf [Accessed 21 February 2019].

Maryan, 2018. *Real Estate Company sold the first property in Spain with cryptocurrencies.* [Online]. Available at: http://infocoin.net/en/2018/10/02/real-estate-company-sold-the-first-property-in-spain-with-cryptocurrencies/ [Accessed 27 November 2018].

Mashatan, A. and Roberts, Z., 2017. An Enhanced Real Estate Transaction Process Based on Blockchain Technology. In: A Tradition of Innovation: Organisational Transformation and Information Systems, Twenty-third American Conference of Information Systems. Boston, America, 10-12 August 2017. Massachusetts: Association of Information Systems.

McGregor, S.L.T. and Murnane, J.A., 2010. Paradigm, methodology and method: Intellectual integrity in consumer scholarship. *International Journal of Consumer Studies*, 34(4), pp.419-427.

Merriam-Webster, 2011. The Merriam-Webster Dictionary. Massachusetts: Merriam-Webster. Available at: https://www.merriam-webster.com/ [Accessed 15 October 2019]

Muhle, A., Gruner, A., Gayvoronskaya, T. and Meinel, C., 2018. A survey on essential components of a self-sovereign identity. *Computer Science Review*, pp. 80-86.

Nakamoto, S., 2008. *Bitcoin: A Peer-to-Peer Electronic Cash System.* [Pdf] Bitcoin.org. Available at: https://bitcoin.org/bitcoin.pdf [Accessed 25 March 2018].

Narayanan, A., Bonneau, J., Felten, E., Miller, A. and Goldfeder, S., 2016. *Bitcoin and Cryptocurrency Technologies.* Princeton: Princeton University Press.

Nasarre-Aznar, S., 2018. Collaborative Housing and Blockchain. *Administration,* 66 (2), pp.59-82.

Nedbank, 2015. *Make Your Home Sweet Home Happen*. [Pdf]. Johannesburg: Nedbank. Available at: https://www.nedbank.co.za/content/dam/nedbank/site-assets/Personal/Home_Loans/Brochures/Buyers%20Guide/buyers-guide_full.pdf [Accessed on 28 September 2018].

Neil Esterhuysen and Associates Inc, 2015. *Conveyancing Process Guide*. [Pdf]. Centurion: Neil Esterhuysen and Associates Inc Available at: https://www.nea.co.za/nea/NEA_ConveyancingGuide_DIGITAL.pdf [Accessed on 13 March 2018].

Noor, K.B.M., 2008. Case Study: A Strategic Research Methodology. *American Journal of Applied Sciences*, 5(11), pp.1602-1604.

O'Loughlin, E., 2009. *An Introduction to Business Systems Analysis: Problem Solving Techniques and Strategies*. Dublin: The Liffey Press.

Picken, S., 2017. *The next $13 Trillion Dollar Industry to be disrupted.* [Online] Available at: https://www.thesouthafrican.com/lifestyle/the-next-13-trillion-dollar-industry-to-be-disrupted/ [Accessed 15 April 2018].

Prior, L., 2003. *Using Documents in Social Research: Introducing Qualitative Methods.* London: SAGE Publications.

PropertyWheel, 2018. *Blockchain and the future Property Landscape.* [Online] Available at: https://propertywheel.co.za/2018/07/blockchain-and-the-future-property-landscape/ [Accessed 22 July 2018].

Propy, 2017. *Global Property Store with Decentralised Title Registry*. [Pdf]. California: Propy. Available at: https://tokensale.propy.com/Propy-White-Paper-17-Jul-2017.pdf [Accessed 04 May 2018].

Propy, 2018. *Propy Completes the First Real Estate Deal Recorded on Blockchain in the US.* [Online]. Available at: https://medium.com/@propy/propy-completes-the-1st-real-estate-deal-recorded-on-blockchain-edcec38b5f19 [Accessed 09 February 2019].

Rajasekhar, P.V., 2006. E-Conveyancing: Challenges and Ambitions. In FIG Commission 7, International Conference on Enhancing Land Registration and Cadastre for Economic Growth in India. New Dehli, 31 Jan – 01 Feb 2006. India: FIG OICRF International Office for Cadastre and Land Records.

SA Home Loans, 2016. *Your Complete Guide to Buying a Property: Everything you need to know*. [Pdf]. Johannesburg: SA Home Loans. Available at: https://www.sahomeloans.com/content/uploads/2016/05/home-buyers-guide-english.pdf [Accessed on 15 April 2018].

SadlerInc, 2015. *Why is my Property Transfer taking so long?* [Online]. Available at: https://www.sadler.co.za/2018/06/11/why-is-my-property-transfer-taking-so-long/ [Accessed on 25 February 2018].

Schindlers, 2016. *Property Law Manual*. [Pdf]. Johannesburg: Schindler. Available at: http://www.schindlers.co.za/wp-content/uploads/2016/05/Schindlers-Property-Law-Manual-May-2016.pdf [Accessed on 03 March 2018].

Schramm, W., 1971. *Notes on Case Studies of Instructional Media Projects.* [Pdf] California: Stanford University. Available at: https://files.eric.ed.gov/fulltext/ED092145.pdf [Accessed 13 September 2018].

Schwandt, T., 1998. *The Landscape of Qualitative Research: Theories and Issues. California,* Thousand Oaks: SAGE Publicaions.

Silver, C. and Lewins, A., 2014. *Using Softwarein Qualitative Research Research: A step-by-step guide.* 2nd ed. London: SAGE Publications.

Smith Tabata Buchanan Boyes, 2018. *Property Guide: Your Key to Buying Property*. [Pdf]. Cape Town: Smith Tabata Buchanan Boyes. Available at: https://www.stbb.co.za/wp-content/uploads/STBB-Property-Guide-Your-key-to-buying-property-Brochure-April-2018.pdf [Accessed on 13 October 2018].

Smith, J.A. and Osborn, M., 2015. *Qualitative Psychology: A Practical Guide to Research Methods.* 3rd Ed. United Kingdom: The British Psychological Society and Blackwell Publishing Ltd.

Smith, P., 2018. *Spain: First Real Estate Sale Using Only Bitcoin.* [Online]. Available at: https://bitcoinist.com/spain-first-real-estate-sale-using-only-bitcoin-in-country/ [Accessed 15 October 2018].

Snape, D. and Spencer, L., 2003. *Qualitative Research Practice.* London: SAGE Publications.

South, G., 2018. *Propy launches blockchain pilot in Vermont to record real estate transfers.* [Online]. Available at: https://www.inman.com/2018/01/24/propy-launches-blockchain-pilot-in-vermont-to-record-real-estate-transfers/ [Accessed 28 June 2018].

Spielman, A., 2016. *Blockchain: Digitally Rebuilding the Real Estate Industry*. Master of Science. Massachusetts Institute of Technology. Available at: https://dspace.mit.edu/handle/1721.1/106753 [Accessed 12 September 2018]

Spielman, A., 2017. *This is Real Estate, Why Should I Care about Blockchain?* [Pdf]. Society of Industrial and Office Realtors. Available at: http://www.sior.com/docs/default-source/Profreport/blockchain_spielman.pdf?sfvrsn=43edeba8_0 [Accessed 12 February 2018].

Stake, R.E., 1995. *The Art of Case Study Research.* California: SAGE Publications.

Stoman, W., 2017. *Future of property payments to speed up transfers and stop fraud*. [Online]. Available: https://www.property24.com/articles/q-and-a-future-of-property-payments-to-speed-up-transfers-stop-fraud/26494 [Accessed 5August 2018].

Swan, M., 2015. Blockchain Thinking: The Brain as a Decentralised Autonomous Corporation. *IEEE Technology and Society Magazine*, [e-journal] 34 (4), pp.41-52.

Szabo, N., 2016. *Smart Contracts: 12 Use Cases for Business Beyond.* [Pdf]. Washington: Chamber of Digital Commerce. Available at: http://digitalchamber.org/assets/smart-contracts-12-use-cases-for-business-and-beyond.pdf [Accessed 26 February 2018]

Veldhuizen, J., 2017. *Blockchain and Real Estate: Mining Unexplored Terrain*. [Pdf]. Netherlands: The Real Estate Finance Journal, Deloitte. Available at: https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/real-estate/deloitte-nl-fsi-re-blockchain-in-re.pdf [Accessed on 19 March 2018]

Veuger, J., 2017. Attention to Disruption and Blockchain Creates a Viable Real Estate Economy. *Journal of US-China Public Administration,* 14 (5), pp.263-285.

Veuger, J., 2017. *Institute of Real Estate Studies - Trust in a viable real estate economy with disruption and Blockchain. In:* Institute of Real Estate Studies, *2nd Conference of Interdisciplinary Research on Real Estate*. Cartagena, Colombia, 21-22 September 2017. Ljubljana: Institute of Real Estate Studies.

Voloshyn, A., 2017. *Technical Overview: the first real estate deal on the blockchain.* [Online]. Available at: https://medium.com/propy/technical-overview-the-first-real-estate-deal-on-the-blockchain-18a34979403 [Accessed 05 February 2018].

Voloshyn, A., 2018. *First Government Sanctioned Blockchain Recorded Real Estate Deal in the US.* [Online]. Available at: https://medium.com/propy/first-government-sanctioned-blockchain-recorded-real-estate-deal-in-the-us-bb83e8292a7f [Accessed 13 August 2018].

Voloshyn, A., 2018. *Revealed: 7 Steps to Selling Real Estate on the Blockchain.* [Online]. Available at: https://medium.com/propy/revealed-7-steps-to-selling-real-estate-on-the-blockchain-dfe1a43c6d05 [Accessed 12 November 2018].

Vos, J., 2016. *Blockchain-Based Land Registry: Panacea, Illusion or something in between? Legal interference of Registrars in the e-conveyancing process.* [Pdf] Dubai: International Property Registries Association. Available at: https://www.elra.eu/wp-content/uploads/2017/02/10.-Jacques-Vos-Blockchain-based-Land-Registry.pdf [Accessed 10 March 2018].

Walsham, G., 1995. The Emergence of Interpretivism in IS Research. *Information Systems Research,* 6(4), pp.376-394.

Wohed, P., van der Aalst, W., Dumas, M., ter Hofstede, A. and Russell, N., 2006. On the Suitability of BPMN for Business Process Modelling. In: QUT ePrints, *4th International Conference on Business Process Management.* Vienna, Austria, 2006. Vienna: Open access archive of QUT research literature.

Wolfson, R., 2019. *Global Real Estate Platform Completes Sale of $1M California Home Using Blockchain Technology.* [Online]. Available at: https://www.forbes.com/sites/rachelwolfson/2019/02/07/global-real-estate-platform-completes-sale-of-1m-california-home-using-blockchain-technology/#98d10203a928 [Accessed 14 March 2019].

Yilmaz, K., 2013. Comparison of Quantitative and Qualitative Research Traditions: epistemological, theoretical, and methodological differences. *European Journal of Education Research Development and Policy,* 48(2), pp.311-325.

Yin, R.K., 2003. *Case Study Research Design and Methods.* 3rd Ed. California, Thousand Oaks: SAGE Publications.

Yin, R.K., 2011. *Qualitative Research from Start to Finish.* 2nd Ed. New York: The Guilford Press.

Zlotowitz, I., 2018. *Technology's Growing Role in the CRE Ecosystem?* [Online] Available at: https://www.nreionline.com/technology/technology-s-growing-role-cre-ecosystem [Accessed 26 March 2018].

Zuckerman, MJ., 2018. *Vermont's Pilot Program Completes First US All-Blockchain Real Estate Transaction*. [Online]. Available at: https://cointelegraph.com/news/vermonts-pilot-program-completes-first-us-all-blockchain-real-estate-transaction [Accessed 02 September 2018].

Appendix A

Interview Guides

Summary

In this appendix the reader is provided with the full interview guides. In *Chapter Two*, a summarised version of these guides was presented to the reader. These interview guides were created to ensure that the interview questions asked directly related to all aspects of the study. This approach illustrated the alignment throughout the study.

Table A.1: Blockchain Stakeholders Interview Guide

#	**Interview question**	**Purpose of question**	**Literature informing the question**	**Research question addressed**	**Themes addressed**	**Aspect of integrated model addressed**
1	What opportunities does blockchain technology offer in terms of record-keeping, taking into account digitisation of documents and digital signatures?	Blockchain technology represents a decentralised digital ledger containing transactional records. According to Vos (2017) and Bal (2017) real estate record-keeping represents one of the technology's biggest use cases. By implementing a blockchain-based land registry, digitisation and automation can occur. This is in contrast to traditionally manual approaches. Through blockchain-based record-keeping systems, transparency is improved as real-time tracking of transactions is possible. Records are more secure as records on blockchain are immutable and transactions are enhanced as costs are reduced are processes are expedited Bal (2017). The purpose of this question is to gain views on how blockchain-based record-keeping can trump manual approaches and the advantages thereof. Furthermore, it aims to uncover what needs to be considered for putting ownership records onto a blockchain network. These answers can then be applied in relation to property records and how a blockchain-based land registry system could operate.	*- Vos (2016)* *- Bal (2017)*	*Research question one*	***Opportunities*:** Immutability; transparency	*Group 2; Group 3*
2	How would core characteristics, such as immutability and transparency, influence adoption of blockchain-based operations?	In *section 4.5* of the literature review immutability and transparency were recognised as key characteristics (and thus opportunities) for blockchain technology's involvement in the estate sector. Transparency allows all records on blockchain to be visible to all participants in a network and immutability means information in the ledger cannot be tampered with (manipulated or deleted), making it both safer and more trustworthy Malviya (2017) and Veldhuizen (2017). This purpose of this question is to understand whether or not blockchain experts see these benefits in the same light as the literature. This question is also aimed at probing their views on the main aspects that can drive the acceptance and adoption of blockchain technology both in South Africa and globally.	*- Malviya (2017)* *- Veldhuizen, (2017)*	*Research question one*	***Opportunities*:** Immutability; transparency ***Challenges*:** Adoption	*Group 2; Group 3*

3	Real estate transactions represent a cumbersome business process – one that primarily adopts a manual paper-based approach comprising various stakeholders and costs. In light of this, how could blockchain technology's qualities such as: transparency, accessibility and speed, and cost reduction, be integrated and used to impact the business process of real estate transactions?	Throughout the literature review, blockchain technology's applicability in the real estate sector was highlighted. Real estate transactions can benefit from: increased speed through smart contracts; concurrent payments and transfers through smart contracts; improved real-time transparency; and reduced fraud as property ownership can be clearly stated, verified, and immutably recorded. The purpose of this question is to determine how applicable experts view blockchain's use in the real estate sector. Additionally, this question probes to determine where the technology can be best adopted in the real estate sector – primarily in transactional tasks or in property record-keeping through a blockchain-based land registry.	*- Barbieri and Gassen (2017)* *- Graglia and Mellon (2018)*	*Research question one **and** research question four*	***Opportunities*:** Transparency; costs; Accessibility and Speed ***Challenges*:** Human involvement; initial information capture	*Group 2; Group 3*
4	Once information is entered into blockchain's ledger it is near impossible to edit and change this information. As a result, it is important that initial information is correct. How would you view both the opportunities and challenges that this brings to real estate transactions and record keeping, given that South Africa (a developing country) has a strong history related to corruption and ambiguity surrounding governmental administration procedures?	From *Section 4.6.2* a key challenge for blockchain's implementation was identified – importing the correct initial property information and ownership rights for a blockchain-based land registry system. Graglia and Mellon (2018) state that records should be entirely correct before being imported onto the blockchain. This is reiterated by Veuger (2017) who states that initial consensus of property rights is vital before records are uploaded to an immutable network. Barbieri and Gassen (2017) sum it up by saying that blockchain technology will not solve the problem of corruption – disputes on property ownership rights will not be rectified by the technology. Once the correct initial information is uploaded, then blockchain's true potential will be realised. This question aims to understand the severity of this challenge in terms of blockchain-based record-keeping. It enquires whether or not a move towards blockchain-based record-keeping systems will be more beneficial than current manual and paper-based systems employed, once (if) hurdles are overcome.	*- Barbieri and Gassen (2017)* *- Veuger (2017)* *- Graglia and Mellon (2018)*	*Main research question **and** research question one*	***Opportunities*:** Immutability ***Challenges*:** Initial information capture	*Group 2*

Table A.2: PropTech Stakeholders Interview Guide

#	**Interview question**	**Purpose of question**	**Literature informing the question**	**Research question addressed**	**Themes addressed**	**Aspect of integrated model addressed**
1	How would you view the impact that blockchain technology has already had on the real estate sector, taking into account the challenges that come with the adoption of emerging technologies?	The integration of technology in the real estate sector is known as PropTech. However, literature shows that real estate practices have been slow to adopt new technologies. PropTech 3.0 sees the incorporation of blockchain technology but with new technologies and new business processes, come new challenges. An obstacle for emerging technologies is the legality involved – for blockchain to be used in real estate transactions, a legal framework must be developed (Couse, 2017; Graglia and Mellon, 2018). Nevertheless, real estate blockchain start-ups are tackling land registration systems and real estate transactions - partnering with governments for blockchain-based transaction laws to be passed (Karayaneva, 2017). Given the technology's involvement in the real estate sector, this question aims to find out the degree to which blockchain is impacting real estate and how. In essence, this question will seek to understand the core aspects of, and areas where blockchain technology has penetrated the real estate sector and will provide knowledge on its implementation and adoption despite present obstacles.	*- Couse (2017)* *- Karayaneva (2017)* *- Graglia and Mellon (2018)*	*Main research question **and** research question three*	***Opportunities*:** Costs; accessibility and speed, transparency ***Challenges*:** Legality; adoption;	*n/a*
2	Smart contracts can provide increased security and transparency to transactions. How do you view the opportunities that smart contracts, in blockchain technology, can bring to real estate transactions, taking into account the traditional processes used?	Smart contracts offer an alternative to traditional paper-based contracts (*see Section 4.3.1*) – representing digital automated contracts that are self-executing once predetermined conditions are met. According to Bal (2017), smart contracts ensure that digitised contracts are regulated by predetermined rules – allowing smart contracts to certify that real estate transactions adhere to government regulations in a land registry system. Smart contracts need data fed in to them. This is made possible through oracles (*trusted 3rd parties on a blockchain network)* – which may prove to be beneficial in real estate transactions. Smart contracts also permit for real time status tracking of transactions. The purpose of this question is to examine how influential smart contracts can be in real estate transactions and how they can be	*- Vos (2016)* *- Bal (2017)*	*Research questions three*	***Opportunities*:** Costs; accessibility and speed; transparency; immutability; smart contracts	*Group 1; Group 2; Group 3*

		employed. Due to the nature of real estate transactions, the question aims to probe participants to elaborate on oracles and their potential inclusion to smart contracts.				
3	Blockchain technology represents the underlying technology on which cryptocurrencies run but that is just one application of the technology. Physical assets, such as real estate, can be represented and virtually stored on blockchain's networks through tokens – "asset backed tokens". In your opinion, how can tokenisation of physical properties enhance real estate practices, taking into account how it would be executed and the benefits it can provide thereafter?	Representing physical assets on the blockchain can occur through tokenisation. Digital tokens can represent physical property - storing property information and being linked to the blockchain address of the owner. Tokenisation allows for fractional and shared ownership (more common in commercial real estate). These tokens aid quicker transaction turnaround times as smart contracts are embedded into them meaning upon completion of predetermined conditions, tokens can be seamlessly transferred. The purpose of this question is to uncover the value of tokenising physical assets such as real estate. While fractional ownership is usually discussed in conjunction with commercial real estate, the possibilities of it in residential real estate will be discussed (*i.e. a couple wants a property in both of their names upon title transfer*). Information on how tokens can be traded and enhance the process will be collected. This question addresses areas of digital identities, not only for people but also for assets.	*- Malviya (2017)* *- Veldhuizen (2017)*	*Research question one*	***Opportunities*:** Smart contracts ***Challenges*:** Adoption	*Group 2; Group 3*
4	Once information is entered into blockchain's ledger it is near impossible to edit and change this information. As a result, it is important that initial information is correct. How would you view both the opportunities and challenges that this brings to real estate transactions and record keeping, given that South Africa (a developing country) has a strong history related to corruption and ambiguity surrounding governmental administration procedures?	From *Section 4.6.2* a key challenge for blockchain's implementation was identified – importing the correct initial property information and ownership rights for a blockchain-based land registry system. Graglia and Mellon (2018) and Veuger (2017) state that records should be entirely correct before being imported onto blockchain's immutable network. Barbieri and Gassen (2017) state that blockchain technology will not solve the problem of corruption – disputes on property ownership rights will not be rectified by the technology. Once the correct initial information is uploaded, then blockchain's potential will be realised. This question aims to understand the severity of this challenge in terms of blockchain-based record-keeping. It enquires whether or not a move towards blockchain-based record-keeping systems will be more beneficial than current manual and paper-based systems employed, once (if) hurdles are overcome.	*- Vos (2016)* *- Barbieri and Gassen (2017)* *- Veuger, (2017)* *- Graglia and Mellon (2018)*	*Main research question **and** research question one*	***Opportunities*:** Immutability ***Challenges*:** Initial information capture	*Group 2*

5	There exist numerous blockchain-based real estate start-ups that accommodate for either property transactions and/or land registration (Propy, ChromaWay, Ubitquity etc.). For blockchain-based real estate start-ups entering the PropTech sector, what aspects (of current real estate transactions) do you believe need immediate technological intervention and adherence?	The literature review revealed there exist various real estate blockchain-based start-ups working on transactions and land registry systems – Propy, ChromaWay, and Ubitquity (Graglia and Mellon, 2018). This paper focusses on Propy, who have conducted numerous real estate transactions through blockchain technology as well implemented blockchain-based land registries. The purpose of the question is to uncover how accommodating real estate practices are for blockchain's involvement and to reveal where the technology is needed most when considering the current transaction process. The question will probe the participants into answering whether or not they are familiar with PEXSA (*a South African based e-conveyancing platform with identical characteristics to blockchain*) and how it assists in South African real estate transactions.	- *Graglia and Mellon (2018)*	*Research question one* ***and*** *research question three*	*n/a*	*n/a*

Table A.3: Conveyancing Stakeholders Interview Guide

#	**Interview question**	**Purpose of question**	**Literature informing the question**	**Research question addressed**	**Themes addressed**	**Aspect of integrated model addressed**
1	How would you describe the current processes of real estate transactions in South Africa, while specifically considering the costs, time, stakeholders involved, and the transfer of funds and property rights?	The literature review conducted on South Africa's current real estate sector (see Section 3.2) revealed four areas of concern – predominantly paper-based, multiple stakeholders, costs, and a mismatch in payment for property vs transfer of title. Amadi-Echendu (2013) and Stoman (2017) believe the process is too reliant on intensive human resources resulting in lengthy transaction turnaround times. PEXSA (2017) stress the inefficient practice of funds being transferred before the title changes ownership represents a situation of risk for the buyer. The purpose is to ascertain whether or not conveyancers in the current market share this point of view and how they would describe the real estate transaction process.	- *Amadi-Echendu (2013)* - *PEXSA (2017)* - *Stoman (2017)*	*Research question two*	***Opportunities*:** Costs; transparency ***Challenges*:** Human involvement	*n/a*
2	Many of the processes involved in South African real estate transactions (such as FICA, bonds, and deeds) are conducted manually and supported by paper-based documents. How would you view this manual approach which is reliant on paper-based documentation, in terms of transaction transparency and overall efficiency?	Real estate transactions in South Africa are dominated by paper-based processes with manual methods of inputting the information. There exists a minimum of 25 physical paper-based documents needed per transaction. Stoman (2017) states that the pressure on the conveyancers coupled with large volumes of paper-based records is prone to error and fraud. Consequently, transaction transparency (specifically to buyers and sellers) is blurred, and stakeholders are reliant on asking others to inform them. However, Couse (2017) mentions that people tend to prefer physical dealings and interactions when it comes to high value assets (real estate) stating that full trust in a decentralised system to manage information and documents will take time. The purpose of this question is to understand conveyancers and deeds official's views towards how paper-driven the process is and how a manual approach hinders transparency and efficiency. This question will probe participants to share their opinions on moving towards digitised and automated processes where information capture is	- *Schindlers Attorneys Conveyancers Notaries (2016)* - *Couse (2017)* - *Stoman (2017)*	*Research question two*	***Opportunities*:** Costs, accessibility and speed; transparency ***Challenges*:** Human involvement; legality	*Group 1*

		seamless manner and once recorded, available for real-time view to everyone involved.				
3	In what stage of South African real estate transactions do you believe technological innovations could significantly enhance the process?	Blockchain technology has assisted real estate transactions in three core areas – reduced paper-based operations through digitisation, concurrent payments and transfers through smart contracts, and an immutable record keeping through blockchain-based land registries Vos (2016). This question will examine where current conveyancers believe technology can assist the process. Their views will either agree with the literature or give insight into other key areas where property transactions could benefit from technological innovation. This question aims to uncover the motivations for why the technology should be integrated into South African processes.	- *Vos (2016)*	*Main research question* ***and r****esearch question one – research question four*	***Opportunities*****:** Costs, immutability; smart contracts ***Challenges*****:** Human involvement; legality; adoption	*Group 1; Group 2; Group 3*
4	In December 2017, South Africa passed the Electronic Deeds Registration System Bill – intending to expedite the deed registration process and increase transaction turnover times. These intentions replicate those of blockchain technology. In your opinion, how does this legislation support the potential use of blockchain technology for South African real estate transactions?	In 2017, the e-DRS bill was passed in South Africa – allowing conveyancers to lodge deeds electronically (digital documents) thus reducing paper-based documents and saving time. The e-DRS has not yet been fully developed or implemented but the bill is being circulated and finalised. A pilot phase was conducted in July 2018 when the Bloemfontein deeds office lodged the first electronic deed. Furthermore, the Payment Exchange of South Africa (PEXSA) system was launched in May 2017 – for concurrent delivery vs payment (funds and title transfer) in real estate transactions. PEXSA allows South African real estate transactions to be settled electronically in a streamlined manner. Thus, local laws and systems for e-conveyancing are being put in place and a move towards digitisation in real estate is occurring. The purpose of this question is to uncover where South Africa is in terms of technology assisting real estate transactions. Furthermore, the question seeks to understand how and when a technology such as blockchain can be accepted into South Africa's legal framework, given the above mentioned movements. In essence, this question looks to gain a conveyancing perspective on when/how such technologies can be legitimately incorporated into	- *Electronic Deeds Registration Systems Bill (2017)* - *PEXSA (2017)*	*Main research question* ***and*** *research question one* ***and*** *research question four*	***Opportunities*****:** Immutability; smart contracts ***Challenges*****:** Legality; adoption;	*Group 3*

		lawful transactions. The question seeks to expose the views of conveyancers towards technological assistance and whether they deem it necessary.				
5	In your opinion, what are the major challenges preventing the adoption of emerging technologies (specifically blockchain technology) in real estate transaction processes?	Five challenges for blockchain's involvement in the real estate sector were identified (*see Section 4.6*). Of the challenges, the need for a legal framework that accounts for blockchain technology would need to be developed. Furthermore, when incorporating any new systems, skills will be needed for implementation and maintenance. Thus, the role of conveyancers may shift. Implementing a blockchain-based system in a third-world/developing country has been questioned. Vos (2016) states that developing nations usually have corruption issues and current property rights may not be a true reflection of reality. Thus, the question aims to understand the views in terms of challenges and whether these align with literature. Based on the answers given, this question will seek to uncover how participants think their role (as a conveyancer) could shift with the introduction of newer technologies involved in the process.	*- Vos (2016)*	*Main research question **and r**esearch question four*	***Challenges*:** Legality; adoption; initial information capture	*n/a*

Table A.4: ICT Legal Stakeholder Interview Guide

#	**Interview question**	**Purpose of question**	**Literature informing the question**	**Research question addressed**	**Themes addressed**	**Aspect of integrated model addressed**
1	Blockchain technology permits the use of smart contracts with digital signatures as well as facilitating payments being made in cryptocurrency. For blockchain-based real estate operations (smart contracts; blockchain-based property documents; and cryptocurrency payments) to be deemed lawfully acceptable, what aspects will need to be considered and what will need to be put in place by South African conveyancing/legal regulations?	The term PropTech refers to how technology is used and incorporated in the property market. Currently in its third phase, PropTech 3.0 involves blockchain technology being utilised in land registries and property transactions (*see Section 4.4).* As per Couse (2017) and Karayneva (2017) legislation for blockchain technology has been passed in various nations such as America, Brazil, and Ukraine. Such legislation permits the acceptance of digitised documents and cryptocurrency payments. Furthermore, companies such as Propy are partnering with government officials to offer both a blockchain-based real estate transaction platform and land registry system. These nations have recognised the efficiency that PropTech 3.0 brings and are adopting emerging technologies. However, for blockchain-based operations to be legally accepted, a legal framework needs to be developed. The purpose of this question is to ascertain where South African legislation is in terms of emerging technologies and technologies used in government recognised transactions. Furthermore, the question aims to understand the legal challenges that come with emerging technologies. The use of blockchain technology in real estate transactions will require a legal framework to be developed and this question seeks to elaborate on when and how such a framework will come about.	- *Couse (2017)* - *Karayaneva (2017)*	*Main research question*	***Opportunities*** **:** Smart Contracts; accessibility and speed ***Challenges*****:** Legality; fraud	*Group 2; Group 3*
2	What role do you think digital identities could play (both for individuals and for assets) in online transactions, taking into account reducing paper-based processes (such as	In conducting the literature review on the South African real estate sector, the reliance on the paper-based process was highlighted (*see Section 3.2.1*). Of the paper-driven process is the FICA documents required by both transacting parties. Buyer and seller are required to submit five physical documents each to the conveyancers involved as	- Amadi-Echendu (2016) - Schindlers Attorneys Conveyancers Notaries (2016) - Ahmed (2017) - *Graglia and Mellon (2018)*	*Main research question*	***Opportunities*** **:** Transparency ***Challenges*****:** Legality; Initial information capture; fraud	*Group 1*

	FICA in South African real estate transactions) and security of verified identification?	well as the municipalities when obtaining rates and clearance (*see Section 3.5.4*), Schlinders (2016). This leads to duplicated information in various siloed systems. Research conducted by a number of authors suggest the use of digital identities for a more secure proof of identification as well as a safer environment of personal privacy, Amadi-Echendu (2016); Ahmed (2017); and Graglia and Mellon (2018). These authors state how blockchain technology can enable digital identities to be created for both individuals and properties (through tokens or coloured coins). A positive factor that these authors mention is that digital identities can be shared and made available for all parties involved in online transactions to whatever degree you wish as long as you can be legitimately and legally verified. The purpose of this question is to determine whether or not digital identities can serve as a valid form of identification for (online) transactions. Additionally, this question seeks to open doors relating to the benefits they could provide (reduce fraud and identity theft and reduce paper-based processes) and the challenges that they possess (access controls and hacking). Primarily, this question aims to evaluate the legality of online digital identities and whether or not digital identities can be legally accepted.				
3	In December 2017, South Africa passed the Electronic Deeds Registration System Bill – intending to expedite the deed registration process and increase transaction turnover times. These intentions replicate those of blockchain technology. In your opinion, how does this legislation support the potential use of blockchain	In 2017, the e-DRS bill was passed in South Africa. This bill allows the conveyancer to lodge deeds electronically thus reducing paper-based documents and saving time as they do not have to be physically present at the deeds office. The e-DRS has not yet been fully developed and implemented but the bill is being circulated and finalised. However, a pilot phase was conducted in July 2018 when the Bloemfontein deeds office lodged the first electronic deed. Furthermore, the Payment Exchange of South Africa (PEXSA) system was launched in May 2017. PEXSA represents a system concurrent delivery vs payment (funds and title transfer) in the real estate sector.	*- Amadi-Echendu (2016)*	*Main research question **and** research question one **and** research question four*	***Opportunities*** **:** Smart contracts; costs; accessibility and speed ***Challenges*****:** Legality; adoption;	*Group 3*

	technology for South African real estate transactions?	The e-conveyancing platform allows real estate transactions in South Africa to be settled electronically in a streamlined manner. As can be seen, laws and systems for e-conveyancing are being put in place in South Africa and there seems to be a move towards digitising real estate transactions. The purpose of this question is to uncover where South Africa is in terms of technology assisting real estate transactions. Furthermore, the question seeks to understand how and when a technology such as blockchain can enter and be accepted into South Africa's legal framework, given the above mentioned movements. In essence, this question looks to gain a legal perspective on when/how such technologies can be legitimately incorporated into lawful transactions.				

Table A.5: BPMN Stakeholders Interview Guide

#	**Interview question**	**Purpose of question**	**Literature informing the question**	**Research question addressed**	**Themes addressed**	**Aspect of integrated model addressed**
1	In BPMN, models are connected through sequence flows and/or message flows which occur in swim-lanes within pools or across independent pools. Based on the models provided, are the flows of information illustrated correctly as per the specific notation?	In BPMN, business processes are presented as sequences of activities with connected flows linking said activities. When communicating within a swim-lane, sequence flows are typically used but when communicating across pools (i.e. communication between different actors) then message flows will be employed, Aguilar-Sven (2004). The purpose of this question is to ensure that the BPMN constructs that have been developed, abide by the correct notation. This question aims to make sure that activities and processes are connected through the right flows both within swim-lanes and across swim-lanes within pools.	*- Aguilar-Savén (2004)*	*Research question two **and** research question three **and** research question four*	*n/a*	*Entire integrated business process model (including earlier models)*
2	In BPMN-based models, activities and processes can be carried out through various tasks (user, manual, service, etc). In the models provided, is the use of the various tasks correct, taking into account the action they are performing?	BPMN models represent business processes. Business processes are carried out by means of activities and tasks. Depending on the task at hand, there is specific notation to illustrate different activities (*i.e. is it manual? does it employ a system? Is it executed automatically?*) Aguilar-Sven (2004). In the BPMN diagrams constructed that illustrate real estate transactions, there exist many different tasks that are executed which all contribute towards achieving the main business process. The purpose of this question is to ensure that all tasks are properly represented for the activity that they are performing.	*- Aguilar-Savén (2004)*	*Research question two **and** research question three **and** research question four*	*n/a*	*Entire integrated business process model (including earlier models)*

Appendix B

Ethical Clearance

Summary

The interview guides above, as well as the integrated business process model presented in *Chapter Six* (see *Figure 6.3*) were put forward to the Rhodes University Ethical Standards Committee (RUESC) – Human Ethics (HE) committee. This was done before any participation correspondence or interview participation was carried out. A pdf document stating that this research could commence with the data collection procedure is provided below.

Ethical Clearance

RHODES UNIVERSITY
Where leaders learn

Human Ethics subcommittee
Rhodes University Ethical Standards Committee
PO Box 94, Grahamstown, 6140, South Africa
t: +27 (0) 46 603 8055
f: +27 (0) 46 603 8822
e: ethics-committee@ru.ac.za

www.ru.ac.za/research/research/ethics
NHREC Registration no. REC-241114-045

5 July 2019
Jack Tilbury
Review Reference: 2019-0528-676
Email: g14T1233@campus.ru.ac.za

Dear Jack Tilbury
Full title:Integrating Blockchain Technology Into The South African Real Estate Transaction Process

Principal Investigator: Mr. Ed de la Rey
Collaborators: Mr. Jack Tilbury ,

This letter confirms that the above research proposal has been reviewed and **APPROVED** by the Rhodes University Ethical Standards Committee (RUESC) – Human Ethics (HE) committee.

Approval has been granted for 1 year. An annual progress report will be required in order to renew approval for an additional period. You will receive an email notifying when the annual report is due.

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on completion of the research. The purpose of this report is to indicate whether the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloguing number allocated. Sincerely

Prof Joanna Dames
Chair: Human Ethics Committee, RUESC- HE

Appendix C

Participant Correspondence

Summary

In this appendix, the reader is presented with the documents pertaining to the participation correspondence for this research. This process involved reaching out to potential interview participants informing them of what the process will involve. Following this the principal investigator needed to obtain consent from all participants. This consent occurred at two levels. Firstly, individual consent was attained from the participant themselves. Secondly, and where applicable, the research ensured that institutional consent was also provided from the participants organisation or company. The templates of these documents are provided below. Upon engaging in participant correspondence, these documents were adjusted accordingly.

RHODES UNIVERSITY

Grahamstown ⋆ 6140 ⋆ South Africa

DEPARTMENT OF INFORMATION SYSTEMS
Tel: [+27] 84 626 4016
E-mail: g14t1233@ru.ac.za

XX/

XX/2019 Drosty Road
Grahamstown
6139

Dear [Name]

Re: Invitation to participate in research study

You are invited to participate in a research study entitled: **Integrating Blockchain Technology into the South African Real Estate Transaction Process.** The aim of this research is to determine how blockchain technology can be integrated into the South African real estate transaction process. Furthermore, it is the intention of this research to produce an integrated business process model. Your participation and cooperation are important so that the results of the research are accurately portrayed.

The research will be undertaken through interviews which will be conducted digitally and/or telephonically. These interviews will be in-depth interviews that are semi-structured in nature meaning that the predetermined questions will be asked but the possibility of additional questions arising from the interaction is likely. The data to be collected from this research will be qualitative data which will be collected through in-depth interviews. The data collected will be the opinions and views of the interview participants based on the questions asked. Your identity and that of your institution will be treated with complete confidentiality. The collection of this data will require about 60 minutes of your time to complete. I would like to make it clear that audio recordings will be made of the video interviews. I will place a recording device next to the computer in order to capture the audio from the video interview. This will be made clear in the consent form as well and you, the participant, will have the choice on whether you approve or not.

We will provide you with all the necessary information to assist you to understand the study and explain what would be expected of you (the participant). These guidelines would include the risks, benefits, and your rights as a study subject. Furthermore, it is important that you are aware that this study has been approved by a Research Ethics Committee of the university.

Participation in this research is completely voluntary and this letter of invitation does not obligate you to take part in this research study. To participate, you will be required to provide written consent that will include your signature, date and initials to verify that you understand and agree to the conditions. Please note that you have the right to withdraw at any given time during the study without penalty.

Thank you for your time and I hope that you will find our request favourable.

Yours sincerely,

Jack Tilbury	Ed de la Rey	Karl van der Schyff
Research Student	**Supervisor**	**Co-Supervisor**

www.ru.ac.za

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INFORMED CONSENT FORM

Department of Information Systems

Research Project Title:	Integrating Blockchain Technology Into The South African Real Estate Transaction Process
Principal Investigator(s):	Jack Tilbury

Participation Information

I understand the purpose of the research study and my involvement in it
I understand the risks of participating in this research study
I understand the benefits of participating in this research study
I understand that I may withdraw from the research study at any stage without any penalty
I understand that participation in this study is done on a voluntary basis
I understand that while information gained during the study may be published, I will not be identified and my personal results will remain confidential

I understand that I will receive no payment for participating in this study
I understand that audio recordings will be made from the video through a recording device placed next to the computer during the video call.

I understand and give permission for the audio from the video call to be recorded during the interview.

Information Explanation

The above information was explained to me by: Jack Tilbury

The above information was explained to me n: ☒ English ÛAfrikaans isiZulu

00ther: and I am in command of this language

OR, it was comprehensibly translated to me by: n/a

Voluntary Consent		
I, _____, hereby voluntarily consent to participate in the above-mentioned research.		
Signature:	OR, right hand thumb print Witness signature:	Date: /2019

Investigator Declaration	
l, Jack Tilbury, declare that I have explained all the participant information to the participant and have truthfully answered all questions ask me by the participant.	
Signature: 	Date: 20/05/2019

Translator Declaration (n/a)	
l, n/a, declare that I translated a factually correct version of: 1. all the contents of this document 2. all questions posed by the participant 3. all answers given by the investigator In addition, I declare that all information acquired by me regarding this research will be kept confidential.	
Signature n/a	Date:

Notes to Researcher:

• The informed consent must explicitly exclude minors and other vulnerable populations that need bystanders

Participant Correspondence

RHODES UNIVERSITY

Grahamstown • 6140 • South Africa

DEPARTMENT OF INFORMATION SYSTEMS
Tel: [+27] 84 626 4016
E-mail: g14t1233@ru.ac.za

20/05/2019

[Head of Institution]
[Address of Institution]

Dear [Name]

Re: Invitation to conduct research at your institution

Jack Tilbury (under the supervision of Ed de la Rey and Karl van der Schyff) is an Information Systems postgraduate student [Masters] at Rhodes University carrying out research on blockchain-based process modellings in real estate transactions. The aim of this research is to determine how blockchain technology can be integrated into the South African real estate transaction process. Furthermore, it is the intention of this research to produce an integrated business process model. The participation and cooperation of your institution is important so that the results of the research are accurately portrayed.

The research will be undertaken through interviews which will be conducted digitally and/or telephonically. These interviews will be in-depth interviews that are semi-structured in nature meaning that the predetermined questions will be asked but the possibility of additional questions arising from the interaction is likely. The interview will be conducted with [someone in the institution]. The data to be collected from this research will be qualitative data which will be collected through in-depth interviews. The data collected will be the opinions and views of the interview participants based on the questions asked. The identity of your institution and the employees who voluntarily consent to participate will be treated with complete confidentiality. The collection of this data will require from each participant about 60 minutes to complete.

We look to you for acceptance in conducting interviews with employees at your institute (at a time and date that suites them).

Attached for your information is a copy of the participant's Informed Consent Form. If you have questions or wish to verify the research, please feel free to contact us. If you would like your institution to participate in this research, please complete and return the attached form.

Thank you for your time and I hope that you will find our request favourable.

Yours sincerely,

Jack Tilbury	Ed de la Rey	Karl van der Schyff
Research Student	**Supervisor**	**Co-Supervisor**

Notes to researcher:

- Any involvement of students in general, if this is not part of their subject, requires the approval of the Dean of Students
- If the research is carried out in the public areas of the university, the permission of the Registrar is required, and if staff is involved the approval of the Registrar or the Director: Human Resources is required.

Integrating Blockchain Technology into The South African Real Estate Transaction Process
Institution Consent Form

Participation Consent
I consent for you to approach employees [specify which employees e.g. "in HR"]:_____, to participate in the Integration of Blockchain Technology Into The South African Real Estate Transaction Process
I acknowledge and understand:
• The role of the institution is voluntary. • I may decide to withdraw the institution's participation at any time without penalty. ☐ Employees [specify which employees e.g. "in HR"] :_____, will be invited to participate and that permission will be sought from them too. • Only employees who consent will participate in the project. • All information obtained will be treated in strictest confidence. • The employees' names will not be used and individual employees will not be identifiable in any written reports about the study. • The institution will not be identifiable in any written reports about the study. • Participants may withdraw from the study at any time without penalty. • A report of the findings will be made available to the institution. • I may seek further information on the project from **Jack Tilbury** on **084 626 4016**.

Full Name:	
Position:	
Signature:	
Date:	/ /2019

Please return to:	**Jack Tilbury** **Email: jacktibba@gmail.com OR g14t1233@campus.ru.ac.za**

www.ru.ac.za