

The perceived obstacles to the adoption of Blockchain Technology for Interbank Payments in South Africa

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ABSTRACT

Technological innovation in the financial industry has evolved immensely over the past decade. The innovation in the payment space has grown leaps and bounds with online and mobile payments. The South African Multiple Option Settlement System (SAMOS) which is a subset of the general ledger of the South African Reserve Bank (SARB), is the solitary settlement system in South Africa and is owned and operated by the SARB since 1998. Under the National Payment System (NPS) Act, any entries passed are final and irrevocable. The messages of SAMOS are based on the standards and message types of the Society for Worldwide Interbank Financial Telecommunication (SWIFT) (CPSS, 2012).

Recent technological innovation in Blockchain which is a type of Distributed Ledger Technology (DLT) based system has assured enhancement in payment systems without the need for extensive networks and centralised administrators. DLT enables the direct exchange of tokens of value and allows real-time messaging and clearing within a cryptographically secure and resilient environment (Patel, 2017). There are numerous Central Banks around the world that have or are developing prototypes for their domestic interbank settlement systems using DLT. The first phases of the projects were proof of concepts that explored opportunities for DLT to improve the existing payments systems or Real-time Gross Settlement Systems (RTGS) infrastructure (Zhao, Zhang, Rutter, Thompson and Wan, 2018). Many Central Banks that have completed proof of concepts have documented that that their projects were successful.

The aim of this research was to identify the perceived obstacles to the adoption of Blockchain technology for interbank payments in South Africa as numerous successful proofs of concept projects have been concluded by various Central Banks globally including South Africa.

A qualitative research paradigm was used for this research and semi- structured interviews were conducted to collect data. The process of purposive sampling of

non-probability sampling method was applied. This allowed the researcher to use his experience and ingenuity to deliberately select the participants in a manner that the sample was regarded as being representative of the relevant population. The data collected was analysed and interpreted through thematic analysis.

The data analysis revealed that Blockchain technology can work for interbank payments in South Africa however the biggest obstacles are the negative perception around Blockchain technology due to the volatility of Bitcoin cryptocurrency, the central authority fear of losing control, the lack of a compelling business case, business continuity risk, challenges in terms of the interoperability of Blockchain based DLT systems with Banking legacy systems, the cost benefit of a Blockchain based DLT system and the lack of technology maturity and skills in South Africa.

The Central Banks globally together with the Bank of International Settlements should meet to compile a payments systems business case. Technologist must be excluded from this meeting. The business case must be based on the requirements and need for a Blockchain based DLT payment system. The Principles for Financial Market Infrastructures (PFMIs) should be the one of the main focus areas as it helps to adopt the appropriate platform for a Blockchain based DLT system. Once a compelling business case is derived, the South African Central Bank should organise a meeting with the South African financial services industry to discuss the Governance and Regulation of a Blockchain based DLT system.

DECLARATION

I, Mergan Naidoo, declare that this research article is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the Graduate School of Business Administration, University of the WitwatersRand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Mergan Naidoo

Signed at

On the day of 2019

DEDICATION

This research is dedicated to:

- My amazing wife Felicia Venesa Naidoo for her continued support and encouragement through this journey.
- My children Aaliyah, Sashni and Noah Naidoo for their understanding and support.
- My manager Cornelia Jordaan for her support and encouragement.

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TABLE OF CONTENTS

ABSTRACT	ii
DECLARATION.....	iv
DEDICATION	v
ACKNOWLEDGEMENTS.....	vi
SUPPLEMENTARY INFORMATION	vii
TABLE OF CONTENTS	1
1. CHAPTER 1. INTRODUCTION	5
1.1 PURPOSE OF THE STUDY	5
1.2 CONTEXT OF THE STUDY.....	5
1.3 PROBLEM STATEMENT	7
1.3.1 MAIN PROBLEM.....	7
1.4 SIGNIFICANCE OF THE STUDY.....	7
1.5 RESEARCH SETTING	8
1.6 DELIMITATIONS OF THE STUDY.....	8
1.7 DEFINITION OF TERMS	8
1.8 ASSUMPTIONS	9
2 CHAPTER 2. LITERATURE REVIEW	9
2.1 INTRODUCTION	9
2.2 THE NATIONAL PAYMENTS SYSTEM FRAMEWORK AND INTERBANK SETTLEMENT NETWORK	10
2.3 BLOCKCHAIN BASED DLT AND ITS INFRASTRUCTURE.....	15
2.3.1 PERMISSIONLESS BLOCKCHAINS	15
2.3.2 PERMISSIONED BLOCKCHAINS	15
2.4 TYPES OF BLOCKCHAINS	21
2.4.1 ETHEREUM BLOCKCHAIN	21
2.4.2 QUORUM BLOCKCHAIN	21
2.4.3 CORDA BLOCKCHAIN	22
2.4.4 HYPERLEDGER FABRIC BLOCKCHAIN.....	22
2.4.5 RIPPLE BLOCKCHAIN	23
2.5 DISTRIBUTED LEDGER TECHNOLOGY IN THE FINANCIAL SERVICES INDUSTRY	23

2.6	BLOCKCHAIN PROJECTS CONDUCTED BY THE FINANCIAL SERVICES INDUSTRY.....	27
2.6.1	PROJECT UBIN.....	27
2.6.2	PROJECT JASPER.....	28
2.6.3	PROJECT STELLA.....	30
2.6.4	PROJECT BRAZIL.....	31
2.6.5	PROJECT KHOKA.....	32
2.7	LITERATURE REVIEW CONCLUSION.....	34
2.8	RATIONAL FOR CONDUCTING THE RESEARCH	35
3	CHAPTER 3. RESEARCH DESIGN AND METHODOLOGY	36
3.1	RESEARCH PARADIGM.....	36
3.2	RESEARCH APPROACH AND DESIGN	36
3.3	POPULATION, SAMPLING METHOD AND SAMPLING SIZE.....	37
3.4	DATA COLLECTION TECHNIQUES	38
3.5	METHODS OF DATA ANALYSIS.....	39
3.6	LIMITATIONS OF THE RESEARCH	40
3.7	VALIDITY AND RELIABILITY	40
3.8	ETHICAL CONCERNS	41
4	CHAPTER 4. PRESENTATION OF RESULTS	41
4.1	INTRODUCTION	41
4.2	RESULTS PERTAINING TO RESEARCH QUESTION 1	42
4.2.1	BLOCKCHAIN TECHNOLOGY FEASIBILITY IN THE PAYMENTS INDUSTRY	42
4.3	RESULTS PERTAINING TO RESEARCH QUESTION 2	43
4.3.1	FEAR OF ADOPTION.....	43
4.3.2	CENTRAL AUTHORITY CONTROL.....	44
4.3.3	COMPELLING BUSINESS CASE.....	45
4.4	RESULTS PERTAINING TO RESEARCH QUESTION 3	47
4.4.1	CENTRAL BANK REGULATION.....	47
4.4.2	PAYMENTS SYSTEMS GOVERNANCE.....	49
4.5	RESULTS PERTAINING TO RESEARCH QUESTION 4	50
4.5.1	BUSINESS CONTINUITY RISK.....	50
4.6	RESULTS PERTAINING TO RESEARCH QUESTION 5	52
4.6.1	INTEROPERABILITY WITH LEGACY BANKING SYSTEMS.....	52
4.6.2	COST BENEFIT TO THE ADOPTION OF BLOCKCHAIN TECHNOLOGY.....	54
4.6.3	TECHNOLOGY MATURITY AND SKILLS IN SOUTH AFRICA	55
4.7	SUMMARY OF THE RESULTS	57
5	CHAPTER 5. DISCUSSION OF THE RESULTS.....	58
5.1	INTRODUCTION	58
5.2	DISCUSSION PERTAINING TO RESEARCH QUESTION 1	58
5.2.1	BLOCKCHAIN TECHNOLOGY FEASIBILITY	58
5.3	DISCUSSION PERTAINING TO RESEARCH QUESTION 2	59

5.3.1	FEAR OF ADOPTION.....	60
5.3.2	CENTRAL AUTHORITY CONTROL.....	60
5.3.3	COMPELLING BUSINESS CASE.....	61
5.4	DISCUSSION PERTAINING TO RESEARCH QUESTION 3.....	62
5.4.1	CENTRAL BANK REGULATION.....	62
5.4.2	PAYMENTS SYSTEMS GOVERNANCE.....	63
5.5	DISCUSSION PERTAINING TO RESEARCH QUESTION 4.....	64
5.5.1	BUSINESS CONTINUITY RISK.....	64
5.6	DISCUSSION PERTAINING TO RESEARCH QUESTION 5.....	65
5.6.1	BLOCKCHAIN AND DLT INTEROPERABILITY WITH LEGACY SYSTEMS	66
5.6.2	COST BENEFIT TO THE BANKING INDUSTRY	67
5.6.3	TECHNOLOGY MATURITY AND SKILLS IN SOUTH AFRICA	68
6	CHAPTER 6. CONCLUSION AND RECOMMENDATIONS .	68
6.1	INTRODUCTION	68
6.2	CONCLUSION OF THE STUDY	69
6.3	RECOMMENDATIONS	70
6.4	SUGGESTIONS FOR FURTHER RESEARCH	72
7	REFERENCES	73
8	APPENDIX A.....	78
8.1	RESEARCH INSTRUMENT	78
9	APPENDIX B.....	79
9.1	INTERVIEW REQUEST EMAIL.....	79

LIST OF FIGURES

Figure 1: Participating institutions	11
Figure 2: Payment System Network.....	12
Figure 3: Settlement message exchange mechanism.....	14
Figure 4: Blockchain (DL) Network - Example of a transaction	16
Figure 5: Distributed ledger (DL) network - all records are updated.....	17
Figure 6: Centralised Ledger vs Distributed Ledger	18

Figure 7: The process of a distributed ledger transaction	19
Figure 8: The structure of a Blockchain.....	20
Figure 9: Anatomy of a Blockchain transaction	24
Figure 10: Outcomes of hypotheses tested.....	33
Figure 11: Fear of SARB losing control.....	45
Figure 12: Is not having a compelling business case an obstacle for adoption of Blockchain.....	46
Figure 13: Is Regulation an obstacle to adoption of Blockchain.....	47
Figure 14 : Is Governance an obstacle for adopting Blockchain	50
Figure 15: Business continuity is an obstacle.....	51
Figure 16: Is Interoperability an Obstacle.....	54
Figure 17: Is cost an obstacle to adopting Blockchain	55
Figure 18: Technology Maturity and Skills	56

1. CHAPTER 1. INTRODUCTION

1.1 Purpose of the study

The purpose of this qualitative research study is to identify the perceived obstacles to the adoption of Blockchain technology for interbank payments in South Africa.

1.2 Context of the study

The wheels of the South African economy are oiled by payments made by millions of its citizens and businesses. Payment choices available to South Africans range from cash to electronic payments that include credit and debit cards, debits orders, mobile payments and online internet payments. Each day an excess of 350 billion Rand is settled through the National Payment System (NPS) (PASA, 2018). According to SARB (2008) the NPS system does not only involve interbank payments but incorporates the entire payment process which encompasses all relevant systems, mechanisms, institutions, procedures, rules and law. This process comes into effect once a user utilising a payment instrument issues an instruction to make a payment to an individual or business and continues through to the final interbank settlement of the transaction in the books of the Central Bank. The NPS is therefore an important component in enabling transacting parties to exchange value to direct business proficiently (SARB, 2008).

Technological innovation in the financial industry has evolved immensely over the years. The industry has progressed from utilising only cash to a digital arena. The digital arena has made payments for the end-user simple and effective however it lacks some efficiency. The South African Reserve Bank (SARB) in their media statement for their launch of the National Payment System's (NPS) Vision 2025, stated that it is vitally important that as a public service, payment systems are able to meet the ever increasing needs of South Africans (SARB, 2018a). The past decade has seen swift developments which surpassed previous decades. This has enabled consumers of the country to

benefit greatly from innovations such as mobile and internet payments. These innovations make electronic payments and remittances a reality across jurisdictions (SARB, 2018b).

According to SARB (2017) the promotion of innovation necessitates collaboration at an infrastructure and network level. The important element in this regard is recognising what are the business impacts and possible risks associated with new technological developments such as Real-time payments (RTPs), Application programming interface (API) and Distributed Ledger Technology (DLT). These technological developments could allow players in the industry to expand their scope and include services that will address the unbanked and underbanked citizens in rural areas of the country. This would essentially address the social, economic and technological challenges in the greater economy as industry stakeholders would respond accordingly. Patel (2017) states that recent technological innovation in Blockchain which is a type of DLT based system has assured enhancement in payment systems without the need for extensive networks and centralised administrators. DLT enables the direct exchange of tokens of value and allows real-time messaging and clearing within a cryptographically secure and resilient environment.

There are numerous Central Banks around the world that have or are developing prototypes for their domestic interbank settlement systems using DLT. The first phases of the projects were proof of concepts that explored opportunities for DLT to improve the existing Payments systems or Real-time Gross Settlement Systems (RTGS) infrastructure (Zhao, Zhang, Rutter, Thompson and Wan, 2018). Many Central Banks that have completed proof of concepts have documented that their projects were successful.

This makes one wonder why, about ten years after Bitcoin was created, the utilisation of Blockchain technology has not yet turned out to be more predominant? There are absolutely no straightforward answers and the reasons are probably going to differ a great deal depending upon which particular segments we are concentrating on (Teis, 2017).

1.3 Problem statement

1.3.1 Main Problem

The aim of this research is to identify the perceived obstacles to the adoption of Blockchain technology for interbank payments in South Africa as numerous successful proofs of concept projects have been concluded by various Central Banks globally including South Africa.

1.4 Significance of the Study

The current payment system SAMOS serves the needs of the South African Banking industry participants and its stakeholders at large. There is however inefficiencies in the system with regards to delayed payments both from the wholesale and retail industries. Numerous Central Banks globally have completed successful use cases on Blockchain and DLT. To date no Central Bank has adopted the technology for interbank payments.

The study aims to uncover what are the perceived obstacles that are inhibiting the adoption of Blockchain or DLT for interbank payments. This study should provide reasons as to why Blockchain or DLT is not being adopted for interbank payments in South Africa.

The study is focussed on the Banking industry and specifically payment systems however DLT and Blockchain technologies can be utilised into many sectors of business e.g. legal contracts and logics. The technologies may also be of particular interest to groups interested in financial technology, currency management and digital currencies. There are different learnings for different sectors of business however the study will provide insight that will be relevant to all current and aspiring businesses people.

1.5 Research Setting

The South African Banking Industry is the setting for this research. The area of study for this proposal is at the SARB National Payment Systems (NPS) Department, the SARB Fintech Department, Commercial and Investment Banks, Payments Association South Africa (PASA), the Banking Association of South Africa (BASA), Payment Clearing House Bankserve, Fintech Companies, The Council for Scientific and Industrial Research and Consulting companies located in Gauteng South Africa. The researcher resides and works in Gauteng and is employed by the South African Reserve Bank.

1.6 Delimitations of the study

- The research is only focussed on the interbank payments system within South Africa.
- The Southern African Development Community (SADC) is not part of this research.

1.7 Definition of Terms

SAMOS – “The South African Multiple Option System (SAMOS) is an automated interbank settlement system provided by the South African Reserve Bank (SARB) for banks to settle their obligations on an immediate real-time basis, or in a delayed settlement arrangement, providing guaranteed settlement” (SARB, 2019).

SWIFT – “Society for Worldwide Interbank Financial Telecommunication (SWIFT) is a global member-owned cooperative and the world’s leading provider of secure financial messaging services” (SWIFT, 2019).

Distributed Ledger Technology – “Distributed Ledger Technology is an umbrella term used to describe technologies which store, distribute and facilitate the exchange of value between users, either privately or publicly”

(Thake, 2018). “Distributed Ledger Technology (DLT) is a digital system for recording the transaction of assets in which the transactions and their details are recorded in multiple places at the same time. Unlike traditional databases, distributed ledgers have no central data store or administration functionality” (Rouse, 2017).

Blockchain – Blockchain is a type of DLT, a subcategory of a more broad definition (Thake.2018). “The term "Blockchain technology" typically refers to the transparent, trustless, publicly accessible ledger that allows us to securely transfer the ownership of units of value using public key encryption and proof of work methods. The technology uses decentralized consensus to maintain the network, which means it is not centrally controlled by a bank, corporation, or government. In fact, the larger the network grows and becomes increasingly decentralized, the more secure it becomes” (Alyson, 2018).

1.8 Assumptions

- All participants will participate in the research.
- The participants will be honest and objective.
- The participants will appreciate the value of the research.

The literature review that follows will focus on previous proof of concepts carried out by Central Banks around the globe followed by the research methodology.

2 CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

According to Fox and Bayat (2014) a literature review is a critical evaluation and synopsis of the past and contemporary literature in a given subject matter. The reasons and objectives of a literature review are to assist in understanding the

authenticities and theories in the selected field. It also gives a theoretical frame of orientation that may be used to evaluate your own study and research results.

The literature review will focus on Blockchain based Distributed Ledger Technology (DLT) projects and studies undertaken by central banks globally. It is however important to first understand the framework and topology of the National Payments System (NPS) in South Africa and also to understand Blockchain and Distributed Ledger Technologies and its infrastructure.

2.2 The National Payments System Framework and Interbank Settlement Network

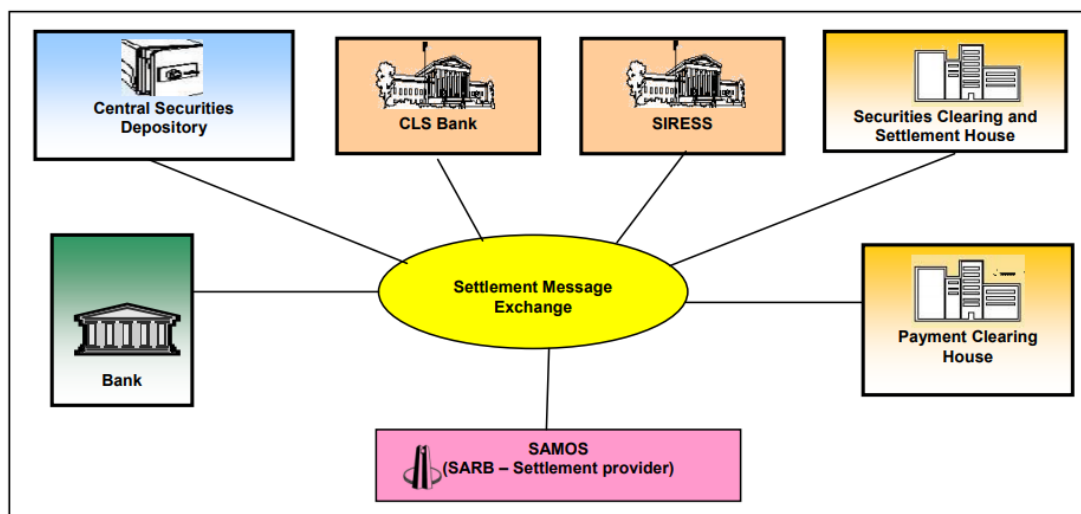
The South African Reserve Bank's (SARB) role and responsibilities in the domestic payment system is governed in the South African Reserve Bank Act, 1989 (Act No 90 of 1989 – the SARB Act). The SARB is authorised to “perform such functions, implement such rules and procedures and, in general, take such steps as may be necessary to establish, conduct, monitor, regulate and supervise payment, clearing and settlement systems”. The effectiveness and integrity of the National Payment System (NPS) is ensured by the SARB and therefore it has the authority to administer the complete payment process, from the moment the payer initiates a payment until the point when the recipient obtains the money (CPSS, 2012).

Central Bank money in the form of passing of entries in its books or cash is the only assets utilised by payment system participants to settle interbank obligations. The South African Multiple Option Settlement System (SAMOS) which is a subset of the general ledger of the SARB, is the solitary settlement system in South Africa and is owned and operated by the SARB since 1998. Under the NPS Act, any entries passed are final and irrevocable (CPSS, 2012). According to Masela (2012) settlement in SAMOS includes the “financial market transactions Rand settlement, interbank transactions and the settlement of foreign exchange transactions with other global banks”.

The liquidity, information and communication technology which includes security requirements set by the SARB must be met by settlement participants in order to participate in SAMOS (Masela, 2012). The SAMOS which is a Real-time Gross Settlement System (RTGS) has an extremely high degree of operational reliability, contingency and security. Its security policies comprise of the network infrastructure and security. The security solutions evolve with technology and when local and international industry standards are improved. Service level and accompanying service level agreements are meticulously matched on an operational level when changes are necessary (CPSS, 2012).

The NPS consists of different tiers of banks or participants that function within the SAMOS payment systems. They include 30 participants, clearing systems and operators (CPSS, 2012). According to Project Khoka Fintech report, the participants in the settlement network include the SARB, registered branches of foreign institutions, cooperative banks, commercial banks, mutual banks and designated settlement systems (SARB, 2018c). Banks that don't qualify to participate in the SAMOS systems use sponsorship arrangements with other qualifying banks to clear and settle payment (CPSS, 2012). Masela (2012) confirms that at least two institutions in addition to the SARB are required for every settlement instruction. The figure below depicts the types of institutions that are involved in the payment system.

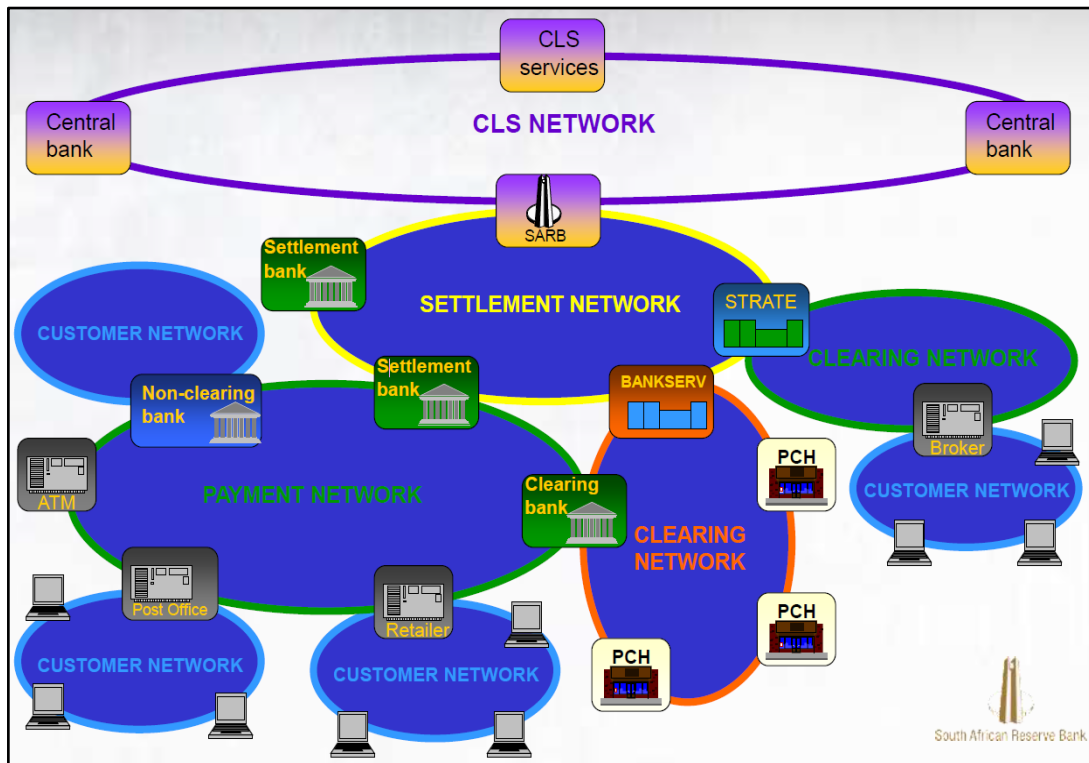
Figure 1: Participating institutions



Source adapted from "Position Paper on the Interbank Settlement Application Interfaces" (SARB, 2014)

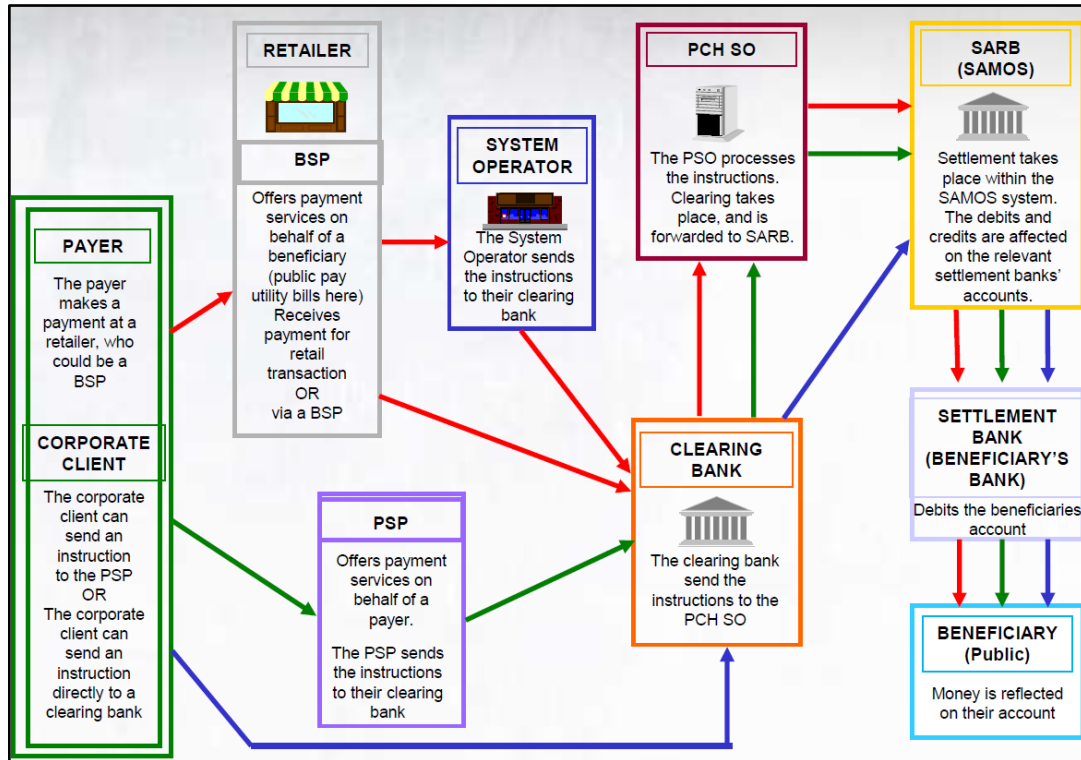
The Bank of International Settlements (BIS) delineates clearing as “the process of transmitting, reconciling and confirming payment orders or security transfer instructions prior to settlement, possibly the netting of instructions and the establishment of final positions for settlement” (Masela, 2012). The figures that follow illustrate the payment system network and the payment flows within the NPS.

Figure 2: Payment System Network



Source adapted from Access to the National Payment System (Masela, 2012)

Figure 3: Payment Flows in the NPS



Source adapted from Access to the National Payment System (Masela, 2012)

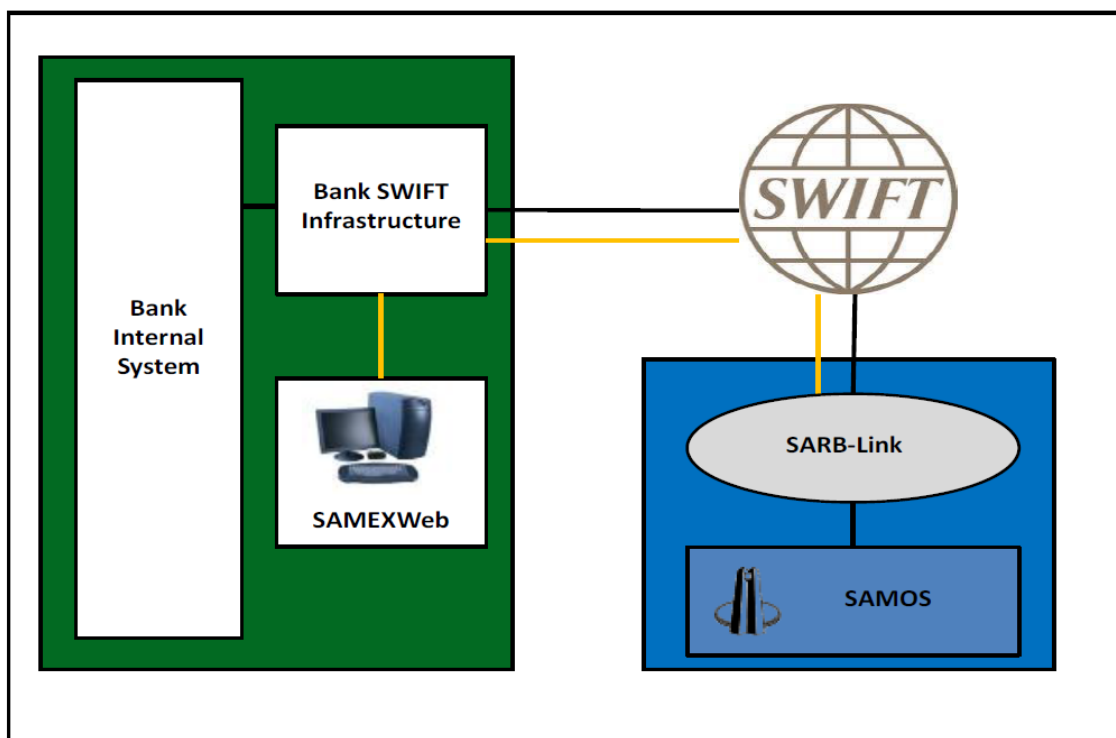
The messages of SAMOS are based on the standards and message types of the Society for Worldwide Interbank Financial Telecommunication (SWIFT). This requires that participants of SAMOS be registered at SWIFT and use a SWIFT BIC-8 code. Participants are identified by a unique number which differentiates them from other users in the system (CPSS, 2012).

The SARB-Link which is a message management and routing facility is the core of the message exchange infrastructure. Instructions are accepted by the SARB-Link through the SWIFTNet services and then routed to the SAMOS application. Upon completion of the process, messages are passed back to the SARB-Link by the SAMOS application. The SARB-Link routes the messages through the applicable SWIFTNet services. The SARB-Link quarantines the SAMOS application from communication complexities and warrants that the transmission and routing of settlement instructions are secure, reliable and auditable. SARB-Link functions include the following (SARB, 2014):

- “Validation of instruction header information, including the logical and physical network addresses and message types;
- Message authentication and encryption/decryption, as well as user and security key administration;
- Secure routing of instructions based on routing rules and message types;
- Logging and time stamping of messages, and maintenance of an audit trail of every message as well as enquiry facilities on the status of messages;
- Intermediate safe storing of messages for delivery to the destination;
- The sequencing and queuing of messages from various sources;
- Guaranteed once and once only delivery of messages and
- Communication protocol conversion and communication gateway services for the predetermined protocols and communication software interfaces”.

The figure following illustrates the settlement message exchange mechanism topology.

Figure 3: Settlement message exchange mechanism



Source adapted from “Position Paper on the Interbank Settlement Application Interfaces” (SARB, 2014)

According to the Interbank Settlement Application Interfaces position paper (2014) the architecture of the SARB-Link supports the provision of the RTGS

system and continues to evolve since the inception of the SAMOS system in 1998. The SARB-Link ensures: “an appropriate, affordable and cost-effective means for participants to interface with the SAMOS system; a solution based on the de facto standards for processing financial transactions; a modular approach which is easily adapted or expanded to satisfy future business needs; the isolation and protection of the applications resident at the various participants from one another and the Reserve Bank through the use of a message-based instruction flow” (SARB, 2014).

2.3 Blockchain based DLT and its Infrastructure

Blockchain is applauded as a technological innovation that revolutionises how people interact and trade. Its reputation is specifically inferable to its properties of permitting mutually mistrusting entities to exchange financial value and interact without placing reliance on a trusted third party. It also offers integrity protected data storage and affords process transparency (Wüst & Gervais, 2017). According to Deloitte (2015) Blockchain is a distributed general ledger recording that confirms a transaction took place, when it took place and that it occurred accurately. It does this without revealing confidential data about the transaction or entities involved. There are two types of Blockchains namely permissionless and permissioned Blockchains.

2.3.1 Permissionless Blockchains

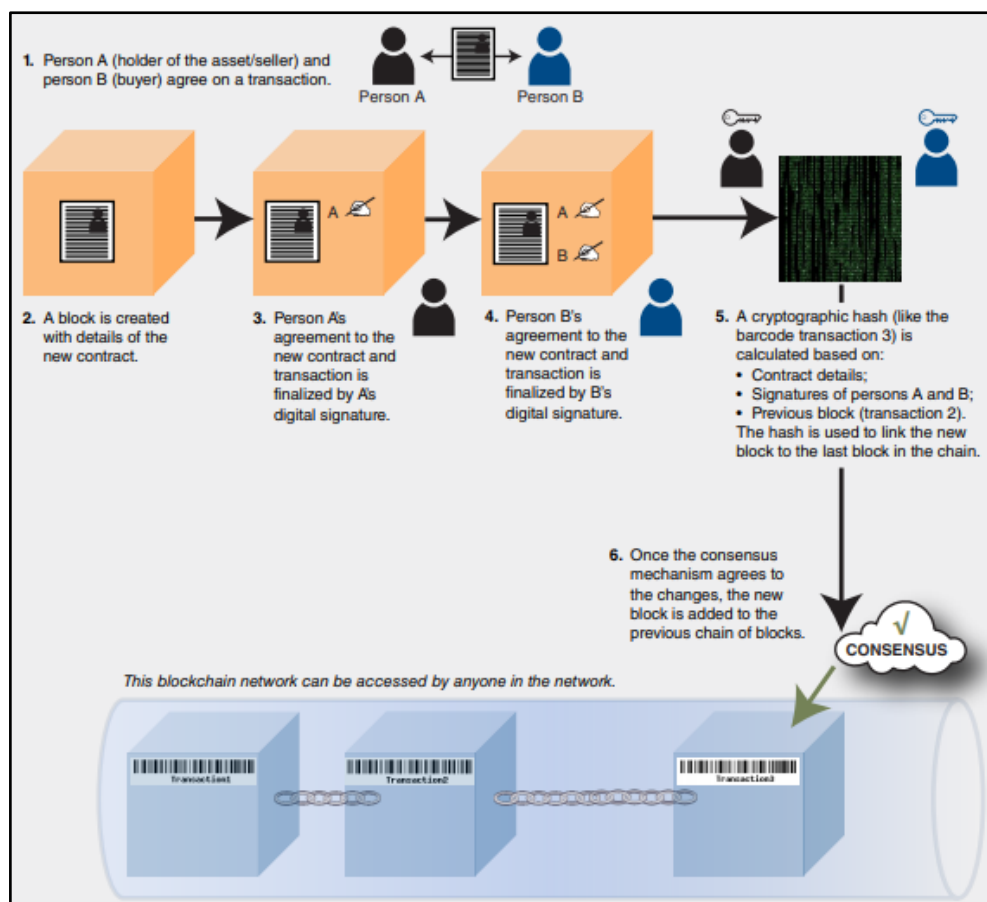
These Blockchains are open, decentralised and written content is readable by any peer. This means that at any time any peer can join or resign from the network as a reader or writer. There is no central authority that manages the membership however it is technically feasible to hide private relevant information with the use of cryptographic primitives. Examples of permissionless Blockchains are Bitcoin and Ethereum (Wüst & Gervais, 2017).

2.3.2 Permissioned Blockchains

A central authority only authorises a limited set of individual peers to participate in the read or write operations of the Blockchain. To provide additional privacy, the reader and writer could run in a separated parallel Blockchain that is interconnected. Examples of permissioned Blockchains are Hyperledger Fabric and R3 Corda Distributed Ledger Technology utilised in the financial services industry (Wüst & Gervais, 2017).

The name Blockchain comes from its technical structure, a chain of blocks. Each block is connected to the preceding block with a cryptographic hash. A block is a data structure which permits to retain a list of transactions. Transactions are made and exchanged by peers of the Blockchain network and alter the condition of the Blockchain. Transactions can trade monetary sums, yet are not confined to financial exchanges and for instance, permit to execute arbitrary code within smart contracts (Wüst & Gervais, 2017). The following figure illustrates an example of a typical transaction.

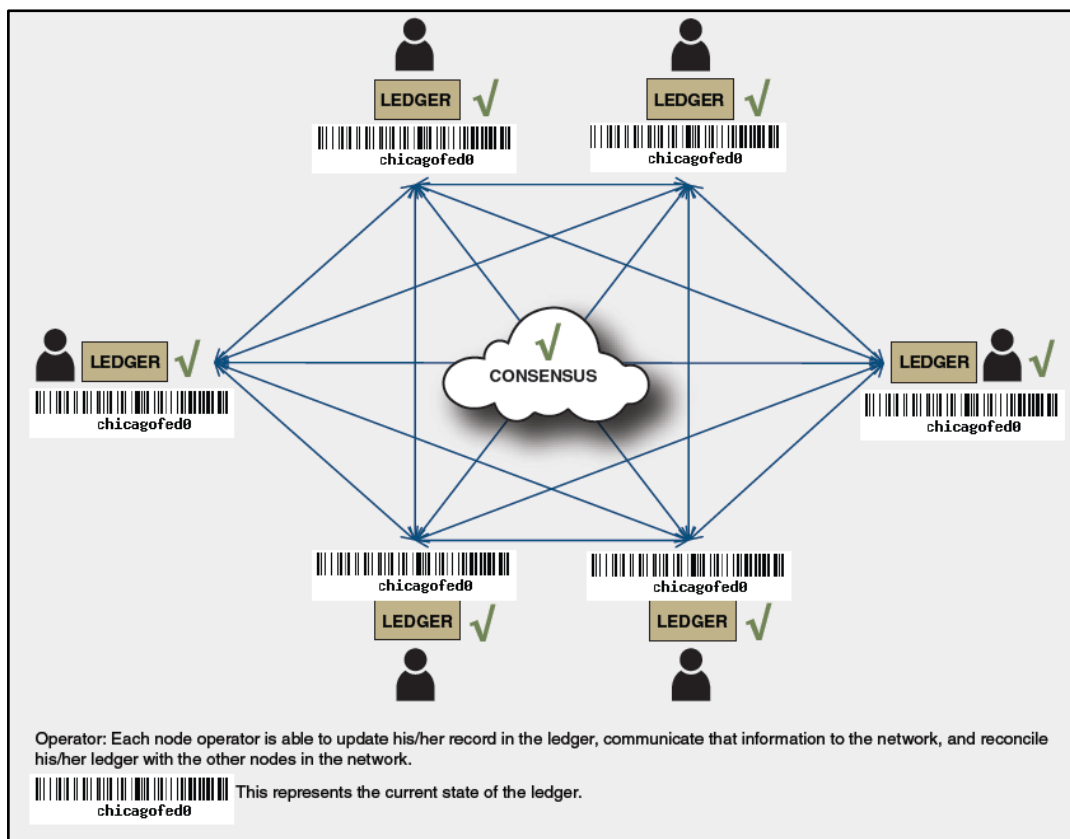
Figure 4: Blockchain (DL) Network - Example of a transaction



Source adapted from Blockchain and financial market innovation (Lewis, McPartland and Ranjan, 2017)

According to Lewis, McPartland and Ranjan (2017) there is a network of users in a Blockchain database. Each of the users stores its own copy of the data. This essentially gives rise to another name for Blockchain technology: Distributed Ledger Technology (DLT). A basic DLT network comprise of: a digital ledger, a network of node operators and a consensus mechanism used to confirm transactions (Lewis, McPartland and Ranjan, 2017). The following figure illustrates a typical distributed ledger network where all records are updated.

Figure 5: Distributed ledger (DL) network - all records are updated



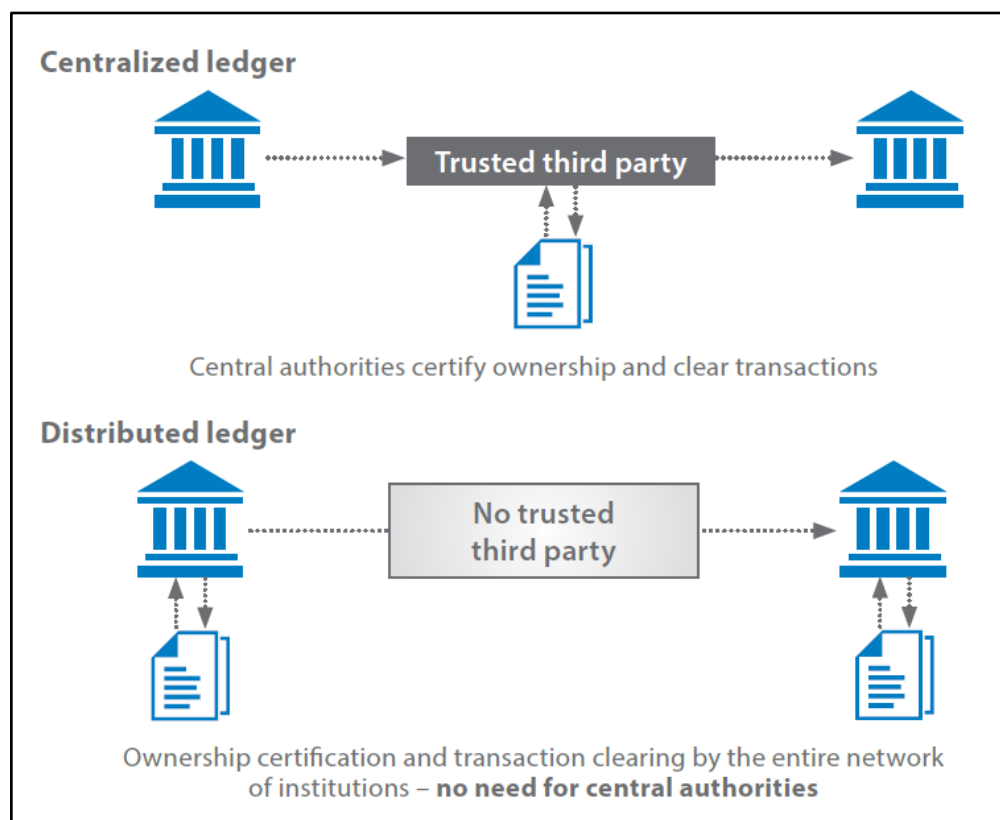
Source adapted from Blockchain and financial market innovation (Lewis, McPartland and Ranjan, 2017)

Blockchains permit organisations to have shared control over the access to and evolution of data. They also provide clarity around asset and data ownership by generating a comprehensive, tamper-resistant record of proprietorship alterations. Network members can regard the Blockchain as the authoritative data source of proprietorship claims. Furthermore, a member can 'posses' the recorded asset or data being referred to while controlling the related private key. This implies that the proprietor is in complete control of the asset or data; it

cannot be transferred without the proprietor's clear assent (Hileman and Rauchs, 2017). There are five key components of a Blockchain that supports this:

- **Cryptography:** A variety of cryptographic techniques are used which includes cryptographic one-way hash functions (Hileman and Rauchs, 2017). A technique for verifying digital identity with a high level of certainty is by using public key cryptography that is enabled by using private and public keys (Deloitte, 2017).
- **Peer to Peer Networks:** A model that is peer to peer, each peer in the system or network is a client or customer and a server. They together supply and consume resources. For example this could enable the establishment of a currency without an advantaged third party (Deloitte, 2017). The figure below illustrates a centralised ledger transaction requiring a trusted third party and a distributed ledger transaction not requiring a trusted third party.

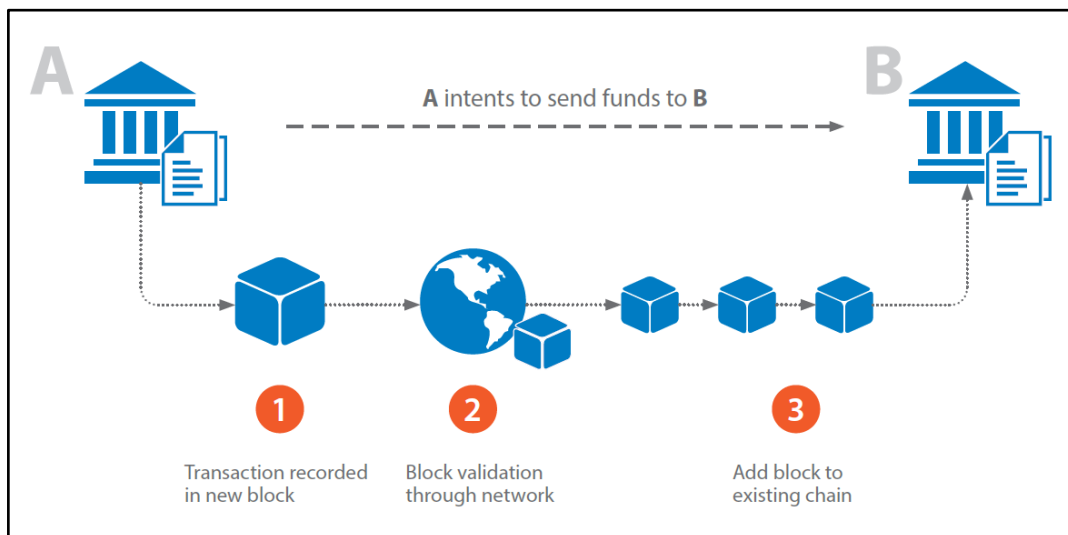
Figure 6: Centralised Ledger vs Distributed Ledger



Source adapted from Blockchain Technology and the Financial Services Market State-of-the-Art Analysis (Krause, Velamuri, Burghardt, Nack, Schmidt and Treder, 2016)

- Consensus Mechanism: A network of nodes performs consensus mechanism which prevents double spending and regulates the correct version of the ledger. When tokens are spent twice, this is referred to as double spending. E.g. If party A only has four tokens but transfers three tokens to party B and at the same time transfers three tokens to party C. In order to eliminate the manipulation of transactions the network of nodes performs a consensus mechanism to prevent this (Krause, Velamuri, Burghardt, Nack, Schmidt, Treder, 2016). The figure below illustrates the process of a distributed ledger transaction.

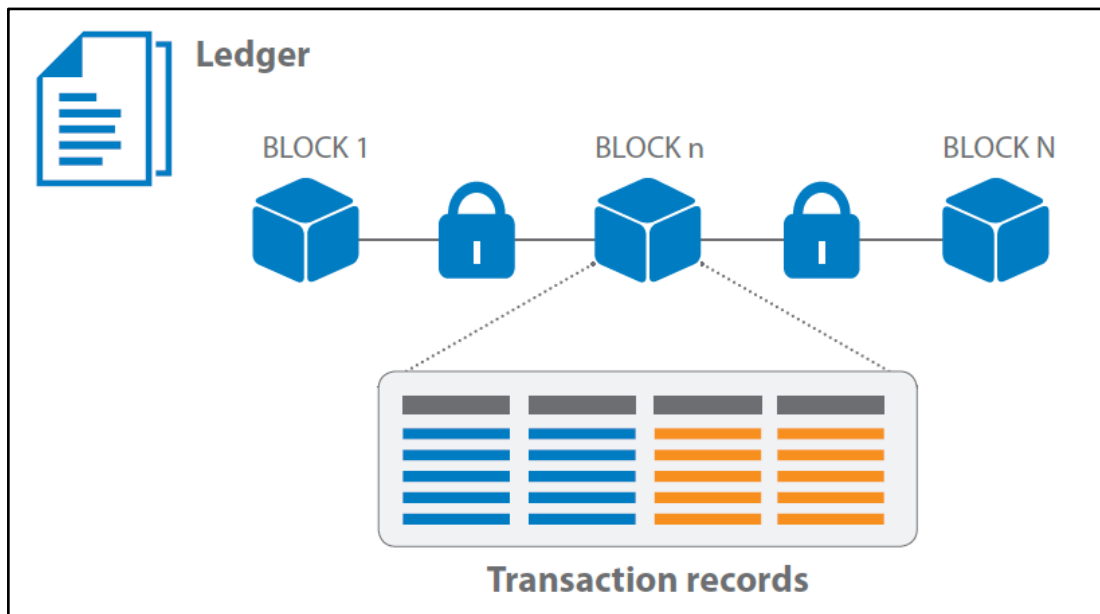
Figure 7: The process of a distributed ledger transaction



Source adapted from Blockchain Technology and the Financial Services Market State-of-the-Art Analysis (Krause et al., 2016)

- Ledger: Electronically chained blocks make up a Blockchain which contain transaction records of a given time frame. Since Blockchain sums up all the blocks which essentially are all the transactions, it therefore represents the entire ledger (Krause et al., 2016). The figure that follows illustrates the structure of a Blockchain.

Figure 8: The structure of a Blockchain



Source adapted from Blockchain Technology and the Financial Services Market State-of-the-Art Analysis (Krause et al., 2016)

Validity Rules: This refers to a set of rules of the network which relates to validity of a transaction and how the ledger is updated (Hileman and Rauchs, 2017).

The quoted benefit of DLT by Central Banks is the prospective for cost reductions with regards to transactions, settlement, and reconciliation costs. Another frequently referred to benefit is using DLT as the backbone of more resilient payment systems. A shared infrastructure in view of DLT could expand resiliency by distributing control, access, and maintenance over the system amongst numerous operators. Some also stipulate that DLT could acquire a conceivable change in current security models (Hileman and Rauchs, 2017). In addition to this, the following are benefits for financial services organisations.

- **Disintermediate:** Transaction intermediaries are removed (Underwood, 2016). The enablement of transactions is permitted without a central, advantaged third party and without trust (Deloitte, 2017).

- Secured by Cryptography: Transactions are secured (Underwood, 2016). It consents for improved security and fortification of data and identity in the network or system (Deloitte, 2017).
- Smart Contracts and Oracles: It permits the safe automation of complex, logical agreements and the business processes and procedures using data collected by oracles (Deloitte, 2017).
- Immutable: A more secure and transparent system or network is created and it generates new ways for regulators (Deloitte, 2017).
- Real-time settlement: Transactions can be completed in near real-time amongst operators on the system or network (Deloitte, 2017). It reduces transaction time and transactions can be observed in near real time (Underwood, 2016).
- Trustless: At least two trustless parties can transact directly with each other (Deloitte, 2017).

2.4 Types of Blockchains

2.4.1 Ethereum Blockchain

“Ethereum is a decentralised software platform that enables Smart Contracts and Distributed Applications to be built and run without any downtime, fraud, control or interference from a third party. The platform is also the basis for its own virtual currency, Ether. Ethereum is not just a platform but also a programming language running on a Blockchain, helping developers to build and publish distributed applications” (Frankenfield, 2018).

2.4.2 Quorum Blockchain

“Quorum is an Ethereum based DLT. The objective behind this is to provide a permissioned implementation of Ethereum which supports transactions and contract privacy. The functioning of Quorum is similar to Ethereum but with a few differences. Quorum is different from Ethereum Blockchain in the following ways: network and peer permissions management, enhanced transaction and contract privacy, voting-based consensus mechanisms and better performance” (Sharma, 2018).

2.4.3 Corda Blockchain

“Corda is said to be the only Blockchain that has been designed and built specifically for business. Corda’s focus on privacy, security and scalability distinguish it from other Blockchain platforms. Unlike Ethereum and Hyperledger Fabric, where all the information is shared between every node on the network, Corda shares information on a bilateral and multilateral level only with parties that need to see it. In this way, Corda, can interoperate in multiple ways, both between its own open source and enterprise deployments, as well as with other platforms” (Meijer, 2018).

2.4.4 Hyperledger Fabric Blockchain

“Hyperledger Fabric is a permissioned Blockchain infrastructure, originally contributed by IBM and Digital Asset, providing a modular architecture with a delineation of roles between the nodes in the infrastructure, execution of Smart Contracts called 'chaincode' in Fabric and configurable consensus and membership services. A Fabric Network comprises 'Peer nodes', which execute 'chaincode', access ledger data, endorse transactions and interface with applications. Orderer nodes which ensure the consistency of the Blockchain and deliver the endorsed transactions to the peers of the network, and MSP services, generally implemented as a Certificate Authority, managing X.509 certificates which are used to authenticate member identity and roles” (Ansari, 2018).

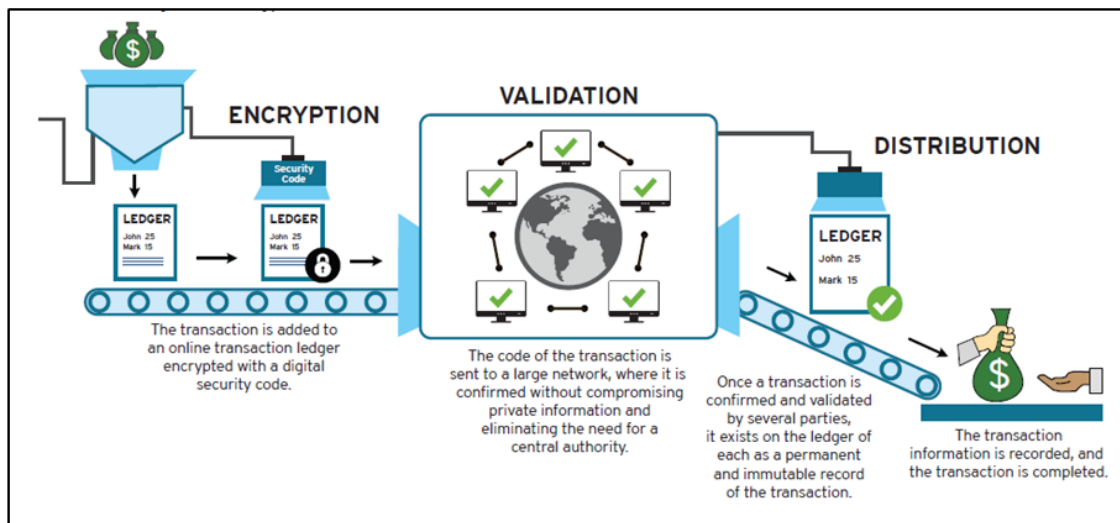
2.4.5 Ripple Blockchain

“Ripple is a Real-time Gross Settlement System (RTGS), currency exchange and remittance network. Using a common ledger that is managed by a network of independently validating servers that constantly compare transaction records. Ripple doesn't rely on the energy and computing intensive proof-of-work used by Bitcoin. Ripple is based on a shared public database that makes use of a consensus process between those validating servers to ensure integrity. Those validating servers can belong to anyone, from individuals to banks. The Ripple protocol (token represented as XRP) is meant to enable the near instant and direct transfer of money between two parties. Any type of currency can be exchanged, from fiat currency to gold to even airline miles. They claim to avoid the fees and wait times of traditional banking and even cryptocurrency transactions through exchanges” (Gordon, 2018).

2.5 Distributed Ledger Technology in the financial services industry

A centralised ledger approach is currently adopted in the financial services industry whereby transactions between two or more parties are processed by trusted third parties. The fundamental responsibility of the trusted third party is the certification of ownership and the clearing of transactions. The anatomy of a Blockchain transaction between two parties occurs algorithmically via Distributed Ledger Technology (DLT) and does not require certification of ownership and the clearing of transactions by a trusted third party (Tandulwadikar, 2016). The figure that follows illustrates the anatomy of a Blockchain transaction in the financial services industry.

Figure 9: Anatomy of a Blockchain transaction



Source adapted from Blockchain in Banking: A Measured Approach (Tandulwadikar, 2016)

According to Rochemont and Ward (2019) Blockchain technology is commonly acknowledged as offering significant potential for improving public administration capacities, specifically to improve the expense and intricacy of troublesome processes, regardless of whether monetary or not. This leads a few countries to position themselves as Blockchain benevolent countries, to entice investment. "Cross border payments, electronic collaterals and security settlements are a good use case for implementation using Blockchain technology", however several countries and central banks have settled that the technology is too immature to risk implementation for large-scale payment systems. The performance does not appear to contest or surpass settlement systems of the most advanced countries, yet it would introduce unknown risks right now, such as, the sustainability of the Blockchain industry and excessive decentralisation observed as the source of its performance inadequacies. There is distrust about the present capability of Blockchain technology for economic applications. Others have raised apprehensions about a bubble situation in "Blockchain investment and finance, with speculation, market manipulation and suggested conduct in breach of law and regulation is widespread".

According to Asay (2018), the banking industry does not have a clear business case to adopt Blockchain technology in spite of them making substantial investments. Beyond perplexity with respect to why the banks ought to utilize

Blockchain, there are likewise concerns about security, legislation, and the adolescence of the technology itself.

Regulatory complexity is significantly affecting Blockchain adoption, according to an Ernest and Young survey of senior specialists who attended the “Ernest and Young Global Blockchain Summit in New York”, 61% consider regulatory complexity to be the greatest hindrance to the adoption of Blockchain technology, trailed by the integration of legacy technology at 51% and an absence of general comprehension of Blockchain's abilities at 49%. In spite of regulatory complexity, respondents refer to changes to regulation as the essential driver for the integration of Blockchain technology into the more extensive enterprise ecosystem at 37%, trailed by the adoption of Blockchain as a digital currency by top organizations at 23% and acceptance of the technology amongst central banks at 18% (Thomas, 2018).

Regarding the matter of whether central banks ought to consider issuing their very own currency based on Blockchain technology, the Bank of International settlements ventured to such an extreme as to acknowledge that a few functions of a central bank could be rendered obsolete. “The emergence of distributed ledger technology could present a hypothetical challenge to central banks, not through replacing a central bank with some other kind of central body but mainly because it reduces the functions of a central body and, in an extreme case, may obviate the need for a central body entirely for certain functions”. In particular, there might be no requirement for a central bank to issue currency if a Blockchain is backing a broadly utilised digital currency. “In some extreme scenarios, the role of a central body that issues a sovereign currency could be diminished by protocols for issuing non-sovereign currencies that are not the liability of any central institution” (Higgins, 2015).

As various financial industry participants explore and introduce DLT frameworks, the potential complexity in interoperability and the potential for new models of business both increase. One of the key obstacles that exist in connection to implementation considerations lies in the capacity of each of the chosen systems to communicate, not just with one another, but in addition with

existing legacy systems. One of the manners by which this can be tended to, is through the introduction of technical interoperability standards as these would give a base layer of connectivity that would institutionalize and bring down implementation and integration costs (SARB, 2018c). According to Browne (2018) the absence of interoperability awards Blockchain coders and developer's autonomy and can give information technology departments cerebral pains as they find that different platforms cannot communicate without translation help. Standardisation could help organisations to work together on application development, approve proofs of concepts, and offer Blockchain solutions and also make it simpler to integrate with existing legacy systems. According to SARB (2018c) one of the key advantages of such activities would be the ability of a financial institution to bring in network scale impacts and efficiencies. There would be technology and resource costs to implementing a new DLT framework; however, these could be offset against the extra functionality that a DLT framework would bring. Due to the resilience of a DLT system, the cost could be offset against running a backup RTGS system.

One of the regularly noted criticisms of bitcoin's Blockchain network is that it depends heavily on intensive computing power and therefore requires large amounts of electricity to operate. Miners utilise massive computer rigs with several servers to keep the Blockchain network operating, and that process is not cheap. A study conducted by Elite Fixtures stated that it cost more than \$26,000 to mine only one bitcoin in South Korea, who are one of the biggest markets for cryptocurrency trading. Despite the fact that bitcoin miners get paid a sum of bitcoin for their works, the cost of validating transactions could be a concern for extensive penetration of Blockchain technology in business activities (Browne, 2018).

According to the University of Cape Town (2017) in order to harness the influence of Blockchain technology for the continent, a new age of highly skilled experts is required to drive its application. Analysts believe that Africa will be affected drastically through the ascent of Blockchain technology, contending that it can improve both efficiency and transparency across sub-Saharan economies. However, while technology is thriving, skills development in its

space isn't. Sawehel (2018) states that requests are intensifying for African universities to keep pace with the world's topmost 50 universities in offering more courses to lead the way for Blockchain-based development. "The Rise of Crypto in Higher Education found that 42% of the world's top 50 universities offered at least one Blockchain or crypto course". The founder of BitHub.Africa John Karanja, detailed that there was "little to no adoption" of Blockchain courses by African universities.

2.6 Blockchain Projects Conducted by the Financial Services Industry

The financial services industry has placed their hopes on DLT to simplify the interbank payment system due to the increasing costs required by the current banking systems (Wüst & Gervais, 2017). Across the financial services industry DLT has become the centre of a massive push for innovation. Although there is no one size fits all solution when it comes to DLT, it certainly has the potential to significantly change the way business is conducted and the manner in which we interact with one another. DLT is often referred to as the "internet of value", as it is claimed to improve efficiency, security and transactional activities transparency (Deloitte, 2017).

Several Central Banks partnered with commercial and investment banks within their respective countries and with the help of Fintech companies embarked on various DLT projects. The following projects were conducted since 2016: Project Ubin: Singapore, Project Jasper: Canada, Project Stella: Europe and Japan, DLT Technical Research at Central Bank of Brazil and Project Khoka: South Africa. The scope and findings of the project are discussed further.

2.6.1 Project Ubin

In 2016, the Monetary Authority of Singapore (MAS) together with a Blockchain consortium R3 developed a proof of concept inter-bank payment system using DLT. The objective of Project Ubin phase one was to assess the ramifications of a Singapore Dollar (SGD) that was tokenised on a distributed ledger and the prospective benefits and or advantages it will have on the financial ecosystem

of Singapore. “The MAS electronic payment system (MEPS) was leveraged in order to allow real-time fund transfers to issue funds on a DLT. The goal of the project was risk and cost reduction for cross border settlements of payments and securities. The prototype was developed with linkage to MEPS+ RTGS and Current Account Systems, which enabled automated management of collateral that backed the outstanding float of SGD-on ledger. The prototype tested the system’s ability to transact 24/7 and its resilience against single points of failure, and timeliness of settlements”. The project started on 14 November and ended on 2 December 2016 (Deloitte, 2017).

The project was successful in building an operational “interbank transfer prototype on a private Ethereum network” with a new Smart Contract codebase. In addition to this it was successful in conducting an “end-to-end integration between the private Ethereum network and MEPS+ test environment through their Common Payment Gateway (CPG)”. A solid foundation of questions was built by the research stream of the project that addressed topics from “monetary policy to operational and legal concerns for taking the prototype to production”. The observations from the project concluded that further evaluations needed to be conducted on the implications of credit and liquidity risks and challenges with the Ethereum platform (Deloitte, 2017).

Phase two of the project focussed on assessing probable consequences of installing DLT for particular RTGS functionalities by concentrating on “Liquidity Saving Mechanism (LSM)” and understanding how RTGS privacy can be guaranteed using DLT. They also compared three “DLT platforms namely: Corda, Hyperledger Fabric and Quorum”. The project findings documented that without compromising the privacy of transactions all three work streams can execute “fund transfers, queue reprioritisation and gridlock resolution in a decentralised manner” (Accenture, 2017).

2.6.2 Project Jasper

The Bank of Canada, Payments Canada, Canadian commercial banks and R3 a Blockchain consortium initiated a project to explore a DLT-based wholesale

payment system. Although they had no intention to advancing a production level system, their first priority was to construct a proof of concept DLT system that leveraged a settlement asset issued and controlled by the Central Bank of Canada. In the first phase they used an Ethereum platform to build a settlement capability and demonstrate its ability to exchange a settlement asset between participants. They sought to evaluate the potential implications of the DLT platforms performance using the Principles for Financial Market Infrastructures (PFMI's) as a framework. The second phase of the project which was built on the Corda platform incorporated a Liquidity Saving Mechanism (LSM) that permits participants to coordinate their payments to reduce liquidity requirements (Chapman, Garratt, Hendry, McCormack, and McMahon, 2017).

The systems also tested for resilience and the following findings were noted: "Each participant would need to invest in data replication and archiving to ensure business continuity and the recreation of the ledger. They would need to back up all the private data, including private keys and customer account information. The notary and supervisory nodes are needed for consensus, thus both represent single points of failure and both would need to maintain high-availability systems. One solution would be to run several notary node clusters. Corda nodes can queue pending requests to other nodes in the event that a node is forced offline. While the transactions will be processed when this node comes back online, the impact of an offline node on the ecosystem could be substantial. Incorporating a central queue or LSM component would require consideration of the need for high availability, as this would introduce a single point of failure" (SARB, 2018c).

The project highlighted vital understandings of how interbank payments on different DLT platforms can be completed by a Central Bank and financial institutions. In addition to this it also highlighted how features of modern payment systems such as queues could be integrated to improve efficiency by reducing collateral requirements. The projects concluded that in a DLT framework, rather than an operator's role being a traditional IT infrastructure operator, it is closer to that of a rule maker. A standard DLT system is doubtful to contest the benefits of a centralised payment system due to certain parts of a

payment system being inherently centralised such as LSM. The additional complexity could lead to operational risks. PFMLs would need to be updated in order to include principles defining regulatory authority's requirements for structuring a DLT for a market infrastructure (Chapman et al., 2017).

2.6.3 Project Stella

The European Central Bank (ECB) and the Bank of Japan (BOJ) conducted in-depth experiments to confirm whether functionalities of their existing payment systems could run on a DLT platform. The findings in terms of efficiency of particular features of RTGS services tested indicate that a DLT based solution does indeed meet the performance requirements of existing large value payment systems. The trade-off between the network size and performance confirmed that when the number of validating nodes increased, the payment execution time increased. In addition to this, performance is impacted with the distance between validating nodes as time required to process transactions increased (ECB and BOJ, 2017).

With regards to reliability and resilience the test results highlights that DLT has the potential to endure issues relating to validating node failures and incorrect data formats. In terms of failures to nodes, the results confirm that a validating node could recover in a reasonably short period of time regardless of downtime. The results also showed that whenever the certificate authority was not available, transactions were rejected. This generally constitutes to a single point of failure. Once the certificate authority became available again, processing resumed without the intervention of any other systems. Smart contracts manage transaction requests with incorrect formats. Although these results were derived from a test environment, the joint effort by the two Central Banks reflect a comprehensive set of results that deliver reasons to be optimistic with respect to the competencies of DLT within payment systems (ECB and BOJ, 2017).

2.6.4 Project Brazil

The Brazilian study of Blockchain technology on an interbank payment system in its first phase was very similar to other Central Bank projects whereby use cases were identified and a proof of concept DLT using Ethereum was constructed. The only difference was not to replace or create a main settlement system but to create a minimal funds transfer backup system for the main system in the event of a complete main RTGS meltdown. The project also did not analyse whether a backup RTGS system may yield economic consequences and to what extent. The second phase concentrated on analysing additional platforms in the context of the same use case. As privacy was a problem that was unsolved in the first phase, the ultimate goal was to source a platform that allowed development of a RTGS that agreed with all requirements (CBB, 2017).

The three DLT platforms that were used to test resilience are Hyperledger Fabric, Corda and Quorum. Their findings indicate the following, “For the Hyperledger Fabric prototype, a node needed to be enrolled using certificates provided by a membership service, which may present a single point of failure. The use of Practical Byzantine Fault Tolerance (PBFT) as a consensus mechanism increases the resilience of the system, as consensus does not rely on a single, set node. Interestingly, the Hyperledger Fabric 0.6 environment supports smart contracts with fewer coding restrictions than Ethereum, which means that it could be possible to write non-deterministic code that could present a risk to the system. In Corda, there is no public Blockchain and no private channels; each transaction occurs in a peer-to-peer manner. Without a disaster recovery feature built into the platform, the process of retrieving data from the network would be cumbersome and risky. Furthermore, the notary function presents a single point of failure. The Quorum prototype is regarded as resilient, particularly as it benefits from (at the time) two years of Ethereum code being tested publically” (SARB, 2018c).

The project was concluded with privacy still being a huge challenge. The experiments with the different platforms confirmed that it was not possible to

achieve privacy without giving up consensus. They do however acknowledge that zero-knowledge proofs and secure computing enclaves are encouraging solutions in this field. The project outlines that additional investigation is required in order to validate if the mentioned options will be able to resolve the issue and the evaluation of other innovative methods should also be considered (CBB, 2017).

2.6.5 Project Khoka

Project Khoka is South Africa's version of "exploring the use of Distributed Ledger Technology for interbank payments in South Africa". This was a collaborative project led by the South African Reserve Bank, a consortium of settlement banks from South Africa, a technical service provider and a consulting practice company. This project was built on the initiatives embarked on by the Central Banks comprising of Singapore, Canada, Europe, Japan and Brazil. The project ran for 14 weeks which commenced in January 2018 (SARB, 2018c).

The project scope was to create a distributed ledger "built on a private permissioned Quorum Blockchain, amongst participating banks for a wholesale payment system that is backed by Central Bank deposits, allowing participating banks to pledge, redeem and track balances of the tokenised Rand on the ledger". The aim of the project was to simulate a "real world" trial of a wholesale clearing and settlements systems by assessing the privacy, scalability, performance, resilience and finality of the DLT solution under realistic conditions. This meant that each participating bank were responsible for setting up and managing its own distributed node and private keys, which ultimately resulted in a combination of on premise and cloud-based nodes. The project also sought to gain a better understanding of how DLT would integrate with the SAMOS system. In addition to this, the project sought to test the ability of the DLT to adhere to Principles for Market Infrastructures (PFMIs). The three principles that the project concentrated on were namely PFMI 8: Settlement finality, PFMI 9: Money settlements and PFMI 17: Operational risk (SARB, 2018c).

The results of the project indicate that the use of DLT is technically feasible to process wholesale payments amongst banks with the South African Reserve Bank still having complete visibility from an operational perspective. The design of the project testing schedule reflected a level of volume that was realistic and at the same time maintained confidentiality of balances and transaction amounts. The performance tests indicated that all transactions were approved without any operational involvement by the SARB although there was still sight of the transactions. The practical implication of this is that even if the SARB node is not operational, banks would still be able to transact with each other. The figure that follows depicts the hypotheses tested and its outcomes (SARB, 2018c).

Figure 10: Outcomes of hypotheses tested

Hypothesis	Outcome
 Real-time gross settlement transactions can be executed using standard payment message formats (leveraging the ISO 20022 format).	Proven
 Messages can be processed at sufficient scale in line with the current system processing times.	Proven
 Blocks should be propagated within one second to a 95% confidence level and within two seconds to a 99% confidence level.	Proven
 The confidentiality and privacy of transactions between commercial banks is maintained.	Proven
 The visibility of the system for the SARB is sufficient for oversight and operational management.	Proven

Source adapted from Project Khoka: Exploring the use of Distributed Ledger Technology for interbank payments settlement in South Africa (SARB, 2018c)

The results indicated that the performance required can be delivered by the DLT Quorum platform which ultimately matches and even exceeds the current performance criteria. Testing conducted without full optimisation indicated twice SAMOS systems performance for transactions per second with confidentially

and settlement finality being enabled as part of the system design (SARB, 2018c).

The SARB confirms that it has achieved its objectives of providing useful insights to all parties and anticipates continuing to work and contribute to the body of knowledge in DLT based systems. According to Project Khoka (SARB, 2018c) “the governance of the DLT system in a live environment would need to reside with the SARB due to its regulatory oversight mandate, regardless of the system used”.

2.7 Literature Review Conclusion

As the shared single source of truth, Blockchain technology empowers participants to rapidly and securely transfer value of any sort. The vision of the 'internet of value' without focal intermediaries and to the benefit of many is by all accounts turning into a reality. This makes one wonder why, about ten years after Bitcoin was created, the utilisation of Blockchain technology has not yet turned out to be more predominant? There are absolutely no straightforward answers and the reasons are probably going to differ a great deal depending upon which particular segments we are concentrating on (Teis, 2017).

Concerning financial markets, it is useful to note that these business sectors are highly regulated, with regulation having turned out to be much more stringent as of late since the financial crisis. Subsequently, many Blockchain features are inconsistent with the existing regulation. A simple case is customer anonymity which is diametrically restricted to the tautened transparency prerequisites requested by regulators as of late (e.g. in the area of tax collection, Know Your Customer, Compliance, and so on.). This basically eliminates the utilisation of a public distributed ledger development for the financial services industry. The current regulatory framework forces a few other such constraints to the use of this technology (Teis, 2017).

2.8 Rational for conducting the research

Literature has showed that the global financial services industry has completed numerous proofs of concept projects on Blockchain technology and the results indicate that it has the potential to revolutionise interbank payments systems however it has not yet been formerly adopted by the financial services industry. Therefore the problem depicted is: *“The banking industry is not adopting Blockchain technology for interbank payments in South Africa although numerous successful proofs of concept projects have been concluded by various Central Banks globally including South Africa”*.

Consequent to the problem statement, the succeeding primary research question will be addressed in this research:

What are the obstacles to the adoption of Blockchain technology for interbank payments in South Africa?

To answer the primary research question, the primary objective of this research is to; *“identify the obstacles the South African Banking Industry is facing in adopting Blockchain technology for interbank payments in South Africa”*.

To address the primary objective of the research, the following secondary questions will be used:

1. Can Blockchain technology work for interbank payments in South Africa and why?
2. What are the biggest obstacles to the adoption of Blockchain technology for interbank payments in South Africa?
3. What are the potential implications for financial market infrastructures?
4. What are the potential implications for safety?
5. What are the business impacts to the financial market eco-system participants?

The following sections of the Research Methodology includes the research paradigm, research approach, the population and sampling procedure, data collection techniques, methods of data analysis, research limitations, validity and reliability and ethical concerns. The research plan was executed by utilising these areas in the process.

3 CHAPTER 3. RESEARCH DESIGN AND METHODOLOGY

3.1 Research Paradigm

This study aimed to establish what challenges the South African Banking Industry is facing in implementing Blockchain technology for interbank payments in South Africa. Therefore an interpretative research paradigm was applied when conducting this research as it attempts “to study human action from the perspective of social actors themselves”. The primary goal was to describe and understand rather than explain human behaviour (Babbie, Mouton, Vorster and Prozesky, 2015).

3.2 Research Approach and Design

In order to identify the challenges faced in implementing Blockchain technology for the interbank payments in South Africa, a qualitative research approach was adopted. A qualitative researcher’s emphasis is placed “on studying human action in its natural setting and through the eyes of the actors themselves, together with emphasis on detailed description and understanding phenomena within the appropriate context (Babbie et al., 2015)”. The reason for selecting a qualitative approach is that it was necessary to clasp important aspects of the challenges from the viewpoint of the participants.

A phenomenological approach was utilised as a basis for the research design as it is “concerned with understanding social and psychological phenomena from the perspectives of the people involved (Welman and Kruger, 2001)”. “A phenomenological approach is based on a paradigm of personal knowledge and subjectivity, and emphasise the importance of personal perspective and

interpretation. As such it is powerful for understanding subjective experience, gaining insights into people's motivations and actions, and cutting through the clutter of taken-for-granted assumptions and conventional wisdom" (Lester, 1994).

3.3 Population, Sampling Method and Sampling Size

The process of purposive sampling of non-probability sampling method was applied in this research. This allowed the researcher to use his experience and ingenuity to deliberately select the participants in a manner that the sample was regarded as being representative of the relevant population (Fox and Bayat, 2014).

The participants comprised of both male and female in payments management, financial technology, Blockchain and Distributed Ledger Technology capacity from the commercial banks, investment banks, the South African Reserve Bank, Payments Association South Africa, The Banking Association of South Africa, Payment Clearing Houses, Fintech Companies, The Council for Scientific and Industrial Research and Consulting companies based in Gauteng South Africa.

The sample size for this research was a total of fourteen participants. The table that follows shows the profile of the participants involved.

Table 1: Profile of Participants

Organisation	Area of Expertise	Number of Participants
FirstRand Bank	Payments	1
Nedbank	Financial Technology and Payments	1
Investec	Blockchain and DLT	1

Organisation	Area of Expertise	Number of Participants
Payment Clearing House Bankserve	Financial Technology and Payments	1
Payment Association South Africa	Payments	1
Banking Association South Africa	Payments	1
South African Reserve Bank National Payments Department	Payments	1
South African Reserve Bank Fintech Department	Financial Technology and Payments	2
Delloite Consulting	Blockchain, DLT & Payments	1
Fintech Consensys	Blockchain, DLT & Payments	1
Fintech Valr	Blockchain, DLT & Payments	1
Fintech Adhara	Blockchain, DLT & Payments	1
CSIR	Blockchain & DLT	1
Total		14

Source: Author derived

3.4 Data Collection Techniques

Semi-structured face to face interview technique of data collection was adopted in this research as it “offered a versatile way of the collecting data. The semi-structured interviews allowed the interviewer to use probes with a view to clearing up vague responses, or to ask for incomplete answers to be elaborated

on. Such probes varied from 'Why?' to 'could you elaborate on this?' Even by remaining silent with the pencil poised to continue writing, the respondent was given the necessary encouragement to proceed" (Huysamen, 1994). The benefit of this technique of data collection is that the researcher was able to probe further for a deeper meaning or stray from the existing sequence of questions to acquire more detail on the research question. The researcher also conducted WhatsApp video and telephonic interviews due to the unexpected unavailability and geographic distance of some of the participants. Refer to appendix A of this paper for the research instrument utilised.

Email communication was used to request an interview with the participants. The participants were informed of the purpose of the research and all confidential issues was discussed and addressed accordingly. The interviews were conducted at the participant's place of work and neutral locations where the respondents were in a more comfortable environment. This enabled the interview to flow more sinuously. Appendix B of this paper depicts the email invitation used to participate in the interview.

3.5 Methods of Data Analysis

According to Maguire & Delahunt (2017) "thematic analysis is the process of identifying patterns or themes within qualitative data. It is a method rather than a methodology". This implies that, in contrast to numerous qualitative methodologies, it isn't attached to a specific epistemological or theoretical point of view. This makes it a very adaptable method. The researcher followed the following six step framework according to Maguire & Delahunt (2017) to interpret and analyse the data.

- Step 1: Became familiar with the data,
- Step 2: Generated initial codes,
- Step 3: Searched for themes,
- Step 4: Reviewed the themes,
- Step 5: Defined the themes,

- Step 6: Wrote the analysis.

3.6 Limitations of the Research

- The researcher chose respondents that were in the financial services industry.
- The unexpected unavailability and geographic distance of some of the respondents resulted in WhatsApp video and telephonic interviews for four participants.

3.7 Validity and Reliability

Validity clarifies how well the gathered data covers the actual area of examination. Validity essentially means “measure what is intended to be measured” (Taherdoost, 2016). The researcher was able to achieve this by purposively selecting participants who are experts in the fields related to the research topic. The researcher asked questions that were specific to the research topic and also directed the interviewee participant to the subject and question at hand when he or she began to digress. The interviews were voice recorded to ensure that all responses were captured for detailed analyses and interpretation.

“Reliability concerns the extent to which a measurement of a phenomenon provides stable and consist result. Reliability is additionally concerned with repeatability. For example, a scale or test is said to be reliable if repeat measurement made by it under constant conditions will give the same result” (Taherdoost, 2016). The research study was based on a new technology which is relatively immature in business. It is highly unlikely that the results will be repeated as the interviews were semi-structured and the technology is evolving and developing rapidly. The proof of concepts for the use of this technology is increasing within the financial industry.

3.8 Ethical Concerns

Ethical considerations are bound to be raised in research projects and is especially true when people are directly involved. The participants that were interviewed and questioned involved getting approval. Voluntary participation is the fundamental rule that stresses that participants should not be compelled to take part in research and if they consented to participate, they were allowed to withdraw at any stage during the research. There are two standards that are applied to assist in the protection of the privacy of research participants namely: confidentiality whereby they are ensured that no recognising data will be provided to anybody not involved with the research and the principle of anonymity, this essentially implies that the participants will stay anonymous throughout the research (Fox & Bayat, 2014). An email requesting participation was sent to each proposed participant. Once approval was received from the proposed participants, interview sessions were scheduled. Some of the interviews were conducted after hours. The data collected during the interviews was used purely for academic purposes.

4 CHAPTER 4. PRESENTATION OF RESULTS

4.1 Introduction

The aim of the research was to identify what are the perceived obstacles to the adoption of Blockchain technology for interbank payments in South Africa. The participants were chosen based on their expertise and experience in the payments and Blockchain based DLT platform fields. The interviews were semi-structured which enabled the researcher to direct participants back to the topic when they digressed. A thematic analysis method was utilised in identifying patterns and themes within qualitative data. Numerous themes emerged however the researcher delved into themes that were most prevalent to the research topic.

4.2 Results pertaining to research question 1

The first research question was can Blockchain technology work for interbank payments in South Africa and why? The major theme that emerged from this question was Blockchain technology feasibility in the payments industry.

4.2.1 Blockchain technology feasibility in the payments industry

All of the respondents agreed that Blockchain technology can work for interbank payments in South Africa. The proof of concept is available and there is feasibility. However, the findings reveal that most parties are comfortable experimenting, but it seems that they are not yet willing to go beyond experimenting towards implementation; therefore the adoption may not materialize in the near future. One of the respondents explained that they thought South Africa had the potential to become a centre of excellence for this technology and probably be able to export it around the world and that's largely because the SARB was willing to take a risk and try it out. However, results also show that there is a lack of general understanding of Blockchain's capabilities.

For example, the banking forums do not discuss enough details around how to implement and the discussions are really broad and vague, which speaks to gaps in common understanding and varying experiences of payment systems. Although, there is consensus that Blockchain can work in South Africa, there are unanswered questions that were raised, as to whether is Blockchain appropriate use of technology for interbank payment? There are a lot of unknowns in the technology so are we willing to risk upsetting things just for the sake of adopting technology? Policy makers need to always stay in control. By Central Banks, creating the interbank settlement system based on a Blockchain, Central Banks are actually gaining more control than losing it.

The interbank payments are really a close network of participants that are settling amongst themselves right now, through the use of the Central Bank. Blockchain technology is most useful where the distribution is a decentralized network however the payment network in South Africa is not decentralized, so it

begs the question just for payments in itself, the more expensive technology that doesn't necessarily have concomitant benefit to it. Therefore, one needs to ask the question of whether it's appropriate use of technology.

4.3 Results pertaining to research question 2

The second research question was what are the biggest obstacles to the adoption of Blockchain technology for interbank payments in South Africa? Three themes emerged from this question, namely: the Fear of Adoption, Central Authority Control and a Compelling Business Case.

4.3.1 Fear of Adoption

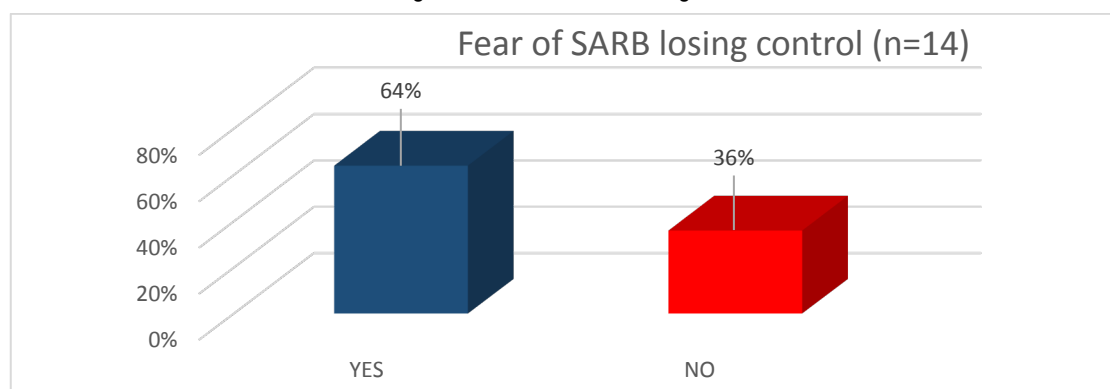
One of the big risks that were identified was the fear of adoption or the fear of implementing a new system. People do not want to be the first adopters. Blockchain education or the lack of it is also an obstacle. Most importantly people are not educating themselves and with that come the fear of the unknown. For example how many people have truly studied Blockchain? One of the respondents emphasised that one of the biggest barriers to the adoption of Blockchain is perception itself. One of the issues is that, for the average person and specifically for banks themselves, Blockchain and the primary application of Blockchain which is cryptocurrency have a very negative perception in regulated financial circles. For example, there has been proof of concept Khoka, which was actually quite successful and was perceived a landmark project and was very well regarded in around the world. However, because the perception around cryptocurrency is still negative there has not been any adoption. Other barriers include the regulatory issues around data privacy, and the enforceability of the contract. It also has to do with the consensus between the participants around issues of Governance, Compliance Legislation, Regulation, ownership and cost.

4.3.2 Central Authority Control

According to the 64% of the respondents, the SARB fears losing control. One of the reasons could be bureaucratic. The idea of giving up something that has been known to work and has been around for a long time seems to be one of the difficulties. It seems that the Central Bank prefers to work with what has been proven and robust. There is also fear of possible chaos when the control measures no longer rests with the Central Bank. It also has to do with power, the extent to which the control will be disbursed to participants in a network (Blockchain). The Central Banks' core thing is that they need to reduce risks, by managing monetary supply in the country, managing the liquidity and the risk around the liquidity for banks, they need to manage cross border payment Compliance, financial stability, and they need to make sure that syndicates are not using their currency through illegitimate means. So, they have a couple of mandates but the respondents do not think that being the Blockchain payment operator is one of them. Therefore, project Khoka where the Central Bank was the issuer, was a much better route.

Around one third or 36% of the respondents were of the view that the Central Bank does not fear losing control; it has more to do with the inability to anticipate what Blockchain would look like in the future. Other underlying factors beg the question, why would you want to try and change a system that is currently working fine? Moreover, regulators are experimenting with the technology and taking a balanced view to creating safe and efficient financial market infrastructure. One of the respondents explained that the SARB would be gaining more control in terms of the interbank payment system on Blockchain. The digital platform has transparency of the transacting cryptocurrency for example, which can allow the Central Bank to trace the currencies, and exert controlling measures when necessary.

Figure 11: Fear of SARB losing control



Author derived

Blockchain use case for payments still need to be proven, in terms of efficiency, scalability and speed. There is clearly a risk around the newness of the technology, mitigated by the fact that the public chain is technology based. In the permission networks, the only thing you really change is the consensus mechanism on an Ethereum Blockchain for example and that's typically where the problem sits. Although, the risks are currently mitigated, but when the technology grows, there will definitely be some risk. For example, if a technical glitch happens, the risk of not being able to make payments, who will be liable for that. The biggest risk here is rushing to adopt interbank payment systems on Blockchain without getting the right Governance models in place.

Other respondents believed that it is more of a political will which will require that the Governor of the Central Bank to approve it, and to slowly migrate the current payment system to the new payment system. However, for that to happen, there are conceivably quite a lot of risks. Due to the newness of the technology, not knowing exactly how it's going to work, what the pitfalls will be, what the security downfalls will be would render it difficult for the governor to approve and take the risk.

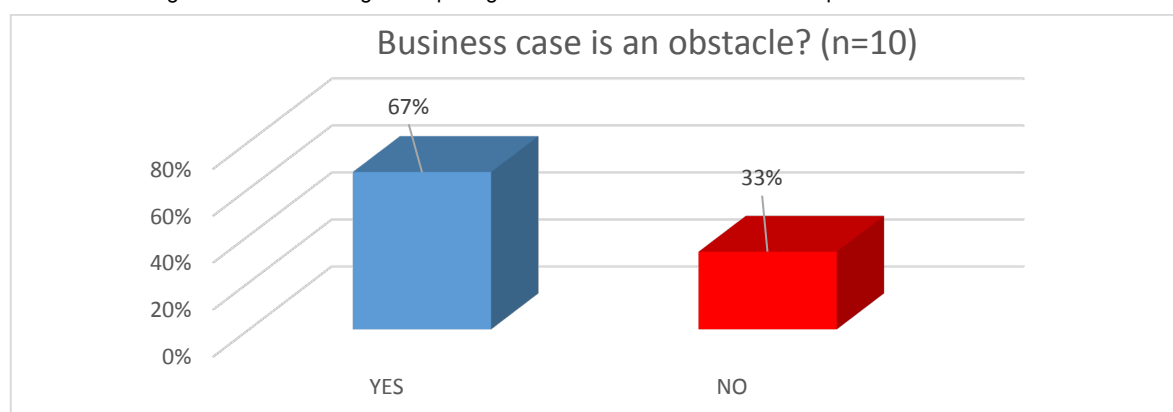
4.3.3 Compelling Business Case

One of the respondents emphasised that one needs to clearly separate the business case from the technology. To clearly articulate what problem are we trying to solve using the technology? The respondent gives an example of India;

they clearly articulated the problem they were trying to solve which was the need to enrol 1.3 billion people into a biometric system. Once that was figured out, technology was then used to solve the problem. With the value proposition being that people can access banks irrespective of their literacy status using biometrics. Another respondent asserts this by saying that there should be a specific problem that needs to be solved and not a situation where a solution is chasing the problem. Therefore, concluding that currently there is no compelling business case.

Currently in South Africa, the perception is that it is very expensive; to have to run two systems while the old one is working fine. Not having a compelling business case is an obstacle in the sense that it currently is not fit for purpose yet, fit for purpose means it needs to be cheaper, it needs to be more effective, it needs to give you something that the old system didn't give you. The respondent suggests that perhaps South Africa should incrementally adopt the one that is right for them and the problems identified. Of the 14 respondents, the response from 4 respondents did not answer the question as to whether or not a compelling business case is an obstacle. 67% of the remaining respondents state that not having a compelling business case is an obstacle to adoption of Blockchain technology for interbank payments in South Africa.

Figure 12: Is not having a compelling business case an obstacle for adoption of Blockchain



Author derived

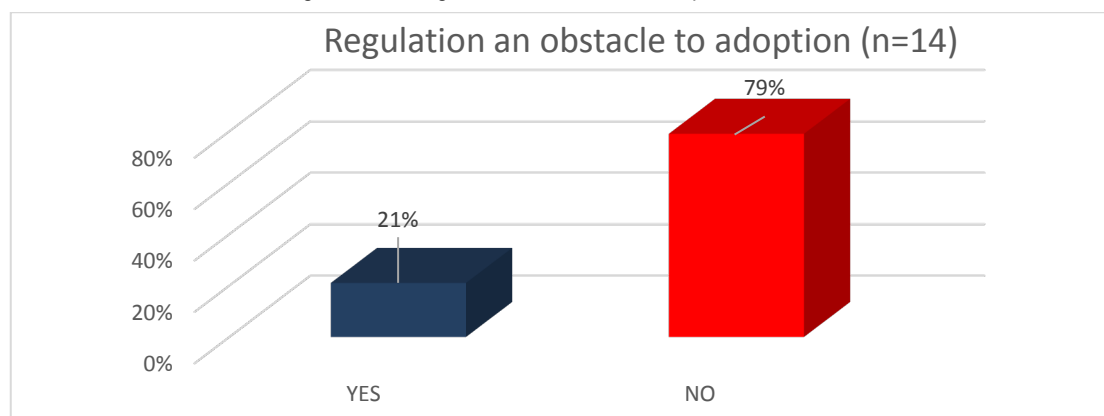
4.4 Results pertaining to research question 3

The third research question was what are the potential implications for Financial Market Infrastructures? Two major themes emerged namely: Central Bank Regulation and Governance of Payments systems.

4.4.1 Central Bank Regulation

The respondents all agreed that Blockchain has the potential to change the landscape of financial services. Only 21% of the respondents reported that Regulation could be an obstacle to adoption of Blockchain. Reasons being that the technological platform might introduce difficulties for regulatory authorities and policymakers. For example, where in the value chain will the Central Bank exert their authority, as they regulate entities? There is a need for controls in place for public Blockchain ledgers and this is the main obstacle around Regulation. Regulation is the primary barrier to widespread Blockchain adoption integration with legacy technology as well as integration of the Blockchain into the financial eco-system. But others think that the SARB has been really good at it for example with the Intergovernmental Fintech Working Group (IFWG) and the SARB Fintech team.

Figure 13: Is Regulation an obstacle to adoption of Blockchain



Author derived

One of the respondents reported that while the issuance of a South African Rand onto a Blockchain network would be highly governed, controlled and

managed, the key difference is that the issuance of Bitcoin would not be as highly governed. It is part of the monetary supply; it will need to be backed by collateral exactly the same way as the reserve account or actual account is backed. It would need to be managed and then there will therefore be recourse back to the SARB.

The regulatory paradigm that came up with the 24 Principles for Financial Market Infrastructures (PFMIs) of which 17 is related to payments did not leave scope for a technology that is completely decentralized and not run by entities. Respondents did not think that all 24 principles could be accommodated and that it will take some time and processes before that can be done. However, they also felt that it was not an obstacle. Those that thought it would be possible to accommodate all 24 principles alluded to that fact that the software just needs to adhere to those principles. Due to they only need to be a Regulation of software and protocols. Users are already looking at whether they would need to alter some, add them or remove some of the principles. It was also reported that the biggest of the principles was settlement finality; there is a need to reduce risks. Settlement risk (ensuring payment are final and irrevocable) and operational risk where issues such as cyber security and threats are pertinent, you need settlement finality; you need to reduce risk. That's much less of an issue at the inter-bank settlement level because that's not competitive, that's really just risk management, but given that the SARB wants more participation in the whole network of different layers. Payment Clearing House (PCH) rules need to be established for such settlement, all existing structures such as Payments Association South Africa (PASA) committees for different payment streams should be evaluated.

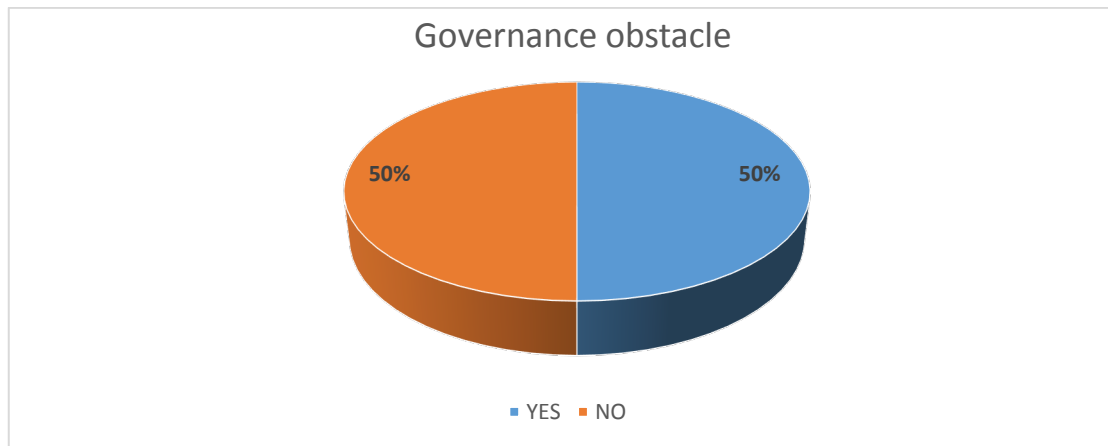
It was reported that it is more around setting up the infrastructure from an organizational perspective to manage and understand these principles; however, the findings show that there is low confidence in that regard, as respondents suggested that there is still a long way to go. For example, one, mentioned that if Blockchain collapses who will be to blame? There are companies right now who are working incredibly hard with regulators to say, if we were running for example an interbank network and the banks, the

consortium banks were operating on the network, what will the legal structure on that look like, who would be responsible, how do you capitalize it, how do you run the risk, what is the cost of the risk, what kind of insurance would you need in that? One of the respondents explained that it is not unprecedented; we have payment infrastructures that have been run by groups or consortium before. It's just taking all those older learnings and applying them in this new world.

4.4.2 Payments Systems Governance

The Governance framework of the Blockchain is like the consensus of algorithms; the Governance is between participants. The Governance framework is not necessarily preventing the adoption of Blockchain. The interbank settlement networks built on Blockchains basically get to choose their Governance framework. For example, one can create a private token on top of a public chain like Ethereum on Quorum, and there is an oversight because you have a leader who approves. However, the Central Bank would need to decide what level of influence over the technology those will have. One of the barriers could possibly be the reporting obligations done by financial institutions. Another identified obstacle was that there were no networks in place yet, although companies are doing some work with other banks around the world where they are building small pieces of networks. The benefit of these extended regulated networks remains to be seen. 50% of the respondents reported that Governance is an obstacle to Blockchain adoption. There are a variety of propriety commercially controlled payments environments and it would be very difficult to apply some imposed public policy objectives on to that for example. And in theory the Central Bank will have authority but these remain private.

Figure 14 : Is Governance an obstacle for adopting Blockchain



Author derived

We know we have Ethereum, Bitcoin, other large unregulated public Blockchains and that's great from a testing perspective and the software will be taken up and that's going to make more robust and useful in a regulated space. So Khoka was there to prove that there could be a network put up if needed, but the network was never put up. Therefore, the next steps are going to be around getting these networks in place. South Africa is very well positioned; there are a couple of very clear use cases where it would make sense to make the investment into a network for a real business case. There are also issues around who owns the Blockchain and can participants be subjected to upgrades and other decisions. If something goes wrong who will be accountable? If the Governance does not allow for accountability, then it is simply not worth it.

4.5 Results pertaining to research question 4

The fourth research question was what are the potential implications for safety? The major theme that emerged was Business continuity risk.

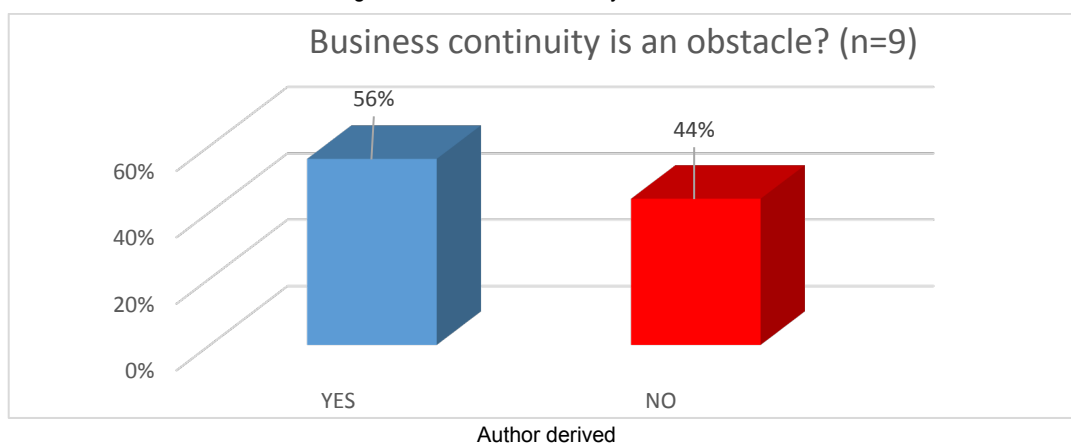
4.5.1 Business continuity risk

Five which is 56% out of the nine respondents whose response answered the question on business continuity risk, said it is an obstacle to the adoption of Blockchain. Respondents explain that, even though Blockchain might not have a single point of failure, this is not entirely true. The core ledger in the back-end

doesn't need you to have one server running because you have it in multiple locations. From the practical learnings from Jasper, there was an identified need to build that interface which actually allows you to interact with the Blockchain *"...and even if you look at the R3 Coda, it has this notary concept. And notary is not distributed."* Blockchain helps you know the distributing environment, but you still have a lot of challenges to make all the enabling services to be kind of more resilient. One of the respondents said that, if there was a compelling case to have business continuity, they would have to run parallel platforms until they are comfortable enough to use Blockchain alone.

Another respondent said that when introducing something new there is a period of time that is required for learning in order get to operational efficiency, it doesn't happen overnight. For example, when you get into multi-firm environment like payments, it takes even longer and even more complex because companies would have to move at the pace of the slowest player. The other issues were around not being able to reverse and repair transactions with a clear position in the Blockchain market. The ability to reverse and recreate transaction is evident in the DLT, but can this be done in the Blockchain, with a clear known position (balance)? The respondent explains that to keep processing in the market means that you are running some sort of risk because you don't know what your exposures are. For example, the black swan event in UK with the Bank of Scotland where something went down and they tried to fix it, where something broke and they effectively couldn't fix it.

Figure 15: Business continuity is an obstacle



Four or 44% out of the nine respondents whose response answered the question reported that business continuity would not be an obstacle in adopting Blockchain. There is more robustness in terms of business continuity, especially because for example, in a network when there are several nodes and then one node is down the others can still carry on, so the business continuity is built in. Due to the distributed set up of systems and its connectedness, there is no single point of failure and as such it is distributed to the network. One respondent cautions that you would want the permissioned networks because you know who the nodes are and who is working on those nodes from a conservative approach of Central Banks that would give participants comfort.

Respondents believed that Blockchain is unbelievably resilient; the whole point of having a distributed ledger is to increase the resilience. For example, Bitcoin Blockchain which has been running for 10 years now has never gone bad. It has been run by some hackers; it has been run by a number of university students initially, it has never stopped working. It is much like the internet, you can't switch the internet off anymore, and the beauty of Blockchain is that it's the internet. It was created in such a way that you have options whether the system is up or down, such that even if it is functioning at 70%, it is still functional. What you do is that you are now replicating these nodes in as many computers as you want. The computers are going to be situated in as many countries as you want, and that is called the natural technology for business continuity, therefore, the multiple nodes for the various institutions is a Business Continuity Plan (BCP) on its own.

4.6 Results pertaining to research question 5

The fifth research question was what are the business impacts to the financial market eco-system participants? Three major themes emerged namely: Interoperability with legacy banking systems, Cost benefit to the adoption of Blockchain Technology and the Technology Maturity and Skills in South Africa.

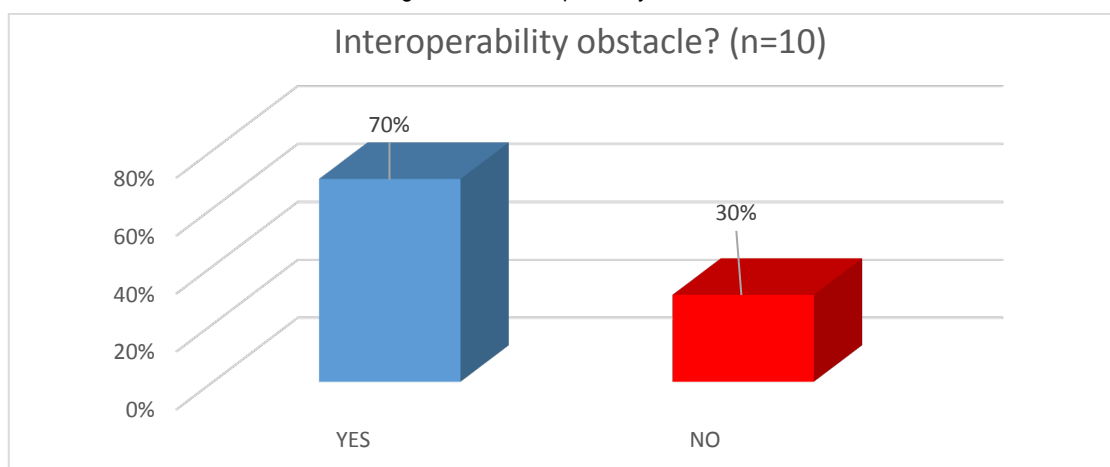
4.6.1 Interoperability with Legacy Banking Systems

Banks are already running on core systems, which took years of investment. The main question that all the respondents seem to raise is that, bearing in mind the cost of a new system, who is going to be accountable for those costs and will it be worthwhile to start a parallel system? Therefore, asking, from a banking point of view would it be effective? More than two thirds of the 10 respondents whose response answered the question which is 70% of the respondents said that interoperability is an obstacle to adopting Blockchain.

It was suggested that the only way that it would work is if the SARB say that the SAMOS will be the way of connecting to the main ledger. Where there would be able to build a simple interface to connect up to that network and get all ledgers to talk to that. However, everybody has got different risks and benefits into replacing ledgers with Blockchain, so now you need to get all the banks to kind of agree to replace the same ledger that is inside their systems with this Blockchain. How do you decide which Blockchain? How do you make sure that the same ledgers are going to be changed in all the banks on the same page?

These are some of the difficult questions that arise, also issues that relate to interoperability. Things that need further exploration are interoperability with the existing commercial banking systems, inter-ledger that enables interaction from different Blockchains, it is a challenge and there are standards required to be enable interoperability. Systems have been around for decades and have a lot of interconnectedness and dependencies, so it would cost a lot of money to replace ledgers with Blockchain and one respondent said this might even take as many as ten years. And then the question is, is it worth it? Respondents explained that in payment systems we see that sometimes the technology moves quite fast but the integration into the legacy systems (banks, clearing house, consumer community, settling environment etc.), takes a long time so there are number of waves of change one needs to go through.

Figure 16: Is Interoperability an Obstacle



Author derived

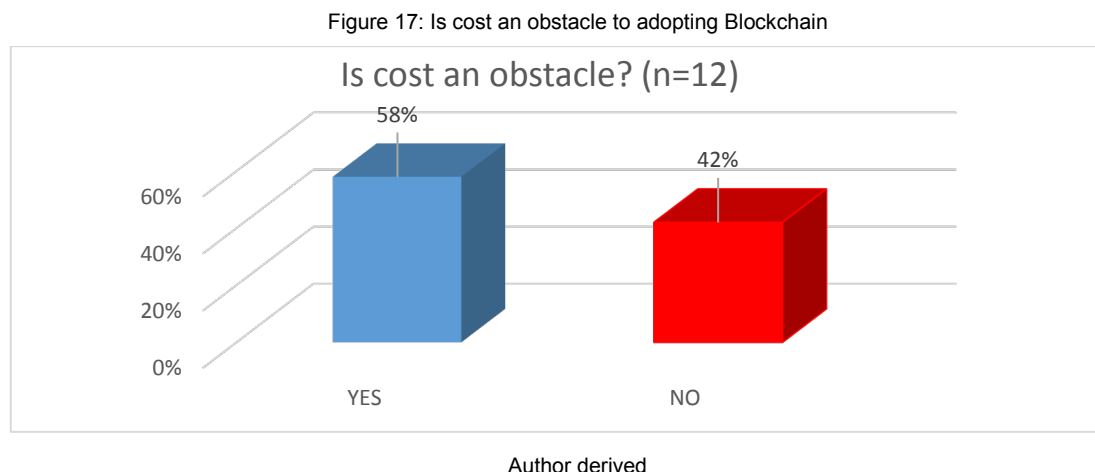
With Project Khoka it showed how funding can be integrated as the funds are transferred to existing Central Banks accounts in SAMOS and a portion is reserved for 'tokenisation' to be used in the DLT system. Other issues relate to immutable and irrevocable. One of the biggest challenges identified, that is holding back implementation is what they call the integration of different Blockchains, because Blockchains don't speak to other Blockchains unless they are the exact same platform (interoperability). The thing that needs to be solved is not a technical one, the thing that needs to be solved is actually a business model.

4.6.2 Cost Benefit to the Adoption of Blockchain Technology

Banks invest heavily in payment systems infrastructure. New infrastructure need to prove that it can provide the same safety, security, resilience and efficiency measures. There are systemic risk issues around adopting Blockchain for interbank payments. Having a ledger that is synchronized and is updated in real time isn't an issue on itself, the issue becomes when you get a bank-run and you have this instant settlement that takes place between participants, essentially moving liability. So creating more of this instant settlement in a fractional reserve monetary system where payment is moving a claim on money (liability). That's where the risk comes in, or it could make it worse and then you don't have the extended benefit of Blockchain ledgers that

are constantly synchronized within the bank. Real benefit comes with adoption at system level, tokenised Rand for example can be used in connection with tokenised security which could speed up DVP (delivery vs payment).

There are Regulations that are changing through the NPS Act as its being updated and that will require resources to be allocated. However, there is not any appetite to allocate even more spend now to creating these new rails where people are not even sure what the benefits might be. 58% out of 12 respondents whose response answered the question believe that cost is an obstacle to adopting Blockchain technology for interbank payments.



One of the respondents explained that theoretically the overall system of interbank payment through Blockchain is expected to be cheaper. This platform eliminates intermediaries and some reconciliations, that results in real time experience for customers, and so far it is a far superior technology than the one used currently.

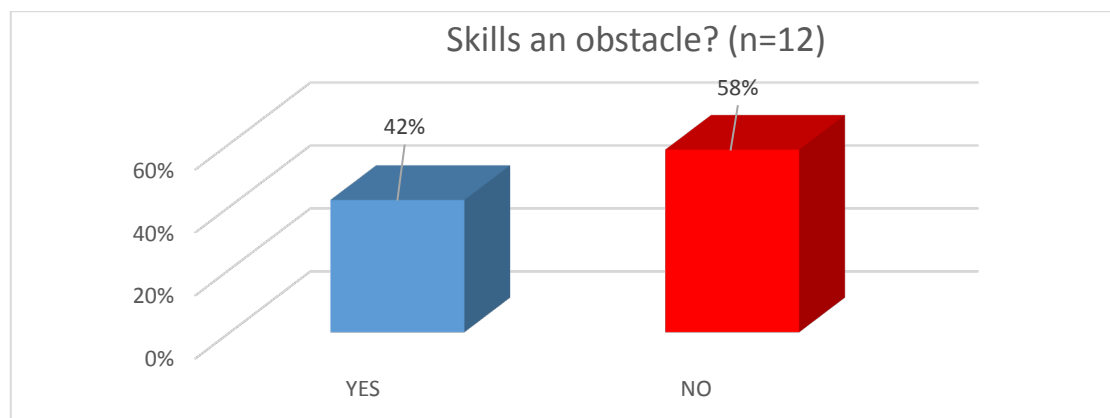
4.6.3 Technology Maturity and Skills in South Africa

Project Khoka was a coordinated project with existing financial institutions that set up their own infrastructure, and technology partner as an advisor. The tech partners also consisted of South African citizens, thus I would argue that the skills already exist in SA. So there's definitely a maturing however, at this stage skills are limited, people need to get comfortable in cryptography first. Because

like anything, it's going to take time to build the whole value chain all the way through to the Central Bank.

There is a need in South Africa to get professionals ready for cryptography straight from school and universities. Due to what happened with Project Khoka, was really exciting in that it has accelerated that process. As a result, there are definitely more people at universities that are interested in the field. For example, people who are studying finance, are studying cryptography and have expressed an interest in Blockchain have all heard about Project Khoka and they all know that there has been a successful project in South Africa. Some of the key respondents explained that South Africans are very capable and have the skills evident through Khoka. There are some sceptics that expressed that the skills are scanty and that it goes for most countries around the world as well, but are of the opinion that there is enough for the Central Bank to feel comfortable to have the entire payment system onto a new technology.

Figure 18: Technology Maturity and Skills



Author derived

While more than half which is 58% of the respondents whose response answered the question reported that skills in South Africa is currently not an obstacle to the adoption of Blockchain, 42% purported that these skills are very scarce. These relate to a broad based skill set, such as accountants, engineers, software developers, general software and developers. The issue is that currently they are experimenting and gaining skills but these are not in depth

expertise. There is need to enhance skills in country to equip the next experts in the Blockchain platforms.

One of the biggest risks would surely be who my provider for the Blockchain is. The respondent said currently the technical company Consensus would be the preferred entity. As such, until someone becomes firmly established as an entity that supplies these services to Central Bank this is a risk that would require proper oversight. The other concern is that there are no networks in place yet. Therefore, it is about making sure that there is no common single point of failure in the entity, there has to be proper Governance.

4.7 Summary of the results

The aim of the research was identify what are the perceived obstacles to the adoption of Blockchain technology for interbank payments in South Africa. The participants were chosen based on their expertise and experience in the payments and Blockchain based DLT platform fields. The interviews were semi-structured which enabled the researcher to direct participants back to the topic when they digressed. A thematic analysis method was utilised in identifying patterns and themes within qualitative data.

Numerous categories and themes emerged in the analysis however only the most prevalent categories and themes were analysed in detail.

- Blockchain Technology Feasibility
- Fear of Adoption
- Central Authority Control
- Business Case
- Central Bank Regulation
- Payments Systems Governance
- Business Continuity Risk
- Blockchain and DLT Interoperability with Legacy Systems
- Cost Benefit to the Banking Industry

- Technology Maturity and Skills in South Africa

The following chapter discusses the results that were presented in this chapter.

5 CHAPTER 5. DISCUSSION OF THE RESULTS

5.1 Introduction

The results pertaining to chapter 4 will be interpreted and discussed. The research study sought to identify what are the obstacles to the adoption of Blockchain technology for interbank payments in South Africa? A qualitative research approach was utilised to answer the research problem. The discussion of the results will follow the same layout as the presentation of the results which is per research question.

5.2 Discussion Pertaining to Research Question 1

The first research question was can Blockchain technology work for interbank payments in South Africa and why? The significance of this question was to immediately get a perspective on what the participants' views were on the adoption of Blockchain technology for interbank payments. It was important to understand their perspectives in terms of the validity of the emerging technology and its feasibility for interbank payment systems. It was also fundamental to understand whether they viewed the recent use case conducted by the South African Reserve Bank as being credible or not. One major theme emerged and will be discussed further.

5.2.1 Blockchain Technology Feasibility

A significant finding of the study was that 100% of the respondents believe that Blockchain technology can work for interbank payments in South Africa. This is an important finding as it shows that the respondents appreciated and valued the South African Reserve Bank DLT use case project Khoka. This shows that there was validity and credibility in the project results. The project was a live

simulation of payments between banking participants in the South African Banking eco-system. Project Khoka won an international award for this use case. Although, several Central Banks use cases proved that Blockchain technology can work for interbank payments, there are some very legitimate concerns.

According to Deloitte (2017) the observation from project Ubin concluded that further evaluations needed to be conducted on the implications of credit and liquidity risks and challenges with the Ethereum platform. After concluding project Jasper, it was stated that a standard DLT system is doubtful to contest the benefits of a centralised payment system due to certain parts of a payment system being inherently centralised such as Liquidity Saving Mechanisms (LSM) (Chapman et al., 2017). Project Brazil concluded with privacy still being a huge challenge. The experiments with the different platforms confirmed that it was not possible to achieve privacy without giving up consensus (CBB, 2017). The differences in the literature compared to the study finding is not unexpected as the use cases carried out by the Central Banks used different DLT or Blockchain platforms and to some extent the scope varied.

5.3 Discussion Pertaining to Research Question 2

The second research question was what are the major obstacles to the adoption of Blockchain technology for interbank payments in South Africa? The significance of this question was to understand that whilst the respondents are stating that Blockchain technology can work for interbank payments, what are the obstacles to adoption? It was fundamentally important to identify these obstacles from the respondent's viewpoints as this would reflect the challenges faced by the financial services industry. These challenges could be used as a platform to improve Blockchain technology, amend or improve the payments systems regulations and to create a compelling business case. There were many themes that emerged from this question; however, there is a balanced view that there are three major obstacles which is Fear of Adoption, Central Authority Control and a Compelling Business Case.

5.3.1 Fear of Adoption

The results indicate that the fear of adoption of a new system is a major obstacle. This entails that they don't necessarily want to be the first adopters. It is basically the fear of the unknown. This is consistent with what literature states as according to Rochemont and Ward (2019) "cross border payments, electronic collaterals and security settlements are a good use case for implementation using Blockchain technology", however several countries and central banks have settled that the technology is too immature to risk implementation for large-scale payment systems. The performance does not appear to contest or surpass settlement systems of the most advanced countries, yet it would introduce unknown risks right now, such as, sustainability of the Blockchain industry and excessive decentralisation observed as the source of its performance inadequacies. There is distrust about the present capability of Blockchain technology for economic applications. Others raised apprehensions about a bubble situation in "Blockchain investment and finance, with speculation, market manipulation and suggested conduct in breach of law and regulation is widespread".

This is an important finding as the average South African Citizen does not know Blockchain, but they do know Bitcoin cryptocurrency. So when they think of Blockchain they think of Bitcoin cryptocurrency. From a financial industry perspective and especially the banking industry, the separation between Bitcoin cryptocurrency and Blockchain needs to be clearly outlined. The negative perception is evident with the volatility of Bitcoin cryptocurrency. Not enough awareness has been created around Blockchain and this is an obstacle as if and when Blockchain is adopted for a payments system, the general public will lose faith in the Central Bank and more importantly it would possibly result in the loss of faith to the country's currency.

5.3.2 Central Authority Control

According to the results, 64% of the respondents believe that one of the major obstacles to the adoption of Blockchain technology is the SARB's fear of losing

control. This finding is vitally important as it talks to the future of payments, intermediaries and Banking in general. According to Chapman et al. (2017), project Jasper concluded that in a DLT framework, rather than an operator's role being a traditional IT infrastructure operator, it is closer to that of a rule maker. The theory of project Jasper supports the findings. Blockchain technology removes the role of payment clearing houses and the central authority certifying payments. This means that they have an oversight node from a financial surveillance perspective in terms of money laundering and anti-terrorism funding, but they don't play a role in the clearing of transactions. This basically means that even if the Central Bank node is offline, transactions will still take place and be cleared.

Regarding the matter of whether central banks ought to consider issuing their very own currency based on Blockchain technology, the Bank of International settlements ventured to such an extreme as to acknowledge that a few functions of a central bank could be rendered obsolete. "The emergence of distributed ledger technology could present a hypothetical challenge to central banks, not through replacing a central bank with some other kind of central body but mainly because it reduces the functions of a central body and, in an extreme case, may obviate the need for a central body entirely for certain functions". In particular, there might be no requirement for a central bank to issue currency if a Blockchain is backing a broadly utilised digital currency. "In some extreme scenarios, the role of a central body that issues a sovereign currency could be diminished by protocols for issuing non-sovereign currencies that are not the liability of any central institution" (Higgins, 2015). The question remains as to what is the future of Central Banks in payments and if it is really part of their mandate.

5.3.3 Compelling Business Case

Another significant finding of this study was that 67% of respondents reported that there is no compelling business case to adopt Blockchain technology for interbank payments in South Africa. This finding is consistent with theory as according to Asay (2018), the banking industry does not have a clear business

case to adopt Blockchain technology in spite of them making substantial investments. Beyond perplexity with respect to why the banks ought to utilize Blockchain, there are likewise concerns about security, legislation, and the adolescence of the technology itself. This is extremely relevant as a use case does not necessarily mean that a system is fit for purpose. Numerous use cases globally have been completed by Central Banks in two phases, namely: project Ubin, project Jasper, project Stella and a project in Brazil. South Africa has only completed one phase which is project Khoka. All of these projects speak to mainly the use of the technology; it does not speak to the business case. The major question is what problem we are trying to solve. What can Blockchain technologies give the payments industry that they don't already have? How would it improve the payments industry? One of the respondents commented that Blockchain technology is a solution chasing a problem.

5.4 Discussion Pertaining to Research Question 3

The third research question was what are the potential implications for financial Market Infrastructures? The significance of this question was to understand whether or not the principles for financial market infrastructures are even relevant when adopting Blockchain technology. It was also important to understand if the principles for financial market infrastructures could be updated or tailored for a countries specific requirements and needs. Two major themes were derived through the analysis namely Central Bank Regulation and Payments System Governance. The themes are discussed in detail.

5.4.1 Central Bank Regulation

The results reveal that only 21% of the respondents believe that Central Bank Regulation is an obstacle to the adoption of the Blockchain technology for interbank payments in South Africa. This finding is inconsistent with other studies. Thomas (2018) states that regulatory complexity is significantly affecting Blockchain adoption, as according to an Ernest and Young survey of senior specialists who attended the "Ernest and Young Global Blockchain Summit in New York", 61% consider regulatory complexity to be the greatest

hindrance to the adoption of Blockchain, trailed by the integration of legacy technology at 51% and an absence of general comprehension of Blockchain's abilities at 49%. In spite of regulatory complexity, respondents refer to changes to regulation as the essential driver for the integration of Blockchain technology into the more extensive enterprise ecosystem at 37%, trailed by the adoption of Blockchain as a digital currency by top organisations at 23% and acceptance of the technology amongst central banks at 18% (Thomas, 2018).

According to Chapman et al. (2017) the Principles for Financial Market Infrastructures (PFMIs) would need to be updated in order to include principles defining regulatory authority's requirements for structuring a DLT for a market infrastructure (Chapman et al., 2017). There are 24 PFMI's of which 17 is relevant to payments. The PFMI's standardises best practices to be adhered to. As the PFMI's are best practices according the current manner in which payments are completed suggests that the PFMIs could either be altered to accommodate Blockchain technology or the Blockchain technology software could be coded to adhere to the PFMI's. The interview respondents believe that Regulation is actually an enabler for Central Banks.

5.4.2 Payments Systems Governance

Through interviews with the respondents, there is a 50% split as to whether Governance is an obstacle or not to the adoption of Blockchain technology for interbank payments in South Africa. Although, the Governance framework was not tested explicitly in the proof of concepts carried out by Central Banks. The findings of project Jasper is relevant as it concludes that in a DLT framework, rather than an operator's role being a traditional IT infrastructure operator, it is closer to that of a rule maker (Chapman et al., 2017).

This begs the question as to who owns the Blockchain or DLT system and what level of influence the Central Bank will have. Another defining point is that if the system fails and if there is a systemic risk, which entity is accountable. According to project Khoka (SARB, 2018c) "the governance of the DLT system in a live environment would need to reside with the SARB due to its regulatory

oversight mandate, regardless of the system used”. This theory clearly specifies the intentions of the SARB in terms of Governance and it also supports the respondent’s results in terms of governance being an obstacle to adoption. It also reiterates the results of the SARB’s fear of losing control as an obstacle to the adoption of Blockchain technology for interbank payment systems in South Africa. 50% of the interview respondents however believe that Governance is actually an enabler for Central Banks as Blockchain technology allows Governance and policy frameworks to be built and incorporated around the system. The limitations to Governance around Blockchain based DLT systems are that consultations among financial industry participants have not yet taken place.

5.5 Discussion Pertaining to Research Question 4

The fourth research question was what are the potential implications for safety? The question is particularly significant in terms of risk and the risk of adopting Blockchain technology for interbank payments. It was important to identify the various types of risk areas from the respondent’s perspectives as the respondents would be able to compare their current risk appetite with risks of adopting Blockchain technology for interbank payments. One major theme that was prevalent in the analysis was business continuity risk. The theme is discussed in more detail.

5.5.1 Business Continuity Risk

Another significant finding of this study is that 56% of respondents reported that business continuity risk was an obstacle to the adoption of Blockchain technology for interbank payments. This finding is significant as it is in accordance with literature (SARB, 2018c). Project Brazil concluded that in a “Corda Blockchain, there is no public Blockchain and no private channels; each transaction occurs in a peer-to-peer manner. Without a disaster recovery feature built into the platform, the process of retrieving data from the network would be cumbersome and risky. Furthermore, the notary function presents a single point of failure” (SARB, 2018c).

Project Stella concluded that in terms of failures to nodes, the results confirm that a validating node could recover in a reasonably short period of time regardless of downtime. The results also showed that whenever the certificate authority was not available, transactions were rejected. This generally constitutes to a single point of failure. Once the certificate authority became available again, processing resumed without the intervention of any other systems (ECB and BOJ, 2017).

“Project Jasper concluded that Corda Blockchain nodes can queue pending requests to other nodes in the event that a node is forced offline. While the transactions will be processed when this node comes back online, the impact of an offline node on the ecosystem could be substantial. Incorporating a central queue or LSM component would require consideration of the need for high availability, as this would introduce a single point of failure” (SARB, 2018c).

The failure of a payments system would result in a systemic risk to the country as payments are a vital component to the financial stability of the country. The current SAMOS system has a disaster recovery mechanism and plan in the event of data, power and operational failure. Blockchain or DLT confirm that the disaster recovery is built into the system. For example, Bitcoin Blockchain which has been running for 10 years now has not yet failed. Technologists and literature claim that a Blockchain or DLT based systems are extremely resilient, however, project Brazil, Project Stella and Project Jasper still highlight some concerns regarding a single point of failure. It is important to note that different Blockchain platforms were used by various Central Banks and only certain Blockchain platforms had concerns of single point of failures. South Africa used a Quorum Blockchain platform in project Khoka and there were no concerns of resilience in terms of single point of failure.

5.6 Discussion Pertaining to Research Question 5

The fifth research question was what are the business impacts to the financial market eco-system participants? This question is vitally important as the industry participants will be directly impacted by the adoption of Blockchain

technology for interbank payments. It was essential to identify whether there will be positive or negative impacts to the banking systems and processes and what are the financial implications to the financial services industry. These results are fundamental to determining the feasibility of Blockchain technology for interbank payment systems. Three major themes were derived through the analysis namely; Blockchain and DLT interoperability with legacy systems, Cost benefit to the Banking Industry and Technology Maturity and Skills in South Africa. The themes are discussed in detail.

5.6.1 Blockchain and DLT interoperability with legacy systems

More than two thirds which are 70% of the respondents stated that interoperability is an obstacle to adopting Blockchain technology for interbank payments. This finding is consistent with what literature states about interoperability. According to SARB (2018c), as various financial industry participants explore and introduce DLT frameworks, the potential complexity in interoperability and the potential for new models of business both increase. One of the key obstacles that exist in connection to implementation considerations lies in the capacity of each of the chosen systems to communicate, not just with one another, but in addition with existing legacy systems (SARB, 2018c).

According to Browne (2018) the absence of interoperability awards Blockchain coders and developer's autonomy and can give information technology departments cerebral pains as they find that different platforms cannot communicate without translation help. Standardisation could help organisations to work together on application development, approve proofs of concepts, and offer Blockchain solutions and also make it simpler to integrate with existing legacy systems.

The major concern at this stage is different platforms of Blockchain can't integrate with each other, and there isn't a concrete solution or interphase for Blockchain or DLT to integrate with existing banking legacy systems. One of the major limitations is that the Banking systems infrastructure has taken years to construct and there are already allot of interconnectedness and dependencies.

Therefore, if Blockchain technology cannot integrate with the Banking legacy systems, it will prolong Blockchain technology adoption.

5.6.2 Cost benefit to the Banking Industry

A total of 58% of respondents confirm that cost of implementing a Blockchain system for payments is an obstacle. This finding is consistent with literature as one of the regularly noted criticisms of bitcoin's Blockchain network is that it depends heavily on intensive computing power and therefore requires large amounts of electricity to operate. Miners utilise massive computer rigs with several servers to keep the Blockchain network operating, and that process is not cheap. A study conducted by Elite Fixtures stated that it cost more than \$26,000 to mine only one bitcoin in South Korea, who are one of the biggest markets for cryptocurrency trading. Despite the fact that bitcoin miners get paid a sum of bitcoin for their works, the cost of validating transactions could be a concern for extensive penetration of Blockchain technology in business activities (Browne, 2018).

According to the SARB (2018c) there would be technology and resource costs to implementing a new DLT framework; however, these could be offset against the extra functionality that a DLT framework would bring. Due to the resilience of a DLT system, the cost could be offset against running a backup RTGS system (SARB, 2018c).

Banks are already running on core systems, which took years of investment. The main question to be answered, bearing in mind the cost of a new system, is who is going to be accountable for those costs and will it be worthwhile to start a parallel system. New infrastructure need to prove that it can provide the same safety, security, resilience and efficiency measures that the current payments system is offering. The limitation to this is that the cost of implementing a Blockchain or DLT system for interbank payments has not yet been established. This therefore, leaves room for speculation on costs.

5.6.3 Technology Maturity and Skills in South Africa

While more than half which is 58% of the respondents reported that skills in South Africa is currently not an obstacle to the adoption of Blockchain, 42% purported that these skills are very scarce. This finding is very subjective as it is mostly based on the fact that the technical team Consensus who worked on Project Khoka in South Africa is the same team that worked on Project Ubin in Singapore. The reality is that this is a small number of technical expertise to cover the entire South Africa. The technical expertise is more often based on a particular platform of Blockchain which limits technical expertise even further. The question remains which Blockchain platform does South Africa adopt.

The amount of awareness and training of Blockchain in South Africa is not evident in majority of businesses, universities and schools in South Africa. Sawehel (2018) states that requests are intensifying for African universities to keep pace with the world's topmost 50 universities in offering more courses to lead the way for Blockchain-based development. "The Rise of Crypto in Higher Education found that 42% of the world's top 50 universities offered at least one Blockchain or crypto course". The founder of BitHub.Africa John Karanja, detailed that there was "little to no adoption" of Blockchain courses by African universities.

The limitation is that Blockchain is a very new technology and not many technical companies or universities understand the technology well enough to teach it. This essentially raises the question as to whether there would be enough resources to maintain and support a Blockchain based DLT system for interbank payments in South Africa.

6 CHAPTER 6. CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the conclusion to the research and it provides recommendations and suggestions for further research.

6.2 Conclusion of the study

The research problem was “The banking industry is not adopting Blockchain technology for interbank payments in South Africa although numerous successful proofs of concept projects have been concluded by various Central Banks globally including South Africa”. The primary research question was to identify the obstacles the South African Banking Industry is facing in adopting Blockchain technology for interbank payments in South Africa. The study presented the perceived obstacles to the adoption of Blockchain technology for interbank payments in South Africa.

The first research question was can Blockchain technology work for interbank payments in South Africa and why? Blockchain technology can work for interbank payments in South Africa however the results show that the financial services industry is not comfortable to proceed past an experimentation stage. The respondents question the concomitant benefit that a technology like Blockchain has and advise that the adoption may not materialise in the near future.

The second research question was what are the major obstacles to the adoption of Blockchain technology for interbank payments in South Africa? The results indicate that the obstacles to the adoption of Blockchain technology for interbank payments are not a technology issue but more of a business decision making issue. The business case must be separated from the use case. This would require the financial industry to develop a compelling business case and then give it to the technologist and tell them this is what we want to achieve.

The third research question was what are the potential implications for financial market infrastructures? The respondents are in agreement that Central Bank Regulation and Governance is not an obstacle to the adoption of Blockchain technology for interbank payments, however this is not consistent with other surveys in terms of regulation as another survey indicated that regulatory complexity is a hindrance to the adoption of Blockchain technology. There are

areas within Central Bank Regulation such as the amendment of the PFMLs and Governance issues such as ownership that requires attention and consultation in order to move to the next step and possibly to a production level.

The fourth research question was what are the potential implications for safety? The difference in the research results amongst the participants regarding Blockchains resilience in terms of business continuity is not significant. Whilst the Bitcoin Blockchain has not failed, proof of concepts by some Central Banks has experienced failures on certain platforms. This, however, raises concerns because, although they are different platforms the technology is based on the same principle and there is potential for failure.

The fifth research question was what are the business impacts to the financial market eco-system participants? The respondents agree that the impact to the financial services industry eco-system participants is great. The interoperability of Blockchain technology with legacy systems is still an unresolved matter. The cost benefit of Blockchain technology has not been conclusively established. Who bears the cost of the technology implementation is a huge factor and would possibly be an obstacle that prolongs the adoption. Although South Africa has Blockchain specialists the expertise in South Africa is limited and is a scarce commodity.

6.3 Recommendations

- a) The Central Banks globally together with the Bank of International Settlements should meet to discuss the requirements for a Blockchain based system and then decide on an appropriate platform.
- b) The Intergovernmental Fintech Working Group (IFWG) together with the SARB Fintech Department must create awareness programmes on Blockchain technology and use the media as a primary source of awareness.

- c) The South African financial services industry must meet to discuss the appropriate requirements for payments systems in South Africa. They must exclude technologist and derive a business case that is purely based on business and the countries requirements.
- d) The Central Banks globally together with the Bank of International Settlements should meet to discuss the possibility of altering the 17 PFMLs related to payments to accommodate Blockchain and DLT. Areas that cannot be altered should be coded on the Blockchain software to accommodate the PFMLs.
- e) The South African Central Bank should arrange a meeting with the South African financial services industry to discuss the Governance and Regulations of a Blockchain based DLT system.
- f) A parallel Blockchain DLT system should be installed and then tested for business continuity.
- g) The Intergovernmental Fintech Working Group (IFWG), the SARB Fintech Department and South African based technology companies should investigate possible solutions for interoperability.
- h) A cost analysis for the implementation of a Blockchain DLT system for payments in South Africa should be completed by the Intergovernmental Fintech Working Group (IFWG), the SARB Fintech Department and South African based technology companies.
- i) South African Universities, Technicon's and Colleges must recruit Blockchain and Cryptography specialists and offer courses and degrees in this field.

6.4 Suggestions for further research

- a) The feasibility of a tokenised South African Rand: The implementation of a Blockchain or DLT based systems requires the use of a tokenised Rand.
- b) The mandate of the SARB in terms of payments.

7 REFERENCES

- Accenture (2017). Project Ubin Phase 2: Re-imagining Interbank Real-time Gross Settlement System Using Distributed Ledger Technologies.
- Alyson (2018). "What is Blockchain Technology?" from <https://support.Blockchain.com/hc/en-us/articles/211160223-What-is-Blockchain-technology->.
- Ansari, M. N. (2018). "Hyperledger Fabric: The Enterprise Blockchain." from <https://medium.com/coinmonks/hyperledger-fabric-the-enterprise-Blockchain-104f5e59f169>.
- Asay, M. (2018). "Why Blockchain adoption has stalled in financial services and banking." from <https://www.techrepublic.com/article/why-blockchain-adoption-has-stalled-in-financial-services-and-banking/>.
- Babbie, E., et al. (2015). The Practice of Social Research. Vasco Boulevard, Goodwood, Cape Town, Republic of South Africa, Oxford University Press.
- Browne, R. (2018). "Five things that must happen for blockchain to see widespread adoption, according to Deloitte." from <https://www.cnbc.com/2018/10/01/five-crucial-challenges-for-blockchain-to-overcome-deloitte.html>.
- CBB (2017). Distributed ledger technical research in Central Bank of Brazil.
- Chapman, J., et al. (2017). Project Jasper: Are Distributed Wholesale Payment Systems Feasible Yet?
- CPSS (2012). Payment, clearing and settlement systems in South Africa.
- Deloitte (2015). Blockchain Disrupting the Financial Services Industry?
- Deloitte (2017). Project Ubin: SGD on Distributed Ledger.

ECB & BOJ (2017). Project Stella - Payment systems: liquidity saving mechanisms in a distributed ledger environment.

Fox, W. and M. S. Bayat (2014). A guide to Managing Research. Landsdowne, Cape Town, South Africa, Juta and Co Ltd.

Frankenfield, J. (2018). "Definition of Ethereum." from <https://www.investopedia.com/terms/e/ethereum.asp>.

Gordon, S. (2018). "What is Ripple?" from <https://bitcoinmagazine.com/guides/what-ripple/>.

Higgins, S. (2015). "BIS: Digital Currencies Could Disrupt Central Banking Model." from <https://www.coindesk.com/bis-digital-currencies-could-disrupt-central-banking-model>.

Hileman, G. and M. Rauchs (2017). Global Blockchain Benchmarking Study.

Huysamen, G. K. (1994). Methodology for the Social and Behavioural Sciences, International Thomson Publishing Inc.

Krause, E. G., Velamuri, V. K., Burghardt, T., Nack, D., Schmidt, M., & Treder, T.-M. (2016). Blockchain Technology and the Financial Services Market State-of-the-Art Analysis. Retrieved from http://www.infosysconsultinginsights.com/wp-content/uploads/2016/10/InfosysConsulting_HHL_Blockchain.pdf

Lester, S. (1994). "An Introduction to Phenomenological Research." from <https://www.rgs.org/CMSPages/GetFile.aspx?nodeguid=7ad9b8d4-6a93-4269-94d2-585983364b51&lang=en-GB>.

Lewis, R., McPartland, J., & Ranjan, R. (2017). Blockchain and financial market innovation. Retrieved from

<https://www.chicagofed.org/~media/publications/economic-perspectives/2017/ep2017-7-pdf.pdf>

Maguire, M. and B. Delahunt (2017). "Doing a Thematic Analysis: A Practical, Step-by-Step Guide for Learning and Teaching Scholars." 8(3).

Masela, T. (2012). "Access to the National Payment System (NPS)." 2018, from http://www.treasury.gov.za/coopbank/Conferences/CFI%20Indaba%2016%20-%2019%20October%202012/Access%20to%20the%20National%20Payment%20System_Masela_SARB.pdf.

Meijer, C. R. W. D. (2018). "Corda Enterprise Blockchain Platform: unlocking new opportunities." from <https://www.finextra.com/blogposting/15557/corda-enterprise-Blockchain-platform-unlocking-new-opportunities>.

PASA (2018). "Overview." National Payment System. 2018, from <http://www.pasa.org.za/national-payment-system/overview>.

Patel, N. (2017). Blockchain KYC/AML Utilities for International Payments: A Regulatory Solution for Anti-Money Laundering and Financial Inclusion?

Rochemont, S. and O. Ward (2019). Understanding Central Bank Digital Currencies (CBDC).

Rouse, M. (2017). "Distributed Ledger Technology (DLT)." from <https://searchcio.techtarget.com/definition/distributed-ledger>.

SARB (2008). "Financial Stability Review." 2018.

SARB (2014). Position Paper on the Interbank Settlement Application Interfaces. Pretoria.

SARB (2017). "The National Payment System Framework and Strategy Vision 2025." 2018, from

[https://www.resbank.co.za/RegulationAndSupervision/NationalPaymentSystem\(NPS\)/Documents/Overview/Vision%202025.pdf](https://www.resbank.co.za/RegulationAndSupervision/NationalPaymentSystem(NPS)/Documents/Overview/Vision%202025.pdf).

SARB (2018a). Media Statement. Pretoria, South Africa, South African Reserve Bank Media Relations.

SARB (2018b). Launch of National Payment System's Vision 2025 Pretoria, South African Reserve Bank.

SARB (2018c). Project Khoka: Exploring the use of Distributed Ledger Technology for interbank payments settlement in South Africa. Pretoria.

SARB (2019). "SAMOS System (South African's Real Time Gross Settlement (RTGS) System)." from [https://www.resbank.co.za/RegulationAndSupervision/NationalPaymentSystem\(NPS\)/SAMOSSystem\(RTGS\)/Pages/SAMOSSystem\(RTGS\)-Home.aspx](https://www.resbank.co.za/RegulationAndSupervision/NationalPaymentSystem(NPS)/SAMOSSystem(RTGS)/Pages/SAMOSSystem(RTGS)-Home.aspx).

Sawahel, W. (2018). "Universities should address demand for blockchain skills." from <https://www.universityworldnews.com/post.php?story=20181010064727399>.

Sharma, T. K. (2018). "What is Quorum Blockchain?". from <https://www.Blockchain-council.org/Blockchain/what-is-quorum-how-is-it-different-from-other-Blockchain/>.

SWIFT (2019). "About Us." from <https://www.swift.com/about-us>.

Taherdoost, H. (2016). "Validity and Reliability of the Research Instrument; How to Test the Validation of a Questionnaire/Survey in a Research." SSRN Electronic Journal 5(3).

Tandulwadikar, A. (2016). Blockchain in Banking: A Measured Approach.

Teis, S. (2017). "Blockchain: Challenges in financial sector use." from <https://www.world-exchanges.org/focus/index.php/features/trading-technology/185-Blockchain-challenges-in-financial-sector-use>.

Thake, M. (2018). "What's the difference between Blockchain and DLT?". from <https://medium.com/nakamo-to/whats-the-difference-between-Blockchain-and-dlt-e4b9312c75dd>.

Thomas, J. (2018). "Regulatory complexity is the greatest barrier to widespread blockchain adoption, while regulatory changes are the primary driver of broader integration, according to EY poll." from https://www.ey.com/en_gl/news/2018/06/regulatory-complexity-is-the-greatest-barrier-to-widespread.

Underwood, S. (2016) Blockchain Beyond Bitcoin.

University of Cape Town. (2017). "Keeping blockchain booming in Africa." from <https://www.news.uct.ac.za/article/-2017-10-19-keeping-blockchain-booming-in-africa>.

Welman, J. and S. Kruger (2001). Research Methodology for the Business and Administrative Sciences.

Wüst, K. and A. Gervais (2017) Do you need a Blockchain?

Zhao, X., Zhang, H., Rutter, K., Thompson, C., & Wan, C. (2018). Cross-Border Settlement Systems: Blockchain Models Involving Central Bank Money. Retrieved from https://www.r3.com/wp-content/uploads/2018/05/CrossBorder_Settlement_Central_Bank_Money_R3-1.pdf

8 APPENDIX A

8.1 Research Instrument

The researcher made use of a semi-structured interview with the following questions:

1. Can Blockchain technology work for interbank payments in South Africa and why?
2. What are the biggest obstacles to the adoption of Blockchain technology for interbank payments in South Africa?
3. What are the potential implications for financial Market Infrastructures?
4. What are the potential implications for safety?
5. What are the business impacts to the financial market eco-system participants?

9 APPENDIX B

9.1 Interview request email

Dear

I trust you are well.

By way of introduction, I am Mergan Naidoo, a Wits MBA student.

As part of my MBA programme, I have to complete a research project. I am currently in the data gathering phase of my final report and my research topic is, "The perceived obstacles to the adoption of Blockchain Technology for interbank payments in South Africa".

It would be greatly appreciated if you would allow me to interview you for my research project.

The interview will be face to face at a location suited to you, semi-structured, voice recorded, not exceed an hour and remain confidential as no names or designations are documented in the research paper. My ethical clearance number is: WBS/BA1789839/665

Kindly advise if you would be able to accommodate me within the next week.

Kind Regards,
Mergan Naidoo
012 399 7112
083 631 4061