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Knowledge-mapping of blockchain technology applications for a banking institution

by

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Supervisor: Prof Tanya du Plessis

MAY 2019
DECLARATION

I certify that the dissertation submitted by me for the degree Master’s of Philosophy (Information Management) at the University of Johannesburg is my independent work and has not been submitted by me for a degree at another university.

NATISHA SEWPERSADH
Acknowledgement

First and foremost, I would like to thank God Almighty for giving me the strength, knowledge and opportunity to undertake this research study. Without the blessings from the almighty, this achievement would not have been possible. In my journey towards this degree, I have found a teacher, an inspiration, a role model and a pillar of support in my Guide, Professor Tanya Du Plessis. She has been there providing her heartfelt support and has given me invaluable guidance, inspiration and suggestions in my quest for knowledge. Without her guidance, this thesis would not have been possible and I shall eternally be grateful to her for her assistance.

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Abstract
Blockchain technology is a relatively new technology which provides many opportunities for knowledge-mapping. Blockchain technology is best described as a decentralised ledger system that stores information about transactions and uses digital currencies such as Bitcoin. The best possible utilisation of a new technology usually depends on how quickly people can develop and apply new knowledge of the technology. Knowledge is a key component to leverage the most useful features of any new technology. Moreover, it is crucial to know how to avoid the pitfalls of a new technology in order to develop solutions. This study’s unit of analysis is knowledge of blockchain technology, that is, the knowledge possessed by people operating in the banking industry.

The banking industry is sternly regulated in all jurisdictions and employee know-how is a valuable resource. The recent wide dissemination of blockchain technology, the popularity of cryptocurrencies, and the Initial Coin Offering have contributed to the fact that financial institutions’ management underline the vast potential of blockchain technology in the financial industry. For example, large banks are conducting tests of decentralised asset technology and implementing decentralised ledger systems in business processes. Banks are investing in projects and start-ups that are developing blockchain-based solutions. Therefore, bank employees with know-how and prior experience with blockchain are essential to create blockchain solutions.

The objective of this study is to map the existing know-how and identify knowledge gaps of blockchain technology know-how and its possible application in a South African Banking Institution (SABI). This is done through an analysis of knowledge of how the utilisation of blockchain technology changes the existing operations models of financial institutions.

The research methodology consists of an inductive knowledge-mapping strategy and mixed-method approach. The quantitative data collection method involved gathering data via an online questionnaire sent to a purposive sample, namely, SABI’s clients, investors, experts, and individuals with the common denominator: Blockchain technology knowledge interest who had attended the Blockchain Africa Conference. The qualitative data collection method was an interview with individuals who had a specific technical knowledge of blockchain technology, with the common denominator: SABI blockchain knowledge group.
The data analysis was sequential; the quantitative data analysis was followed by qualitative data analysis.

The findings identify categories of knowledge that are needed to inform and build new blockchain technology-based operations models. Knowledge gaps were identified in the SABI. Based on the findings, the study conceptualises a knowledge map and develops a theory, namely: If the blockchain knowledge maps of financial institutions integrate knowledge across their Core Banking Application pillars, then the financial services industry will create an Internet of Value-Exchange advantage for everyone on the network. Further study is required in order to test this theory.

A key recommendation is to perform knowledge-mapping of the Core Banking Application pillars as the next step of SABI’s knowledge maturity of blockchain technology. In conclusion, knowledge maturity of blockchain technology is essential to create an Internet of Value-Exchange advantage for everyone within the network. The mapping of knowledge provides a measurement of knowledge maturity. Blockchain technology provides many opportunities for knowledge-mapping.

**Keywords:** Blockchain technology; Bitcoin; cryptocurrency; core banking application pillars; decentralised ledgers; foundational technology; Internet of Things; Internet of Value-Exchange, knowledge-mapping; knowledge maturity; pseudonymity.
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List of Abbreviations

AML Anti-Money Laundering
B2B Business-to-Business
BTC Bitcoin Cryptocurrency
CBA Core Banking Application
cf compare further
FSI Financial Services Industry
i.e. that is
ICT Information and Communication Technology
IVE Internet of Value-Exchange
IM Information Management
IoT Internet of Things
IT Information Technology
KM Knowledge Management
KYC Know Your Customer
P2P Peer-to-Peer
PoS Proof-of-Stake
PoW Proof-of-Work
RMB Rand Merchant Bank
FNB First National Bank
SARB South African Reserve Bank
SARS South African Revenue Service
sic Used in brackets after a copied or quoted word that appears odd or erroneous to show that the word is quoted exactly as it stands in the original
TCP/IP Transmission Control Protocol / Internet Protocol
UJ University of Johannesburg
viz to be exact
List of Terminologies

Banking institutions.................“Offering products to individual consumers such as deposit accounts, lending and limited financial advice to both demographics” (Finance Corporation International, 2014). Products offered at retail and commercial banks include cheque and savings accounts, certificates of deposit, personal and mortgage loans, credit cards and business banking accounts. In South Africa a banking institution would be Absa, FNB, Nedbank and Standard as the big four among other smaller banks.

Bitcoin........................................“Bitcoin is a digital asset designed by its inventor, Satoshi Nakamoto. Bitcoin is one of many types of cryptocurrency. It is accepted on a worldwide payment system. It was known to be the first decentralised digital currency as the system works without a central bank or single administrator. It allows people to send or receive money across the Internet, even to someone they don’t know or don’t trust. Money can be exchanged without being linked to a real identity (Lingham, 2016).”

Blockchain.................................“A digital ledger in which transactions made in Bitcoin or another cryptocurrency that will be recorded chronologically and publicly on the digital ledger” (Orgera, 2018).

Cryptocurrencies......................“It is a digital currency in which encryption techniques are consumed to adjust the generation of units of currency and confirm the transfer of funds, functioning independently of a central bank” (Rosic, 2018).

Financial institutions...............“Is a corporation involved in the business of dealing with monetary transactions such as deposits, loans, investments and currency exchange? Almost everyone living in a developed economy has a continuous or at least periodic need for the services of financial institutions. The main categories of financial institutions comprise central banks, retail and commercial banks, Internet banks, credit unions, savings and loans associations, investment banks, investment companies, brokerage firms, insurance companies and mortgage companies” (Kolakowski, 2017).

Financial services industry...“The financial services industry plays a fundamental transitional role in the world economy as it changes money from entities with additional funds to those with a need for funds. It comprises firms that are involved in activities such as investing, lending, insurance, securities trading” (Kolakowski, 2017). Its clients include individuals, businesses, non-profit organisations and agencies of government.
example of these are organisations such as PwC and KPMG, to mention a few.

Fintech..............................“Computer programs and other technology used to support or enable banking and financial services. The term has expanded to include any technological innovation in the financial sector, including innovations in financial literacy and education, retail banking, investment and even cryptocurrencies like Bitcoin” (Fintech Weekly, 2017).

Internet of Things...............“The Internet of Things, or IoT, refers to billions of physical devices around the world that are now connected to the Internet, collecting and sharing data. Thanks to cheap processors and wireless networks, the Internet of Things, or IoT, refers to billions of physical devices around the world that are now connected to the Internet, collecting and sharing data. Thanks to cheap processors and wireless networks” (Ranger, 2018).

Knowledge-mapping............“Knowledge-mapping is a process of surveying, assessing and linking the information, knowledge, competencies and proficiencies held by individuals and groups within an organisation” (Hylton, 2002). It is a “method of analysis to define the knowledge needed and the knowledge available to support a business process” (Driessen, 2007).
Chapter 1

Contextualisation and problem statement

1.1 Introduction

The unit of analysis of this study is knowledge of blockchain technology; more specifically, knowledge of how the utilisation of blockchain technology changes existing operations models of financial institutions. The testing of new knowledge through experimentation and the development of a collective knowledge will lay the foundation of a new technology such as blockchain technology (Meszaros, Adachi, Dharamsi & Yetiskin, 2016; Tandulwadikar, 2016; Hirota, Huber, Stöckl & Sunder, 2018). This study applies the knowledge-mapping methodology to develop a blockchain knowledge-mapping theory.

Knowledge and innovation is the root of prosperity in competitive markets, and mainly every significant business venture can trace its origins to an initial spark of innovation using competent knowledge (Thavanathan, 2017). Technological advances are now demanding enterprise leaders to react to change, and one notable example is the world of banking which is progressing through massive transformations. As stated by Thavanathan (2017), blockchain technology is emerging as an added factor contributing to industry’s forced change into a digital-first age. Blockchain technology is a cryptographically secured ledger and is known as a value exchange protocol (Tandulwadikar, 2016; Garzik, 2017). It allows secure transfers of data with various individuals. In a way, blockchain technology resembles the development of the Internet in the early 1990s, previously it developed a mainstream commodity. A traditional Internet of Things (IoT) system relies on a centralised architecture, as stated by Pauw (2018), billions of devices join IoT networks. In the future, the centralised system will have limited scalability, be exposed to cyber threats, slow transmission times and continuous authentication controls. It has been said by Karlsson Lundström (2016:5) the Internet should facilitate a wider variety of services and modifications in all of humankind’s varied lifestyles. In the IoT sector, the purpose of blockchain technology architecture will be to help solve the above-mentioned bottlenecks.

This first chapter provides a background to the study, leading to the problem statement, research question and research aim and objectives. A summary of the research methodology
reveals how data was collected to understand the knowledge individuals possess how blockchain technology will advance a banking institution’s existing operations models. Moreover, it explains what needs to be ingested to fill the knowledge gaps existing in a banking institution. The potential of Blockchain application outside of Bitcoin market was ultimately recognised, and has since been adopted for several purposes by developers and investors. This study does not analyse the Blockchain, it analyses the knowledge possessed by people of how the technology applies in the banking industry to conceptualise a knowledge map.

The outline at the end of this chapter provides an overview of the structure of the dissertation. This first chapter ends with a summarised initial conceptualisation of the knowledge-mapping of blockchain technology; thereafter the findings produce the conceptualised knowledge map. The last chapter is a summary of the theory that has been developed through inductive study.

1.2 Contextualisation of blockchain technology and virtual currencies

Technical progress has a foundational phase that typically has a great effect on many of humankind’s areas, says Karlsson Lundström (2016:4), for example the areas of spatial geo-positioning, interaction between workers, the living standards of communities, and the dynamics within communities have changed due to a foundational technology such as the Internet (Karlsson Lundström, 2016:4). Many areas are distressed by the recent technical innovations and technological progress of blockchain technology that now seems to be leading to a foundational technology (Velde, 2013:1-4). Blockchain technology is growing and is greatly influencing the Financial Services Industries (FSI). Blockchain technology is mentioned by Karlsson Lundström (2016:6) as one of the new technical innovations that is seeing a rapid emergence. It is on the radar of the FSI and people are now referring to it as the “Internet of Value-Exchange” (Garzik, 2017:8-9).

Blockchain technology is a new “technique” that offers a recordkeeping of several categories in a “distributed database architecture” which is known as a ledger (Garcia, Tessone, Mavrodiev & Perony, 2015). Blockchain technology allows networks to develop in a decentralised manner and is capable of processing in a shorter transaction time. It is apparent that blockchain technology initiatives hold an unlimited influence on the road to a positive
capital market, says Velde (2013:2), adding that it will influence FSIs globally. The probability for dualistic fragments is explained to transfer money over the Internet, that is, a network shorn of a trusty third party (Garcia et al, 2015). The conceptualisation of protected digital currency trades was put into operation through the introduction of the Bitcoin currency, which was initiated in 2008. At present, blockchain technology is viewed as a foundational technology, the foremost technology of a digital currency such as Bitcoin which is using a public shared or distributed ledger.

Within central financial institutions in South Africa there are public institutions that are supposed to manage the varied currencies with the “ability to alter the monetary base” (Winter, 2014). Winter (2014) explains that “the value of a given currency” mostly depends on the “decision taken by the issuing central bank”; in South Africa that would be the South African Reserve Bank (SARB). The SARB ensures the means of payment to have a “fixed purchasing power” (Winter, 2014). Similarly, several decentralised virtual currencies, of which the commonly used is Bitcoin, does not hold a central authority (Clark & Essex, 2012; Leinonen, 2016; Schupmann, 2017). Bitcoin has a monetary base that is defined by an algorithm. The price attached to the Bitcoin is determined by supply and demand (Garcia et al, 2017). Moreover, blockchain technology ensures probable applications ahead of Bitcoin and cryptocurrency offers.

A “blockchain is fairly basic”, explain Clark and Essex (2012:390). Garcia et al (2017) agree and provide the simple explanation that it is a digital, decentralised ledger that retains a record of all transactions that take place across a peer-to-peer (P2P) network. Financial institutions should take note that this technology permits market contributors to transmission assets across the Internet without the need for a third party commonly known as “the bank” (Clark & Essex, 2012:391; Garcia et al, 2017). Basic blockchain technology has various applications for a business that operates in the information technology (IT) space. For example, when blockchain technology inherits next-generation business process improvement software and workflow solutions, a collaborative technology such as blockchain will advance business capabilities, business processes and models that are being used in financial institutions (PwC, 2016). According to Mougayar (2016), the occurrence of the new technology between companies fundamentally sinks the idea of “cost of trust”. Mougayar (2016) stated the technological investment affects companies significantly by providing higher returns for each investment spent than most traditional internal investments in South Africa. Financial
institutions are discovering how they can possibly practise blockchain technology to overturn business process models in the information technology (IT) space.

The fact that financial institutions have discovered the need to develop a new knowledge of blockchain technology presents a research gap – to investigate and analyse the knowledge that is required to deal with blockchain technology and cryptocurrencies such as Bitcoin.

Bitcoin is a decentralised cryptocurrency and its increasing recognition signals a threat to traditional currencies (Crawford, 2015). Therefore, this study investigates how to fill the knowledge gaps on blockchain technology in banks. A positive adaptation to cryptocurrency begins with an understanding of its special qualities to the user such as “high anonymity”, “instant and irreversible transactions”, “low transaction fees” and “openness”, explain Crosby, Pattanayak, Verma and Kalyanaraman (2015). The exchange rates depend on the standard principle of “supply and demand” of the specific cryptocurrency, explains Fernandez (2015), which is usually “acquired in any of the available exchange services available”. The widespread attention to cryptocurrencies makes knowledge of the foundational technology essential.

The attention Bitcoin is receiving from international FSIs signals the need to pay attention to cryptocurrency as a phenomenon (Fin24tech, 2014; Warner, 2016). Once financial institutions have acquired the knowledge and understood the behaviour of the data miner, a financial institution could look for possible co-integration among how Bitcoin and the blockchain infrastructure could possibly affect the financial industry in South Africa. According to Thavanathan (2017), there could be two scenarios describing the banking structure for what can happen; the banks end up losing to the new and more efficient financial services that are in touch with the new digital age and end up competing with the same financial services. Or, the banks focus on the costumer and accept changes to their business model. Once deemed cost-prohibitive, blockchain has the potential to lower the entry barrier to banks and their business functionalities (Thavanathan, 2017). Subsequently, banks are implementing a broad awareness of decentralised ledger technology (DLT), which is being incorporated into banking institutions’ long-range strategic planning (Thavanathan, 2017).
1.3 Contextualisation of blockchain knowledge-mapping

Common knowledge is information that is accepted by a group of people, but not only does this group have a common knowledge, they also know that other participants in the group and others have the same knowledge (Xie, 2018). Even though the Internet is rife with content about cryptocurrencies and blockchain technology, there is a lack of knowledge-mapping studies in scholarly publications based on empirical research of what is commonly referred to by researchers such as Gilfillan (2014), and Lansitiand Lakhani (2017), as “cryptocurrency” and “blockchain technology”. These researchers, and many others, have studied blockchain technology. For example, Fernandez (2015) finds that there has been a growing acceptance of cryptocurrencies since 2012. The use of cryptocurrencies as a compensation mechanism or as a transfer of value is gaining impetus. Furthermore, the number of entities such as issuers, exchangers, faucets, intermediaries, guarantors and block starters, are just a few that are engaging in cryptocurrency transactions – and that number is growing. These entities often need access to traditional banking services, explain Gilfillan (2014), Lansitiand Lakhani (2017).

The SARB promptly cautioned against the abysmal lack of knowledge of blockchain technology and the unique risks and challenges of providing banking services to these entities (Reserve Bank South Africa, 2013). Observing the SARB’s caution, this study has a blockchain knowledge-mapping mindset, which means that it investigates a financial institution management team’s knowledge of blockchain technology and the risks they should consider and what knowledge implementing the technology within the bank. Knowledge-mapping typically entails asking questions such as:

- “What do you need to know?”
- “Where does the knowledge come from?”
- “Who owns the knowledge?”
- “What knowledge, tools and templates exist today?”
- “What knowledge, tools and templates should be created?”
- “What barriers or issues exist?” (cf Section 3.3.4; Driessen, 2007:109-114)

Blockchain knowledge-mapping is crucial especially since cryptocurrencies are prompting multiple operational encounters for financial institutions in South Africa (Fin24tech, 2014; Jenn, 2016; Warner, 2016). The threat imposed can lead to liquidation for financial institutions if they do not possess internal controls to mitigate the risk of loss. Management
should create “dual control and access processes, and think about how this asset will be valued and accounted for on its financial statements”, says Vermeulen (2015). The consideration of the security of the cryptocurrency has been raised and the threat to it can emanate from skilled and software-savvy people who can manipulate the system for personal gain. The main usage for blockchain servers for people who can successfully use blockchain include those who are reluctant to share valuable data in a secure, tamper-proof manner with colleagues whom they cannot trust. Blockchain allows the storage of data using sophisticated mathematical and innovative software rules that are extremely difficult for attackers to manipulate (Orrcutt, 2018).

“In game theory, common knowledge is the foundation of collaboration” (Morris & Song Shin, 1997). Common knowledge is the basis consumed by people to foresee their colleagues’ next outcome. With specific predictions of other actions, individuals can advance identifying the strategy that caters their needs and dynamically lower their risks. Sharing more common knowledge amongst parties allows for more confident and lower cost collaboration, amplifying efficiency across people (Morris & Song Shin, 1997).

In 1997, it was said that “we have new technology for automated global consensus, mutual verification, and reliable state transfer and storage”, and “we see the possibility to industrialize the production of common knowledge” (Morris & Song Shin, 1997). Today, with the assistance of cryptography, the common knowledge on a blockchain not only occurs among humans but also among human and machine, as well as between machine and machine, says Xie (2018). “We are not only making common knowledge creation more competent”, says Xie (2018), but issuing it more broadly. The Internet permitted the communication range to increase to a global scale and enabled individuals to meet and transact from any location in the world (Xie, 2018). According to Cloudbric (2018), a common knowledge base will spread a trust boundary to new frontiers. Small businesses and start-ups are far more likely to innovate and experiment with blockchain than established financial institutions, as stated by Cloudbric (2018), it is advised that blockchain is essential for new start-ups to combat cyberattacks using the technology.

As mentioned by Mehta (2018), “there will be a major paradigm shift for small businesses and start-ups”. Blockchain technology can bring positive changes to small businesses and start-ups. The implementation of blockchain technology will allow for a greater level of
Businesses will be able to navigate strategically with the aid of educated, data-driven decisions. This will position them to innovate swiftly with an application platform that enables them to effect rapid changes. In comparison to small businesses, it does take a while for large banking institutions to deploy major changes to their systems (Cornerstone, 2015). According to Young (2015), it is "very difficult to drive innovation in a bank today given the oversight and the regulation". The infrastructural nature of financial institutions might not be compatible with the blockchain infrastructure of a cryptocurrency such as Bitcoin. That is because this infrastructure is decentralised and can be utilised by anyone, whereas financial institutions are organisations that are limited by regulations and national borders (Murphy & Seitzinger, 2015). O’Brien (Fin24tech, 2014), stated that "banks are bound by borders and different legislation, where Bitcoin isn’t”.

Some financial institutions are opposing cryptocurrencies and the use of blockchain as a foundational technology because “it is not a currency regulated by central banks” (Reserve Bank South Africa, 2013). Crawford (2015) explains that cryptocurrency allows “virtually cost-free transactions” among peers. These transactions do not go through the known banking system (Reserve Bank South Africa, 2013). In other words, “traders do not borrow from the bank” nor do they need the concept of “the bank” to “put their money into a savings or investment account to keep pace with inflation” says Crawford (2015), and so financial institutions will lose revenue and need to reinvent their business models.

Bitcoin and its associated technologies have the potential to transform many different processes in the financial industry. Awareness of these developments should be raised at board level, says Sanchez (2016). Financial institutions must develop a new knowledge of how blockchain technology could help them and whether they should be investing in it. According to the organisers of the Blockchain Africa Conference (2017), the aim of the conference tool was to allow banking institutions in South Africa to “successfully swap asset handling within digital spaces via network blockchain usage”. The conference’s first aim and tested use case in a banking environment was to create a blockchain to be used in an ecosystem to grant a syndicated loan. Many conference keynote speakers stated that leading banks in South Africa such as Absa, Investec, Nedbank, RMB/FNB and Standard Bank, have integrated with the SARB, being the financial services board of South Africa, to create a distributed ledger solution to be accepted for these banks to practise legally in South Africa. According to the executive director of Fractal Solutions at Strate (Knowles, 2016), the platform is blockchain.
The integration in financial institutions’ research and practice provides a good learning platform for sharing knowledge and experience (Blockchain Africa Conference, 2017). Many of the research groups at the Blockchain Africa Conference (2017) have successfully set up a network using Ethereum. The Ethereum network is explained as an open-source or unrestricted usage network for the distributed computing platform (Weinmann, 2016). According to Blockchain Africa Conference (2017), a research group has opted to use this open-source product. The project brief focused on piloting various knowledge-mapped concepts instead of building one system for production. Additionally, the cost of using the licensed products is expensive; several financial institutions with a vested interest in the project and foundational technology found that paying for a product that was being established was not financially feasible. The leader of RMB/FNB’s blockchain initiative, Ehsani (2017), said that the “current approach of learning, certainly enhances the additional platforms to create an all-inclusive environment for production and allows original platforms to evolve”, introducing the notion of smart contracts.

A smart contract, also known as a crypto contract, is a computer program that directly controls the transfer of digital currencies or assets between parties under certain conditions. These contracts are stored on blockchain technology, a decentralised ledger that also underpins Bitcoin and other cryptocurrencies (Reed, 2016a; Bashir, 2017). The South African Revenue Service (SARS) mentioned that it had distributed and issued a smart contract via a distributed network. One of its members, who works as a programme manager in Absa’s Africa technology unit, had investigated smart contracts from the original knowledge for clarification, attempting to remodel and develop smart contracts in financial institutions (Blockchain Africa Conference, 2017). This study’s case organisation’s research group’s objective is to co-create a blockchain-based ecosystem that requires knowledge-mapping. The ideal ecosystem should be constructed on a cryptocurrency that is linked to a legal tender. This will allow banks to form syndicates and grant syndicated loans rapidly and with little fuss.

As the investigation continues, the Blockchain Africa Conference (2017) planned a solution for the integration of syndicated loans that will include a combination of cryptocurrency and allow trading through a smart contract. The main function and vision of the plan will depend on transparency to the market and how to measure shortened settlement times and lower transaction costs, which will require knowledge-mapping to generate internal knowledge findings. At present, there is a manual process which comprises widespread due diligence and
administration procedures with knowledge maps of the latter two. The outcome for syndicated loan transactions takes a while to settle into the financial sector. The lack of blockchain knowledge-mapping makes it difficult to properly present any findings on how these use cases will benefit with the utilisation of blockchain technology.

The Blockchain Africa Conference (2017), emphasised the practice of blockchain networking or working in groups will generate knowledge about the implementation in those areas that are willing adopt the technology. Knowledge-mapping will lead to a greater understanding of blockchain technology. A good example which people can relate to is the Internet. It would be impossible to have Facebook and operate this social platform without the Internet.

“Blockchain technology will impact 40% of a banking institution’s revenue by utilising the payment verifications of transacting by banking directly with the SARB in the near future” as estimated by a research group of the Blockchain Africa Conference (2017).

The main disruption of blockchain to banks is the “ability to disrupt payments” known to be the transfer of value and deposits, which fulfil the “storage of value” (Ziady, 2017). Blockchain technology interrupts payments since it allows people and organisations to manage and trade assets. Ziady (2017) explains that blockchain will disrupt payments such as “cash shares and property”, which will be “directly with each other” by means of blockchain. Blockchain does not necessitate an intermediary to verify the transaction (Guo & Liang, 2016). Instead, the “assets are [...] transferred via a consensus mechanism”, explains Knowles (2016). Knowledge-mapping is crucial to understanding how a network of computers will hold the distributed ledger of the assets in banks and host the consensus mechanisms. As transactions are completed, they will be stored in a blockchain that holds more value than a bank account, which will in turn verify the owner of the assets and ensure that the information cannot be distributed to other individuals, says Ziady (2017).

Ehsani (2017), opines banking institutions should move into adopting blockchain as many individuals need a trusted third-party intermediary to provide authentication and verification for digital transactions. As explained, blockchain removes the need for self-policing, so when a bank utilises a blockchain, it would need to “validate that an asset, such as a car or house, in fact exists before it can be loaded onto the blockchain” (Ziady, 2017). In future, says Ehsani (2017), central banks will distribute “their own cryptocurrencies” through a blockchain,
allowing them to observe all transactions and thereby “allow citizens to bank directly with them”.

As transactions flow, a bank will require a “private blockchain”, says Ziady (2017), where Know Your Customer (KYC) protocols will be observed. If a public blockchain is used – like the one used by Bitcoin clients – it will be linked to a KYC account number, but the individual owning the account number can “choose to be anonymous” (Ziady, 2017). As stated by Ehsani (2017), blockchain invites banking institutions to a new paradigm, which opens a dire need of knowledge-mapping. By delineation, a blockchain prerequisite is the buy-in of numerous companies to operate. The FSI will need to collaborate, develop, share and map out new knowledge on how to use distributed shared ledgers as one. When individuals join a blockchain network it contributes to the consensus process and data verification, as well as accepting that the state with the consensus of the nodes is valid. After a transaction is verified by a node, it is broadcasted to all the other nodes in the network and saved along with the relevant timestamps and certificates (Xie, 2018). Every node in the blockchain acknowledges that the transactions in the blockchain are valid and knows that other nodes will recognise these transactions as valid as well. The idea of Bitcoin was to create a public accounting ledger that records who owns what and keeps track of all transactions. This illustrates that money is stored in the Bitcoin ledger and is common knowledge, says Xie, (2018). This contextualisation of blockchain technology as common knowledge indicates the need for an inductive study to address the problem of blockchain knowledge-mapping in a particular South African financial institution.

1.4 Research problem

There is a need to safeguard banking institutions against the threat of cryptocurrency and to delve into the process of developing new knowledge that relates to a culture of data mining and cryptocurrencies. Information and knowledge management plays a key role in blockchain knowledge-mapping to fill the knowledge gaps created by new technology and to modernise current operations models in a banking institution. The financial services industry should develop innovative ways for conducting new business and create use cases that can assist a banking institution and its clients with the challenges that cryptocurrencies pose to regulators, institutions, companies and individuals. Modern banking institutions need to leverage knowledge-mapping as it will assist with the knowledge gaps created by the
foundational technology with the recent introduction of blockchain. Blockchain technology tests a banking institution’s ability to use foundational technology to create innovative products and services, improve its existing business model and deliver mechanisms in a live environment. To pass this test, the following research question and four sub-questions had to be answered:

*How can the use of blockchain technology change existing operations models and fill knowledge gaps that exist in a banking institution?*

1. Why is the knowledge of blockchain technology necessary in the financial services industry?
2. What is the perceived role of blockchain technology in changing the financial services industry?
3. What are the knowledge gaps in blockchain technology in the financial sector?
4. What current application areas will be utilised to assist possible future implementations for the blockchain technology in a banking institution?

For the purpose of this study, the financial services industry (FSI) refers to regulators, asset management companies, stock exchange brokers, securities, SARS, any financial institution and individuals involved in any form of regulatory and/or financial management. Financial institution refers to companies, for example, financial service providers; whereas a banking institution, in this study, refers specifically to banks as financial service providers.

### 1.5 Research aim and objectives

There is a great awareness of the threats and opportunities that blockchain technology and cryptocurrencies have triggered in many institutions. Against this background, the aim of the research as to map the existing knowledge of the current application areas of blockchain technology and identify its possible applications in a South African Banking Institution (SABI). The aim was to achieve a first level of blockchain knowledge-mapping and identify knowledge gaps to indicate the challenges that foundational technology poses to the SABI.
The research objectives of the study were:

1. To establish the reasons why the FSI needs blockchain knowledge-mapping.
2. To investigate the perceived role of blockchain technology in changing the FSI.
3. To identify a financial sector’s blockchain knowledge gaps.
4. To develop a first level of knowledge-mapping of a banking institution’s current application areas to assist possible future implementations for the blockchain technology in a banking institution.

The overall objective was to identify knowledge categories in Core Banking Application areas or pillars that might provide crucial knowledge during the latter phases of developing new operations models based on a thorough understanding of cryptocurrency and its underlying blockchain technology.

1.6 Research design for blockchain knowledge-mapping

The above contextualisation of blockchain technology indicates the need for an inductive study to address the issue of blockchain knowledge-mapping. The study is guided by its philosophy of interpretivism; it had an inductive approach, with case study, knowledge-mapping strategy. The research applied quantitative and qualitative data collection techniques that are generally associated with knowledge-mapping, namely a questionnaire and an interview.

The quantitative data collection method involved gathering data via an online questionnaire sent to a purposive sample viz Blockchain Africa Conference delegates who were clients of SABI, cryptocurrency investors, miners and individuals from the conference, with the common denominator: Blockchain technology knowledge interest. The qualitative data collection method was an interview with individuals who had a specific technical knowledge of blockchain technology, with the common denominator: SABI blockchain knowledge group. The data analysis was sequential; the quantitative data analysis was followed by qualitative data analysis.

Figure 1.1 illustrates the mixed method research design. Chapter 3 motivates the research design and Figure 3.1 reiterates the illustration of this study’s mixed method research design.
First, a literature review was conducted to develop a conceptual framework of blockchain technology in the context of the FSI. The findings of the literature review, in the next chapter, will focus on developing a conceptual framework of blockchain technology and its applications in the FSI. The conceptual framework was then used later for developing a blockchain knowledge-mapping theory once data had been collected as illustrated in Figure 1.1 and explained in Chapter 3 (cf Figure 3.1).

Blockchain technology is a relatively new technology and the most suitable research approach was an inductive approach, with case study and knowledge-mapping strategy. Since blockchain technology and cryptocurrency developments provide many opportunities for research, the scope of this study has to be clearly defined in order to demarcate the research within the boundaries of knowledge-mapping.

1.7 Study scope

A banking institution in South African expressed the need for knowledge-mapping when using blockchain technology. The study was conducted within the boundaries of the SABI, specifically in the areas of consumer-facing, business-to-business, trading and capital markets, back-end processes and international trade and intermediaries. The unit of analysis
was “knowledge of how the utilisation of blockchain technology changes existing operations models of financial institutions”. As such, the scope of the study was limited to analyses of the respondents’ knowledge of blockchain based on their discussions, debates and knowledge-sharing in respect of the creation of products, services, business model changes, or any new delivery mechanisms in a live environment from a banking industry perspective. This study contributes by bridging the identified knowledge gap between potential application areas of blockchain, and the necessary resource configuration enabling a financial institute to utilise blockchain as a resource for that application area in the bank. By financial institutes applying blockchain framework, together with other resources, for competitiveness, the study demonstrates the relevance of the resource configurations.

The study did not perform gender correlations, for instance, the knowledge and awareness levels of male and female cryptocurrency investors, solution architects, or clients did not form part of the study scope. Also, the study did not aim to bring about knowledge-mapping of regulatory frameworks. The aim was to achieve a first level of blockchain knowledge-mapping and identify knowledge gaps to indicate the challenges that foundational technology poses to the SABI.

1.8 Chapter outline

The study comprises of five chapters.

Chapter 1 explains the background and rationale of the study, underlining the issues of blockchain technology and cryptocurrencies. The formulation of the research problem is discussed on, “How can the use of blockchain technology change existing operations models and fill knowledge gaps that exist in a banking institution?”

Chapter 2 presents the conceptual framework of the study. It is composed of a literature review and identifies the research constructs. These constructs either came from the research findings of other studies and arguments surrounding blockchain knowledge-mapping or were derived from the knowledge sharing Blockchain Africa Conference (2017), which helped to gain insights and use cases being investigated and practised in financial institutions worldwide.
Chapter 3 describes the research design for the study of knowledge of how the use of blockchain technology will change existing operations models and fill the knowledge gaps that exist in a banking institution. The study is guided by its philosophy of interpretivism; it had an inductive approach, with case study and knowledge-mapping strategy, and combined the quantitative and the qualitative approach. Data was collected through a questionnaire and interview.

Chapter 4 covers the data analysis and presents an interpretation and narrative reporting of research results. The quantitative and qualitative data analyses and graphic presentation of results have a sequential approach similar to the structure of the data collection instruments (cf Annexure D and Annexure E). The discussion of results follows the same sequence and culminates in a knowledge map of the Core Banking Application (CBA) segments and areas or pillars to be recognised as critical knowledge (cf Figure 4.12).

Chapter 5 deals with the recommendations gleaned from the findings. This chapter concludes the study and gives due consideration to the study limitations, recommendation and suggestions for further studies.

The dissertation is structured in a way the core aspects pertaining to blockchain knowledge-mapping find their place as constructs in the blockchain knowledge-mapping theory developed for this study.

1.9 Chapter summary
In summary, blockchain technology is creating the need for change; it is a business driver for many financial sectors that will be faced with the issue of cryptocurrencies. New technology requires new knowledge. It is important to develop a knowledge map of blockchain technology as a cryptocurrency enabler for users. Financial institutions and financial users will have to discover or develop new knowledge, develop new strategies, and gain insights into the future of blockchain applications. Some might believe that blockchain technology is disruptive, while others might perceive it as a foundational technology.

Blockchain technology and a cryptocurrency such as Bitcoin could be regarded as a source of disruption of existing systems and processes in the FSI. Alternatively, it could be regarded as a foundational technology. Or it could be regarded as a foundational technology that boasts
disruptive features. This scenario necessitates, at the very least, the first level of knowledge-mapping for a banking institution.

The next chapter expands the literature review and develops a conceptual framework that will provide a plan to conduct the inductive research required for this study. With an inductive approach, concepts will be discussed from the literature to identify relevant constructs. Then the data collection and analysis follow in Chapter 4 to answer the research question: “How can the use of blockchain technology change existing operations models and fill knowledge gaps that exist in a banking institution?”
Chapter 2

Literature review and conceptual framework

2.1 Introduction

This chapter introduces a conceptual view of blockchain technology with a basic blockchain conceptualisation. It is followed by a description of the process called data mining and an overview of the basic system knowledge of blockchain. The literature regards blockchain as a modern technology database concept (Garcia et al, 2015; Tandulwadikar, 2016; Tabora, 2018). The chapter explains how modifications will occur when methods of various interactions with blockchain technology come into play, which necessitates knowledge of blockchain technology. For many individuals working in the IT space, blockchain technology has become a big hype, opines Espiner (2018), which has allocated a new shift in paradigm, says Mougayar (2016). But the opinions of Mougayar (2016) and Espiner (2018) differ, as many others’ opinions differ – some individuals have a foundational view of the technology while others have a categorical view of blockchain as a disruptive technology. Desktop searching of Google Scholar as well as proprietary databases found a myriad of resources on the topic of blockchain technology. However, the literature in relation to previous knowledge-mapping studies was limited.

This chapter outlines blockchain technology in more detail by elaborating on the working principle and technical details required for banks, which leads to a discussion of blockchain’s disruptive features versus its foundational features. The discussion of blockchain’s features leads to an introduction of the dimension of complexity associated with the Internet of Things, as discussed by inter alia Flynt (2016), and Casey et al (2018). According to these and other researchers, the vision of blockchain technology is to change the implementation of invisible processes known to be back-end functionalities in a financial institution (Flynt, 2016; Casey et al, 2018; Hirota et al, 2018). Books on the topic of blockchain technology exist, for example, Adams (2016), Flynt (2016), Norton (2016), Reed (2016a), Reed (2016b), Bashir, (2017), Wattenhofer (2016), and Hirota et al (2018), which has been included in the literature review albeit the topic of knowledge-mapping does not feature. The lack of literature on knowledge-mapping is evident. This chapter ends with a conceptualisation based on the
limited literature review of how Financial Services Industries can move to a blockchain environment and how beneficial it could be if it was adopted.

2.2 Basic blockchain conceptualisation

Some technologies are more “disruptive” than others, state Manyika, Chui, Bughin, Dobbs, Bisson and Marrs (2013), and Fernandez (2015). For example, the technical concepts of blockchain entail a unique combination of hash functions, public key cryptography, digital signatures, consensus methods, blockchain typology and smart contracts (Brakeville & Perepa, 2016). Blockchain technology has been recognised since 2009 when the Bitcoin system was implemented (Hreinsson, 2017). The Bitcoin system has described blockchain as an immutable digital public ledger. It is a distributed database that continuously expands and is cryptographically secured (Crosby et al, 2015). A blockchain can be described as a database because the digital ledger stores information in blocks that resemble data structures (Tabora, 2018). A blockchain differs from a database because information is stored in data structures known as tables.

As explained by Tabora (2018), a blockchain is a database, but a database is not a blockchain as they both store information but differ in design. The purpose of the two technologies are defined by what is best suited for storing certain data. The difference is that those transactions are conducted in a typical centralised system where all information is measured and controlled by a third-party organisation, which differs when using blockchain and transferring transaction details (Norton, 2016). Blockchain technology has been developed to “unravel double-spending” without the need for a “trusted authority or central server”, explains Mougayar (2016).

The objective of blockchain technology is to produce a decentralised environment where no third-party benefits and takes control of the transactions and data (Mougayar, 2016; Wattenhofer, 2016). Blockchain appears to be a suitable key for performing transactions by employing cryptocurrencies such as Bitcoin. As a foundational technology, it has inherited many challenges and limitations that should be reviewed and focused on to gain knowledge of the technology (Wattenhofer, 2016:79-80).

As a foundational technology, blockchain helps with data transactions between companies and individuals, which are typically controlled by the centralised third party known as a bank (Evgenii, 2017). This takes the form of making a payment in the form of a digital transfer which
“requires a bank or credit card provider as a middleman” to conclude the transaction, explains Cornway (2016). The digital payment transaction process comes at an additional cost, a fee from a bank (Chung Wu, 2016).

There are key concepts posed by the foundational technology, state Derman (2015), Cornway (2016), and Coleman (2017). A foundational technology takes hold by streaming through phases, as Derman (2015) explains, each phase of a foundational technology can be described by the novelty of applications such as a TCP/IP evolution to initiate the technology to render it workable. TCP/IP was designed for transformative applications that changed the techniques for value creation in business. It took TCP/IP to transfer through all the phases and redesign the economy (Coleman, 2017). According to Cornway (2016), the phase that blockchain is undergoing adopts an acceptance first known as an “applications low in novelty and complexity”. Lansitiand Lakhani (2017) view “blockchain as a foundational, not a disruptive technology”. The foundational technology can tamper with a traditional business operating model and support for it will be attained by a low-cost solution (Lansiti& Lakhani, 2017). Foundational technology will vastly override mandatory business models, opines Lucasabia (2017), who is of the view that blockchain technology holds the potential of creating new foundations for financial, business, economic and social systems in financial institutions. However, it will take time for the impact of blockchain technology to trickle into financial, business, economic and social infrastructures, says Malladi (2018).

When a technology is high in the novelty phase, the complexity which arises takes decades to transmission, but “can transform the economy and surroundings” states Derman (2015). A foundational technology creates two dimensions due to the impact and evolution of business use cases. The first dimension is the novelty of blockchain technology. Novelty dictates that more effort is required to ensure that users are knowledgeable about the technology. The second dimension is complexity which entails the number and diversity of parties that are collaborating to add value with the technology (Brikman, 2014; Krause, Velamuri & Burghardt, 2017; Malladi, 2018). These dimensions require a knowledge map.

A knowledge map supports an understanding of patterns and phases of transformation (Driessen, 2007). According to Naughton (2016), the transformation process is typical of foundational technologies, for example, the distributed computer networking technology
known as transmission control protocol/Internet protocol (TCP/IP), which established the groundwork for the growth of the Internet.

The technology that uses TCP/IP introduced the Internet (Naughton, 2016). The Internet has reached the transformation phase. It is important to study these phases and compare them to the phases of blockchain applications. Below are some practical examples to help understand the transformation of blockchain:

1. Amazon is an online bookstore and is a good example of a retailer using the foundational technology with a retailer gift card based on Bitcoin.
2. Skype is used for a connection over the Internet for people to communicate—a transformation led by blockchain’s self-executing smart contracts.
3. There was a low degree of novelty in the single-use email on ARPAnet when TCP/IP was introduced as the standard networking protocol on this network. It is compared to a Bitcoin payment; blockchain allows private online ledgers to process financial transactions like an internal corporate email network.

The literature review shows that the basic concept of blockchain is not difficult to understand. However, knowledge of its implications rises in complexity at different levels (e.g. smart contracts), and the implementation of the technology and its actual practice (e.g. private online ledgers and internal corporate email networks). These are important issues that require knowledge for implementation in banks.

The implementation of the foundational technology is set to change the way the world works (Manyika et al, 2013; Fernandez, 2015; Flynt, 2016; Malladi, 2018). To start with, “blockchain is the underlying technology that powers Bitcoin” explains Fernandez (2015). Some of the guest speakers at the Blockchain Africa Conference (2017) explained that the evolution of blockchain merely described the technology as decentralised Peer-to-Peer (P2P) networks. Categories of knowledge exist and knowledge-mapping of blockchain technology is clearly required. Conceptual views of blockchain exist, for example, the view of Brikman (2014) presents a suitable record of events shared between parties, illustrated in Figure 2.1.
Blockchain is a record of events shared between parties, explains Brikman (2014). In Figure 2.1, the conceptual view of blockchain explains how it is a “public ledger where transactions are recorded and confirmed anonymously” (Flynt, 2016:19). More importantly, once information is entered, it “cannot be altered”, explain Meszaros et al, (2016). Tandulwadikar
(2016) explains it as “the open nature of cryptocurrencies” and the “importance of the public having access to other blocks”.

Blockchain is a distributed digital ledger that records transactions where values are exchanged (Bheemaiah, 2015). The ledger is distributed among various participants, called nodes, on a P2P network (cf Figure 2.1; Brikman, 2014). Nodes perform three main functions – sending and relaying transactions, updating the blockchain with new transaction blocks (consensus), and relaying transaction blocks (Flynt, 2016:19). The function that nodes perform relates to a server (Tapscott & Tapscott, 2016). Blockchains could be considered in various subsections which rely on the authorisation required for the verification for network nodes. The other access to the blockchain data is through public or private methods (Peters & Panayi, 2015; Pratap, 2018).

The first categorisation is whether the verification and consensus process is permissioned or permissionless:

- **Permissionless** blockchains are when any individual can set up a node, connect to the network and participate in the verification process
- **Permissioned** blockchains are when mining privileges are delegated by a central authority or consortium (Flynt, 2016; Pratap, 2018)

The second categorisation is whether the ledger is public or private:

- **Public** blockchains are where anyone can obtain a copy of the ledger and initiate transactions
- **Private** blockchains are blockchains where permission is restricted to users in an organisation or entity (Flynt, 2016; Pratap, 2018)

On public blockchains, connection can allow anyone to access one or more nodes and broadcast a transaction (Brikman, 2014). When individual processes a transaction, each receiving node communicates the transaction to its connections which are awaiting a copy of the transaction, explain Swan (2015:6), and Flynt, (2016:19). The blocks of data store, spread and preserve the blockchain data, theoretically a blockchain exists on nodes. A full node contains a copy of the transaction history of the blockchain. It collects transactions into time-stamped blocks. These blocks are broadcasted through the network. Consensus is established when all the nodes, or a supermajority of them, have received a valid block of transactions (cf
Figure 2.1 Peer-to-Peer network; Brikman, 2014). Each new block is digitally signed and includes the signature of the preceding block.

The associated digital signatures secure the integrity of the transactions registered in the blockchain and maintenance is not needed for a central copy as it is created (Egilsson & Valfells, 2017).

The time interval between new blocks being created is called the “block creation time” (Wattenhofer, 2016). The block creation time is established by the core developers of each separate blockchain, depending on what they deem appropriate, says Wattenhofer (2016). New blocks will be created frequently enough to guarantee that the ledger is adequately up to date. The block creation time is dependent on the blockchain’s algorithm which is dependent on the amount of mining occurring on the network (Lewis, 2015; Wattenhofer, 2016; Evgenii, 2017).

A combination of verification and consensus in a process is known as mining (mining = verifying transactions + consensus). Diverse blockchain technology uses various consensus mechanisms (Evgenii, 2017). An example to explain the various setups is that a Bitcoin blockchain is public; this indicates that any individual can purchase equipment, connect to the network and start “mining”. The private blockchains require participants in the consensus process to fulfil predetermined requirements set by the founding core developers of the system.

It is a decentralised system that is robust and secure, state (Tandulwadikar, 2016; Krause et al. (2017). As illustrated in Figure 2.1 “miners collect transactions and add it into a single block” and blocks generally contain “four pieces of information” (Brikman, 2014), namely:

1. Reference to the previous block
2. Summary of included transaction
3. Time stamp
4. Proof-of-Work (PoW)

The above four pieces of one block contain irreversible information that went into creating the secure block (Wattenhofer, 2016). The blocks are consolidated into a chain (Brikman, 2014). The intricate algorithm will securely hash each block, explain Lewis (2015) and Wattenhofer (2016).
Financial institutions should build their employees’ knowledge based on the basic technology use for blockchain. Figure 2.1 illustrates the way blockchain works – it is required for many individuals to gain insight on the knowledge for the implementation to occur in banks. Figure 2.1 has relevance given the need to understand its architecture to fill the knowledge gaps in blockchain technology. The security architecture on blockchain technology ensures that it will safeguard institutions against cyberthreats and improve business processes (Meszaros et al, 2016:3).

2.3 Process of cryptocurrency mining

Cryptocurrency mining comprises two functions. The first is known to add transactions to the blockchain securing, verifying and releasing a currency. As stated by (Rexaline, 2017), “individual blocks added by miners should contain a proof-of-work or Proof-of-Work”. Mining requires a computer and a program, which supports miners competing with other individuals to solve a complicated mathematical problem. This requires substantial computer resourcing. In regular periods, miners try to solve a block holding the transaction data using cryptographic hash functions. The hash value is a numerical one. It consists of a fixed length that uniquely distinguishes the data. (Rexaline, 2017) states that “miners use their computer to zero in on a hash value less than the target and whoever is the first to solve it would be considered as the one who mined the block and is qualified to get a reward”. The blockchain implements a Proof-of-Work (PoW) algorithm, explain Adams (2016), Alam (2018); and Shepherd and Afifi-Sabet (2018).

As previously stated, all distributed ledgers require transactions to be validated, after which a consensus must be established. Blockchains combine verification and consensus in a process known as mining (Wattenhofer, 2016). Mining is one of the blockchain’s fundamental mechanisms to create its security measure based on the principle of decentralisation (Clark & Essex, 2012:391). It secures the cryptocurrency system and enables a system without a central authority. Mining in blockchain technology defines the method of adding transactions to the large distributed public ledger of current transactions. For example, Bitcoin mining remunerates individuals who run mining operations with added Bitcoins (Wattenhofer, 2016).

Different blockchains use different consensus mechanisms. Some blockchains, like the Bitcoin blockchain, are public (Shepherd & Afifi-Sabet, 2018). This means that anyone can purchase equipment, connect to the network and begin mining. The private blockchain requires participants in the consensus process to fulfil some predetermined requirements set down by
the founding core developers. New blocks get published to the chain at a fixed time interval, explain Collier and Neville (2015) and Flynt (2016). On average, Bitcoin blocks are distributed at a range of 10 minutes. The Bitcoin blockchain, gives a greater understanding on how blockchain technically operates (Alam, 2018).

The Bitcoin blockchain uses the PoW procedure to authenticate transactions and generate new blocks (Adams, 2016). Alam (2018), states that the PoW algorithm was initially designed as an economic measure to prevent distributed denial-of-service attacks and other service violations, such as spam, on a network. Proof-of-Stake (PoS) has since been recommended as a possible replacement for PoW and is designed to resolve the problem of the ineffective use of capital resources, such as computing power and energy (Alam, 2018). The basic idea of PoS is allocating mining privileges based on the amount of “stake” a member has in the network. The first blockchain to obtain extensive use and attention is Bitcoin.

In many respects, Bitcoin serves as a template to which almost all other blockchain projects are compared, whether they are open source or proprietary (Egilsson & Valfells, 2015). Bitcoin is one of many blockchains, that is, public blockchains that have been in use at a global scale, according to Lewis (2015) and Evgenii (2017). Bitcoin, Ethereum and Ripple are the most valuable blockchains based on the value of the respectively secured cryptocurrencies (Anwar, 2018). New types of cryptocurrency blockchains are emerging which are designed primarily as transaction platforms for traditional securities, i.e. Chain, Corda and Hyperledger (Anwar, 2018). Eshani (2017) states that it is critical to develop a thoughtful plan of action with the following “key considerations for banks”:

- Identifying opportunities for innovation
- Determining feasibility and the impact on existing systems
- Testing proofs of concept
- Understanding the regulatory and data security implications
- Dissecting the blockchain implementation: open vs permissioned
- Planning for transaction scalability
- Forming partnerships and cross-functional and cross-industry collaboration

The above key considerations mentioned by Eshani (2017), suggest knowledge-mapping of blockchain technology. For example, common knowledge is how the system prevents double spending and becomes more secure with a greater number of people examining transactions
Common knowledge is the blockchain is run by miners that use powerful computers that tally the transactions (Chung Wu, 2016). Their function is to update them each time a transaction is conducted. Chung Wu (2016) explains that this is also done to ensure the authenticity of information and to ascertain if each transaction is secure and is processed safely and adequately. Evgenii (2017) and Malladi (2018) emphasise that common blockchain knowledge is not sufficient in the financial sector. The basic blockchain principles provide an overview of the technology and its underlying consequences and emphasise the importance of knowledge-mapping as part of a financial institution’s action plan.

2.4 Basic blockchain principles and their underlying consequences

The critical concepts of blockchain have captured the interest of investigators (Evgenii, 2017; Malladi, 2018). Financial institutions must investigate this foundational technology and incorporate its fundamental principles in the future operations development of the institution (Eshani, 2017). Exploring the primary system of the operations of blockchain and the principles that govern the technology, will help any organisation, says Chung Wu (2016). A list of five principles of the blockchain is sourced from existing literature and described below:

a. Distributed Ledger

Distributed ledger participants on a blockchain network ensure that no individual can control the data (Velde, 2013). Each participant will verify the records of its transaction partners directly without any third-party partner (Bashir, 2017). A distributed ledger, explains Chung Wu (2016), is a category of database that spans various sites, countries or institutions and is classically public.

The storage of the records is done one after another in an ongoing ledger (Chung Wu, 2016). This happens because it prevents the sorting of blocks, which is timeous. These blocks can only be added once, they meet a minimum number and then participants will be added. An early example cited by Wile (2014), is of a blockchain as distributive ledger for an annual global transactions system that uses Ripple. Ripple has a real-time gross settlement system, currency exchange and remittance network created, creating a list of validators, explains Anwar (2018). It can be described as unique node validators relating to a distributed ledger. With this process in place, it gives an output of a digital signature (Gilfillan, 2014; Egilsson & Valfells, 2017).
A blockchain distributed ledger is a kind of database that receives a sum of records and locates them in a block as a substitute (Gilfillan, 2014). A block is formally “chained” to the succeeding block and consumes a cryptographic signature. This allows blockchains to be exploited like a ledger, it gives permission to allow data to be shared and verified by anybody with the suitable authorisations (Gilfillan, 2014). A distributed ledger is fundamentally a great asset in the digital space; an asset that can be of great use for a database that can be pooled transversely via a network of numerous sites, geographies or institutions (Nakamoto, 2014).

b. Peer-to-Peer transmission

A P2P network is typically used to “share and provide access to a set of resources such as documents, media or data” (De Filippi, 2013:1). In the blockchain, P2P transmission allows direct communications between peers as opposed to a central server (Yi Huumo, Ko, Choi, Park & Smolander, 2016). Every node stores and shares information with the alternative nodes (Malviya, 2017). There is a direct contrast between a P2P and a traditional server client model (Crosby et al, 2016). The server client model serves a symmetrical role and a node is broken down into “a client or a server” (Moskowitz et al, 2016), while a P2P network includes both client and server running simultaneously (Yi Huumo et al, 2016).

The blockchain connection among peers is by means of the Internet (Nakamoto, 2014), and with additional wireless communication occurring between systems and networks (Ranger, 2018). The control in this network is decentralised (Nakamoto, 2014). With this in place, it suggests correspondence among the peers and no one individual in the network has authority (De Filippi, 2013:1-2; Yi Huumo et al, 2016). The algorithms assist Bitcoin to transact and aggregate blocks which are then added to a chain of the existing blocks, which will use the signature that is in cryptographic (Gilfillan, 2014).

P2P transmission is approaching the algorithmic technologies that support a cryptocurrency (Adams, 2016:15). For the “consumer of these services, the technology offers [...] potential”, for instance, individual consumers can “control access to personal records and know who has accessed them” says Nakamoto (2014). It is not difficult to learn and grasp these blockchain concepts such as P2P transmission, but there is a “real skills shortage when it comes to having the ability to develop applications for blockchain” (Frøystad & Holm, 2015:2). Financial institutions must develop knowledge repositories to “deploy and integrate with legacy
systems” and effectively apply the foundational technology across all levels in the financial organisation (Frøystad & Holm, 2015:2).

c. Transparency with pseudonymity

Transparency with pseudonymity states that every action of nodes on the network and associated uses are apparent to anyone with access to the system (Malviya, 2017). The users or the nodes on a blockchain are digitally signed by a unique 30-plus-character alphanumeric address that classifies it. According to Malviya (2017), users can opt to remain unknown or provide proof of their signature to others. Transactions occur between blockchain addresses.

In 2009, a person with the alias, “Satoshi Nakamoto”, released Bitcoin cryptocurrency on Nakamoto’s blockchain invention (Kelly, 2016). Today, this individual (or perhaps group of people), remains anonymous. The Bitcoin used on the blockchain is developed on a P2P network, as mentioned above, permitting the users to transmission value in an anonymous manner (Kelly, 2016). The users use pseudonyms and “they do not have to have a trust built between each other”, explain Frøystad and Holm (2015:2). There is no central authority within the Bitcoin network; the principle is transparency with pseudonymity, which uses an “automated consensus protocol where all users verify transactions” (Levine, 2015).

Reed (2016a) explains that “Bitcoin enables users to store their Bitcoins in digitalised bank accounts called wallets”. These wallets can be “set up by anyone with Internet access” (Jenn, 2016). A user’s name and gender is unknown on the transparent Bitcoin network – the network “does not require any contact with a bank” being the third party (Derman, 2015). According to Nakamoto (2014), users can buy Bitcoin online and the cryptocurrency can be exchanged for local currency in some countries. However, the “rate of exchange is related to supply and demand and the rate has varied a lot” since it was released on the market compared with other currencies (Levine, 2015).

The principle of transparency and pseudonymity is not a “perfect anonymity” (Jenn, 2016). In fact, anonymity is an incorrect term, rather transparency means that everyone can see when and what transaction is happening on the many chains of transactions from wallet to wallet and only the users may use pseudonyms to protect themselves. One should not confuse “anonymity” and “pseudonymity” – the chain “can be traced and tracked in public” explains Segendorf (2014).
d. Irreversibility of records

Static records occur once a transaction is posted to the blockchain network and these records cannot be tampered with, explains Bashir (2017). As a result, they are synced to each transaction record that was posted in the history like a chain (Shepherd & Afifi-Sabet, 2018). Various machine algorithms and processes are implemented to ensure that the saving of the information is perpetual, chronologically ordered, and readily attainable to the network (Collier & Neville, 2015; Flynt, 2016; Alam, 2018).

There are three sections that make a blockchain irreversible, namely, hash-linked blocks, public record, and public opinion (Hirota et al, 2018; Xie, 2018). According to Alam (2018), blockchain irreversibility originates from a public broadcast. Shepherd and Afifi-Sabet (2018), mention that there are various independent observers that have recorded the identical events. The events are hash-linked which means that the public cannot change an event without changing everything that has occurred. Individuals cannot change the history, then everyone will see it is a change, explains Bashir (2017). Public opinion will be firmly behind the original order of events because any other history will be a lie (Brakeville & Perepa, 2016; Hirota et al, 2018; Xie, 2018).

e. Computational logic

Computational logic was described by Malviya (2017) as the digital nature of the ledger. It indicates that blockchain transactions are joined to computational logic. The computational logic is explained as predefined algorithms and rules that initiate transactions between nodes (Lewis, 2015; Shepherd & Afifi-Sabet, 2018). A blockchain platform stocks the connections and transaction of virtual coins in the blockchain. The introduction of the digital economy’s computational logic has disrupted industries across the globe (Shepherd & Afifi-Sabet, 2018). The impact of this computational logic was felt through diverse sectors such as media, fintech’s, governments, transport and even music (Xie, 2018). Indeed, cryptocurrencies have gained significant attention (Hirota et al, 2018).

Attention to the growth of digital transactions across sectors holds important relevance for the global economy, especially in the fields of payments, international remittances and smart contracts in fintech’s. Over time and due to its restrictive costings, Bitcoin as a cryptocurrency and other leading cryptocurrencies, were rendered competitive (Hreinsson, 2017). Currently,
many individuals and companies have emerged to enhance the network to execute more transactions using blockchain technology (Alam, 2018; Xie, 2018).

Knowledge of how the “blockchain technology has the potential to streamline and accelerate business processes, increase cybersecurity and reduce or eliminate the roles of trusted intermediaries” is essential (Brakeville & Perepa, 2016). This will require an understanding of the underlying consequences to blockchain technology. There are more consequences than only these few mentioned here; this study’s literature review was not exhaustive with regard to consequences because the study’s unit of analysis was not blockchain technology. The unit of analysis was knowledge, therefore some of the consequences are mentioned in the context of knowledge-mapping:

● From a knowledge-mapping perspective, it is important to understand that blockchain has an environmental cost due to the extent to which it has been executed. Blockchain relies on encryption to implement its security and secure consensus over a distributed network (Pratap, 2018). Users need to prove they have permission to write to the chain, complex algorithms must be run, which in turn require large amounts of computing power. Smaller-scale blockchains, explained as those that an organisation deploys internally to monitor and record business activity securely, will consume a fraction of the computing power (Pratap, 2018). It is a consideration that the environmental implications and energy costs cannot be overlooked.

● From a knowledge-mapping perspective, it is important to understand that the lack of regulation creates a risky environment. It has been stated that this is a massive problem with Bitcoin or other value-based blockchain networks (Gilfillan, 2014). However, individuals investing in cryptocurrencies initially found costs to be very volatile. Due to the shortage of regulatory laws, scams and market manipulation are expected (Gilfillan, 2014). The cryptocurrency platform faced many scams. Legislators have largely failed to keep pace with innovators or scammers. A speculative investor in cryptocurrencies opt to use relatively established coins such as Bitcoin, Litecoin or Ether. According to Hirota et al (2018), “speculative investment is a high degree of risk where the concentration of the buyer is based on price fluctuations. The investor buys the tradable good to profit from market value changes.” There is a lack of regulatory oversight across the sector.
From a knowledge-mapping perspective, it is important to understand that blockchain technology complexity affects the end user who finds it hard to acknowledge the benefits. As stated by Malladi (2018), blockchain is an innovative application with individual benefit, thus individuals must try to understand the principles of encryption and the distributed ledging of blockchain technology. According to the findings of Malladi’s (2018) study, it takes time and in-depth reading and understanding, before conversing on what makes blockchains potentially valuable. Blockchain technology experts opine that the technology will probably replace the middle-man facilities known as the financial services industry (Lewis, 2015; Krause et al, 2017; Alam, 2018). The technology would replace clearing payments and fraud prevention, state Krause et al (2017). Banks provide this service sufficiently well and at a low cost to the end user (Gilfillan, 2014). However, global events could reignite the appetite for change, but until they ingest, blockchain could continue to remain a hard sell for many financial institutions (Malladi, 2018).

From a knowledge-mapping perspective, it is important to understand that blockchain technology is said to be slow and cumbersome because of the technical complexity of the transacting, compared with “traditional” payment systems such as cash or debit cards given by financial institutions (Marr, 2016; Malladi, 2018). Bitcoin transactions can take many hours to clear which pose inherent problems (Marr, 2016). Vendors need to be willing to take on an element of risk for payment on networks that are used to store value by logging transactions or interactions in an IoT environment (Marr, 2016). These chains are electronic files and have the potential to become slow and unwieldy as they grow in size and the number of computers accessing and writing to the network grows. The problem should be solved with advances in engineering and processing speeds, which requires specialised knowledge.

From a knowledge-mapping perspective, it is important to understand that the “establishment” as stated by Marr (2016), has a vested interest in blockchain failing. Despite the significant benefit of using blockchain technology from the conventional financial industry, banks make vast amounts of profit from playing the middle-man role (Marr, 2016). The costs are distributed among many of their customers and banks
carry enormous lobbying power with governments and legislators (Marr, 2016). This is understandable given that if banks decide their interests in the blockchain technology, it will dramatically reduce its usefulness and restrict its availability (Pratap, 2018).

According to Marr (2016), Krause et al (2017), and Malladi (2018), these issues could pose important hurdles if it is expected that blockchain technology will progress over the coming years. After all, technological advancements, like nature, has a way of finding their way around artificially constructed barriers and knowledge will flow irrespective of the disruptive or foundational nature of blockchain technology.

### 2.4.1 Disruptive technology versus foundational technology

Technologies are an essential component of the world’s economy (McKinsey Global Institute, 2013). Some years ago, Manyika et al (2013) predicted that blockchain technology was one of the 12 disruptive technologies that would significantly modify the position of the global market by 2025. As stated by Graillot (2015), blockchain technology is forecasted by analysts to become one of the most influential technologies in the future. There is a series of events and phases on how blockchain technology has evolved. Initially, the technology became well-known in 2008 when the founders of Bitcoin conceptualised it under the name of Satoshi Nakamoto in a research paper titled “Bitcoin: A Peer-to-Peer Electronic Cash System” (Schmidt, 2013).

The influence of blockchain technology influence is said to be immense. It began with the core component of Bitcoin that was blockchain (Schmidt, 2013). In 2014, blockchain had become a term relating to new applications of the distributed database (Bheemaiah, 2015). In 2017, it was decided that blockchain was a foundational technology and could discover different foundations for economic and social systems (Lansiti & Lakhani, 2017). It could take years for it to be implemented into economic and social infrastructure systems (Bheemaiah, 2015; Lansiti & Lakhani, 2017; Malladi, 2018).

The adoption process will not be rapid because waves of technological and social changes persist (Bheemaiah, 2015). Some experts believe that blockchain is a disruptive technology. According to Lewis (2015), Swan (2015), and Bashir (2017), blockchain technology is unpredictably forecasted on its technical ability. According to Lansiti and Lakhani (2017), and Xie (2018), blockchain is not a disruptive technology, but is foundational.
Disruptive technology is a technology which forms in a comparatively brief period in a new market, explains Bheemaiah (2015), with provision of new values, which will ultimately reconstruct the current marketplace. When defining a foundational technology, it establishes markets and business models (Lucasabia, 2017). The adaptation and development of the technology can take decades. Therefore, the result of blockchain adaptation will be vital. Blockchain technology will affect the social, economic and political systems at a global scale (Lansiti & Lakhani, 2017).

Across the globe, modifications of blockchain technology have provided a new vision of technology and made it appealing for many industries to invest in and to implement, say Bheemaiah (2015) and Xie (2018). There are similarities between implementations, but the differences range from the level of knowledge of blockchain’s innovative capabilities (Alam, 2018; Hirota et al, 2018; Shepherd & Afifi-Sabet, 2018). The McKinsey Global Institute (2013), Bheemaiah (2015), and Malladi (2018), mention analysts of leading tech companies that are representing their solutions based on the technology and fintech companies. The hype for investments in cryptocurrencies spread so fast that it became a new trend to expand investments in it (McKinsey Global Institute, 2013). The expansion occurs even without the support of leading tech companies and provides solutions to various industries, which will ensure that blockchain is a “foundational technology” (Bheemaiah, 2015).

### 2.4.2 Internet of Things

Mattern and Floerkemeier (1996:1) explain that the term, “Internet of Things” (IoT), was devised to denote solely identifiable things and their virtual illustrations in an Internet configuration. It provides all objects in the world with microscopic categorising strategies or machine-readable identifications with the ability to convert day-to-day life. Mattern and Floerkemeier (1996) relate the interconnectedness as all networks with low-cost sensors and actuators that are utilised for the collection of data, decision-making, process optimisation and monitoring. The connected world increasingly involves physical objects (Tapscott & Tapscott, 2016). The IoT can be explained by machinery, shipments, individuals, infrastructure and devices equipped with networked sensors and actuators that can monitor their environment, report on their statuses, receive instructions and even take actions based on the information they receive and analyse, describes Ranger (2018).
Devices worldwide – including computers and smartphones – are connected to the Internet, and this number of connected devices is expected to increase dramatically (Ranger, 2018). In addition to improving productivity in business operations, the IoT can facilitate distinct types of products, services and new strategies in this “era of the Fourth Industrial Revolution or digitisation,” says Pratap (2018), also referred to as Industry 4.0 in earlier literature (Schwab, 2016).

One of the foundation theories regarding a future vision of blockchain technology is the IoT because it is a network of interconnected physical devices or sensors which can collect, analyse and re-use data from the physical world (Tapscott & Tapscott, 2016). There is a capacity to develop the combined, rounded system which assigned self-learning or machine learning which will provide automation and security. IoT enables the employment of systems, which was never applied before due to the technological incompetence to develop them, explain Tapscott and Tapscott (2016).

The current state of the IoT and its challenges should be considered. There are security, connectivity, compatibility and other problems faced by it. Tapscott and Tapscott (2016), state that IoT solutions require technology which is scalable, secure and performs in a conventional design. Security is a critical concern for IoT due to the ability of hackers to infiltrate network devices. Additionally, the number of network devices are continuously growing and there are instances where one node of the network is manipulated to spread the virus software forward and contaminate the entire infrastructure (Banafa, 2017). From the connectivity perspective, the ability to connect to many devices in one network remains a security concern.

Dixon (2017) explains that centralised solutions are sufficient for the current state of IoT, but will be inefficient with the continuous addition of several devices. Supporting centralised systems for billions of devices will not be economically justified (Kasireddy, 2017). In addition to the electricity costs of maintaining servers, it will also include the costs of IT support, which should be scaled. The more devices connected the less efficiently will be the centralised point of access (Banafa, 2017; Dixon, 2017).

The compatibility of network nodes is a challenge to the IoT (Banafa, 2017). Having several systems incorporated into the network will give it the right to develop software to unify the
connecting process by an individual interface. Protocols and standards will also differ for those companies that raise questions about developing technology standards that are supported by all members of the network (Dixon, 2017). As Banafa (2017) emphasises, querying unformatted data will be a problem. Blockchain can be used to solve unformatted data and programme to ensure specific actions to be undertaken in a defined technical scope (Tapscott & Tapscott, 2016).

Connectivity and compatibility matters can be determined by tracing software versions or a combined interface with protocols applied for the blockchain network. Moreover, Tapscott and Tapscott (2016), state that technology companies recognise the potential of blockchain and agree that it is vital for delivering the adequate potential of IoT. As Banafa (2017) has stated, the combination of blockchain and IoT enables a build for a new business operating model, such as providing each node’s computational power. A secure connection with the use of public/private keys allows for users of the IoT network to manage privacy themselves instead of using centralised rules, explains Evgenii (2017).

Blockchain-based IoT indicates a transfer of maintenance, access, and other responsibilities to the community of self-supporting devices for manufacturers (Dixon, 2017; Ehsani, 2017; Ranger, 2018). According to Tapscott and Tapscott (2016), there are nine features in the Ledger of Everything, i.e. a mix of IoT and blockchain, namely –

- Resilient or self-troubleshooting with no failure due to a decentralised network structure
- Ability to receive billions of nodes and transactions
- Real time with 24/7 availability and constant data flow
- Supporting a response to varying conditions
- Openness on the network allowing for continuous developing and ability to update it with new input
- Renewable, i.e. multiple-aimed, reused
- Reductive with optimised costs and increased efficiency
- Revenue-generating, presenting opportunities to new business models
- Reliable, assuring data integrity and sincerity of nodes
To emphasise that blockchain has vulnerabilities, Evgenii (2017) reiterates the above nine features. A blockchain is based on the consensus mechanism of actions approval and the network may be hacked by attackers attempting to manipulate the system (Malladi, 2018; Pratap, 2018). However, the scalability of IoT will help blockchain and assist in security and interoperability (Evgenii, 2017). The blockchain technology will integrate with IoT and generate a valuable opportunity for technologies and industries (Ranger, 2018). The decentralisation of blockchain will bring to IoT security, scalability opportunities, financial benefits, efficiency growth, and the ability to trace history and easily verify actions (Evgenii, 2017).

2.4.3 Blockchain and financial network platforms

According to Pratap (2018), it is essential to gain an understanding of blockchain technology and its technical functions for implementation in financial institutions. “Blockchain evolution in banks is like the Internet revolution” (Scott-Briggs, 2017). Blockchain technology holds all the appealing features required by a robust technology affecting money resolutions in banks. Blockchain technology is reliable, protected, decentralised, transparent and cost-effective (Wattenhofer, 2016). Blockchain provides a very high level of safety and security, and these characteristics make blockchain secure and an in-demand solution for the banking and finance industries (Pratap, 2018; Ranger, 2018). Financial institutions perform the crucial function of keeping money safe and secure for their clients and therefore, the processes expect various mediators, which comes at a cost to the bank. Furthermore as Pratap (2018) states, the responsibility of too many people and manual processes, the uncertainties of errors and frauds increase continuously. Blockchain technology ensures secure transactions and makes the overall customer experience more competent and less time-consuming (Dixon, 2017).

Banking systems rely heavily on paper and outdated processes (Tandulwadikar, 2016; Malladi, 2018). Banks demand a continuous upgraded system installed with reliable and trustworthy technology (Tandulwadikar, 2016). The system upgrades must fend off fraud, scalability and security issues. According to Dixon (2017), Ehsani (2017), and Pratap (2018), the blockchain technology and its decentralised view can provide the solution to banking systems.

If a blockchain system is implemented in banks, it will assist with quicker transfers without taking on the responsibility of risks as the system will be self-sufficient (Ehsani, 2017). The
world is moving rapidly through digital space and with regular technological advances, an increasing number of transactions and payments are being conducted digitally.

The digital economic activity rate is increasing and blockchain technology will enable transfers at a lower fee and scalability of transactions (Dixon, 2017). Financial services outside of banks are continuously developing their systems with the support of modern technology by contributing economically available services at cheaper rates. Banks will benefit by adopting blockchain given its proposed features. Yet, there are many hurdles that financial institutions will have to address if they go ahead with blockchain (Ehsani, 2017; Evgenii, 2017; Alam, 2018).

Blockchain technology is not restricted by any international rules and regulations that mandate it to enforce standards (Tapscott & Tapscott, 2016; Orrcutt, 2018). With the growing necessity for interoperability among large industries like banks, the technology needs to be compatible with several systems (Ehsani, 2017; Orrcutt, 2018). The integration of existing systems with a blockchain-based model is a massive challenge today as the current systems and processes cannot be eliminated (Evgenii, 2017; Alam, 2018). Operational feasibility can be achieved if the adoption of blockchain allows multiple systems to work together smoothly (Lewis, 2015; Malladi, 2018). Individuals trust banks with the safekeeping of their money and blockchain technology will only replace systems in banks if it ensures that the data stored in the blockchain is secure and will not hinder the identification of any individual (Ehsani, 2017). As the transactions transferred on a public blockchain are publicly available, the need for traversing the terrain of private blockchains for data-critical sectors require a resolution of issues like interoperability (Tandulwadikar, 2016; Evgenii, 2017; Tabora, 2018).

According to Evgenii (2017), the private keys are necessary elements to the blockchain technology. They secure the data of a person on the blockchain (Flynt, 2016). The private key is generated and needs to be kept very secure, explain Brikman (2014), and Pratap (2018). Moreover, the encryption used to store data can be jeopardised by finding loopholes in the network which in turn, makes the blockchain susceptible to hacking (Gilfillan, 2014; Egilsson & Valfells, 2017). Conversely, the blockchain network is stable and sturdy as it is implanted with cryptography techniques (Lewis, 2015; Wattenhofer, 2016; Evgenii, 2017).
Cryptographic networks are complicated to hack, and security breaches will require a high amount of computational power to prevent any hack (Blockchain Africa Conference, 2017). When a blockchain network is applied to any banking institution, it must be secured with multiple security protocols. Banking networks should be competent enough to regulate participating authorities to take charge of the network according to the access permission (Flynt, 2016; Pratap, 2018). Depending on the specification, the blockchain connected to the bank’s systems could be permitted or permissionless. Bank staff need to be allowed different levels of access to save the overall network from malicious insiders and cyber-hackers. The growth of existing databases is indisputable (Pratap, 2018) and data entries are only set to increase. The network built through a blockchain should handle the increasing traffic while controlling the speed of accessibility to network participants. As Pratap (2018), explains, blockchain technology implemented in the current banking systems must have the capacity to also handle large volumes of data.

“Banks should analyse before adopting blockchain,” says Ehsani (2017). If blockchain is implemented in the banking sector, the need for international and national regulations will become obligatory (Flynt, 2016). Cryptocurrencies, as the most famous application of blockchain, do not have any regulations governing them (Flynt, 2016; Pratap, 2018). This makes them susceptible to profits and losses. Despite stringent laws in the banking sector, financial institutions have begun to realise the potential of blockchain technology as they witness the demand for cryptocurrencies in current markets (Flynt, 2016). The well-established banking sector has begun executing tests. This is being done to identify the possible use cases for this decentralised technology for their financial business processes (Ehsani, 2017).

2.5 Chapter summary
This chapter reviews the literature on blockchain technology in order to develop a conceptual framework to inform a blockchain knowledge-mapping theory that will benefit a South African financial institution. The objective of the literature review was to identify knowledge categories of relevance to understanding cryptocurrency and its underlying technology. These are the knowledge categories; an understanding of the basic principles of blockchain technology, the process of cryptocurrency mining, disruptive technology versus foundational technology, the Internet of Things, and financial network platforms.
This chapter’s review of available literature, including the proceedings of knowledge sharing events such as the Blockchain Africa Conference (2017) and its research groups, produces a conceptualisation of the knowledge categories of relevance to how blockchain technology will change existing operations models in the case organisation of this study. The case organisation is referred to as the South African Banking Institution (SABI). The next step was to collect data to determine the knowledge categories as a first level of SABI’s blockchain knowledge-mapping, as discussed in Chapter 3, the research methodology and design.
Chapter 3

Research methodology and design

3.1 Introduction

Research can be defined as the systematic process of collecting and logically analysing data for a given purpose (McMillan & Schumacher, 2014:528). However, this definition is generalised to some degree since there are many methods of investigating a problem or a question. Research methods refer to the strategy or plan that a researcher has devised to collect data. These methods have been developed for acquiring knowledge properly and reliably. A research methodology is systematically and purposefully planned in order to yield data on a research problem (McMillan & Schumacher, 2014:529).

This chapter aims to introduce and explain the rationale for the research methods chosen for the study. The chapter begins by restating the research problem, then it positions the research in the mixed-method research paradigm and provides a description of research design.

The chapter elaborates on several aspects of research design such as the methods chosen for answering the research question, the population under study, the sampling procedure and the interpretivist philosophy. The research strategy was a case study and was chosen to bolster the methods used to collect data for knowledge-mapping. An online questionnaire and an interview were the two methods of data collection. The reliability and validity of the research and the ethical considerations relating to the research are also discussed in this chapter.

The study used an exploratory research method which is defined as a study seeking new insights and which clarifies an understanding (Saunders, Lewis & Thornhill, 2009). This is connected to the objective of the study (cf Section 1.5). The research objective strongly affects the chosen method for a study (Cameron, 2009). This study was a mixed-method exploratory study with a sequential data collection approach (cf Section 3.4). The research philosophy brings about the research design, which is discussed next.
3.2 Research philosophy

Research methodology is a systematic investigation that discovers the techniques for solving a research problem (Burns, 2000). There are numerous conceivable techniques to investigate knowledge categories of relevance to how the use of blockchain technology will change existing operations models and fill the knowledge gaps that exist in a banking institution. The “research onion” described by Saunders et al (2009), seems logical in this context because the methods adopted are compared with the research process by underlining the layered approach to research.

The research onion was developed by Saunders et al (2009). According to Saunders et al (2009), the research onion explains the stages that are covered when designing a research strategy. Each onion layer is defined by giving a detailed level of the research process (Saunders et al, 2009). The research onion was chosen for this study because it presents an efficient sequence design for formulating an effective methodology. A description of the layered approach – in the subsequent sections of this chapter – provides a detailed explanation of why this study adopted a specific approach.

The layers of this study are as follow; the research philosophy is interpretivism, which creates the outline for the appropriate research approach, namely an inductive approach. The inductive approach was used since knowledge-mapping of blockchain technology in a financial institution is a new phenomenon. The next layer defines the time horizon, which was cross-sectional. The last layer represents the layer at which the data collection methodology was identified in the study by collecting data from an online questionnaire and conducting an interview with technical experts.

The advantages of the research onion thus create a sequence for better understanding the different methods of data collection and demonstrating the steps by which a methodological study can be explained. According to Kuhn (1996), research philosophy is the “set of standards to which practitioners refer”. Laws and McLeod (2001:1) mention three views on research philosophy relevant to the field of business management research, namely, positivism, interpretivism and realism. This study of knowledge-mapping of blockchain technology is operationalised from an interpretivist worldview. Interpretivism provides the frame for investigating knowledge gaps and for mapping an existing knowledge of the applications of blockchain technology. To justify the knowledge-mapping of blockchain technology in a
banking institution, the research philosophy of interpretivism was undertaken to explain the assumptions inherent in the research. A study typically comprises components of a research paradigm, explain Easterby-Smith, Thorpe and Lowe (2006), referring to epistemology. These components identify the common parameters and assumptions that facilitate the investigation. The research strategy for this study is knowledge-mapping of a case organisation.

The researcher’s understanding of the various combinations of research methods is explained further below. The philosophical paradigm using interpretivism for this research relates to the social constructionism in the main field of management research as explained by Easterby-Smith et al (2006). Interpretivism has relevance to financial institutions using blockchain as a leading technology in the near future. This study develops from ontological assumptions and narrates what is real and objective by interpreting the importance of blockchain technology being a foundational technology based on the beliefs and knowledge of the employees of a banking institution. Mapping the employees’ knowledge of blockchain gives decisive value and sufficient justification for its future applications in the financial services industry.

3.3 Research approach

The research approach depends on the research problem statement coupled with the kind of information that is needed (Strauss & Corbin, 1994:13). There are two main schools of research approaches; the deductive approach and the inductive approach (Nachmias & Nachmias, 1996; Weitzer, 2002). This study has an inductive approach. The inductive approach advocates developing a theory after the research is complete (Norman, Denzin & Lincoln, 2002:2). This study used an inductive approach because the aim was to fill the gap with mapping knowledge by relying on quantitative and qualitative methods to help build theory. The inductive approach in this study involves “the search for patterns from observation and the development of explanations and [it] generates theories for those patterns through series” (Ibimina, 2004:3). This allows the study to be narrowed down to blockchain knowledge.

An inductive approach was taken as it collected the data through a questionnaire provided to people who would be able to provide context to the investigation (Muijs, 2011:46), and by means of interviewing the case organisation’s experts who possess the qualifications and
experience in blockchain technology. The purpose of anonymised research, the case organisation is known as the South African Banking Institution (SABI).

To map knowledge and develop theory, the researcher interviewed SABI employees who were acquainted with the subject known as blockchain technology and cryptocurrency such as Bitcoin. Data has been analysed inductively using quantitative data analysis and qualitative content analysis methods. As the content categories formulate the knowledge-mapping results, they were used as the interpretation of the online questionnaire and interview data. This approach to interpretation is inductive, and as Saunders et al (2009) explain, an interpretivist approach is appropriate for recognising a social agent – in the case of this study, the agent is knowledge of blockchain technology that has an influence on the operations of the case organisation, SABI. The research combined the quantitative and qualitative approach to understand how the use of blockchain technology will change SABI’s existing operations models and fill knowledge gaps in SABI.

### 3.3.1 The quantitative approach

The quantitative approach is concerned with quantitative data (Flick, 2011:296). It holds many accepted statistical standards for the validity of the approach, such as the number of respondents required to establish a statistically significant result (Goddard & Melville, 2004:148). Interpretivism is the guiding philosophy that usually assumes a qualitative approach, but the quantitative approach can be most effectively used in situations where there are many respondents available, where data can be effectively measured using quantitative techniques, and where statistical methods of analysis can be used (Goddard & Melville, 2004:148). Blockchain is a new technology and the limited extent of expertise in this domain affects the number of research participants (cf Section 3.7.1).

### 3.3.2 The qualitative approach

The qualitative approach is drawn from the interpretivism philosophy (Bryman & Bell, 2011). This approach requires the researcher to avoid imposing their personal perceptions of the meaning of social phenomena upon the respondent, explain Johnson, Onwuegbuzie and Turner (2007:113). A qualitative approach augments knowledge-mapping since it helps with identifying tacit knowledge as it translates or manifests in the form of subjective viewpoints. The qualitative approach investigates how a respondent interprets lived experiences in terms
of a respondent’s own reality, perceptions and knowledge (Johnson et al, 2007; Marshall & Rossman, 2009; Bryman & Bell, 2011), which aligns well with the purpose of this study.

Qualitative research is usually used for examining the meaning of social phenomena rather than seeking a causative relationship between established variables (Feilzer, 2009). The advantage of qualitative research for this study was knowledge-mapping; however, the qualitative approach presented unusual challenges. The main challenge faced during the research was the quality of the data gathered in qualitative research that could have been subjective. For example, Hall (2011:2) warns that having an individual perspective and introducing instinctual decisions can lead to generalisations and very specific data. This challenge was countered through an interview or texts where the responses to questions could be open. Furthermore, the researcher allowed questions throughout the process to ensure that the respondent expands on the information provided.

This study’s qualitative methodology draws on an inductive approach, which means that results were obtained from research that was completed instead of examining the data against pre-existing frameworks (Flick, 2011). An in-depth interview was conducted individually with specific SABI employees who had a vested interest and proven expertise in blockchain technology. This approach was taken to ensure that the respondents provided information for examining how blockchain technology will change existing operations models and fill the knowledge gaps that exist in the SABI.

### 3.3.3 The mixed-method approach

A mixed-method approach was used. This approach was a combination of quantitative and qualitative methods. The methods were best suited for this study that was aimed at knowledge-mapping. It involved collecting, analysing and integrating quantitative data by distributing an online questionnaire to people from the Blockchain Africa Conference and a research group associated with the SABI. The respondents to the quantitative research were employees and clients of the bank, cryptocurrency investors, miners and individuals with a knowledge interest of blockchain technology.

In addition to the quantitative approach, the researcher also conducted an interview with technical experts employed by the SABI in order to gather qualitative data. These respondents to the qualitative research were specific individuals from a blockchain knowledge group of
the SABI. This research approach was applied as the integration provided a better understanding of the research problem. The approach ensured; firstly, that there would be findings from quantitative analysis, and secondly, with added insights from qualitative data. An online structured questionnaire was distributed to a homogeneous group of Blockchain Africa Conference delegates, which included clients and employees of the bank, the SABI’s management-level members, SABI’s individuals who are studying blockchain technology, for example, the payments team in the core banking department, a SABI group of knowledgeable people who are Bitcoin and blockchain adopters in the bank, including cryptocurrency investors, miners and individuals with a knowledge interest of blockchain technology. An interview with specific technical experts followed, as illustrated in Figure 3.1.

Figure 3.1 Mixed method research design (own source)

Figure 3.1 illustrates the study’s mixed method research design. The quantitative data collection comprises close-ended questions and is used to measure the attitudes and similar traits of the respondents. The analysis technique of this type of data consists of statistically analysing scores collected on instruments, for example, a questionnaire displaying the score on a graph. Qualitative data typically tracks the route of aggregating it into sections of
information and displaying the variety and similarity of opinions gathered during the interview. The thematic analysis was then summarised in the knowledge categories report.

3.3.4 The knowledge-mapping strategy

Interpretivist researchers adopt a reflective method to understand a phenomenon such as blockchain technology. Knowledge-mapping is one approach to understanding blockchain technology in the FSI context, which begins with identifying what knowledge already exists in a banking institution. Knowledge-mapping generally consists of those question categories mentioned in Section 1.2. In this study, a modified knowledge-mapping strategy is utilised because knowledge maps of blockchain technology do not yet exist in literature of relevance to the SABI. This study promotes the process of the mapping of a banking institution’s knowledge of how the application of blockchain technology will change existing operations models and fill knowledge gaps that exist in a banking institution.

The knowledge-mapping strategy developed for this study consists of two sets of knowledge-mapping questions (cf Section 1.6; Annexure D; Annexure E). These methods are beneficial for collecting and analysing data to formulate a conceptually rich blockchain knowledge-mapping theory. This study’s blockchain knowledge-mapping theory identifies Core Banking Application (CBA) segments to be recognised as critical knowledge (cf Figure 4.12). It shows the knowledge gaps in the current application areas of blockchain technology and knowledge categories that need to translate to implementations of the technology in a specific banking institution. A blockchain knowledge-mapping theory will be useful to identify knowledge gaps that exist in core banking departments and to enter the new era in which technology is heading.

3.4 Research strategy

A research strategy is a researcher’s plan of how to investigate the research problem, which may consist of sub-strategies, explain Saunders et al (2009). In this research, a case study best suited the research to map knowledge about the phenomenon of blockchain technology. The strategy suits the study because the researcher’s employer is a banking institution in need of a blockchain knowledge-mapping theory. The researcher and research participants agreed on the urgency of finding a solution to the research problem.
The research strategy explains in what manner the researcher intends to carry out the work (Saunders et al, 2009). Strategy often consists of diverse approaches because there are several ways to collect empirical data. The important factors that must be taken into consideration should depend on the nature of the research questions, to what extent the researcher has control over behavioural events and to what degree the focus is on contemporary events, which the researcher can choose between.

This case study has an inductive approach. Miller (2006:1-3) describes this approach where patterns derive from the data as a precondition for the study. This strategy allows the interview data to be transcribed and grouped according to the communal factors revealed among respondents. The case study of the SABI’s knowledge of blockchain technology embodies a flexible yet systematic mode of analysis. Charmaz (2006) describes this approach as open-ended analysis and theorising from empirical data.

In this case study, the research question generated a middle-range theory that has not been adequately realised. According to Creswell and Tashakkori (2007:107), middle-range theories are common in the social sciences, which means it has to be tested. A case study strategy gives the necessary scope to a knowledge-mapping strategy. In this manner, the research conveys a clear direction for the SABI and perhaps other banking institutions to map their knowledge of blockchain technology applications.

Knowledge-mapping is an ongoing process and this study is a small section of what should be a much greater contextual analysis of knowledge sharing events such as the Blockchain Africa Conference. Knowledge-mapping must be a continuous strategy; however, for the purpose of this study, the research strategy is a case study with limitations. Even so, a knowledge-mapping strategy extends experiences or adds strength to what is already known through previous research. Therefore, the knowledge-mapping strategy chosen for this research begins by identifying and describing CBA knowledge categories as a first level of knowledge-maturity mapping. Maturity mapping was premature from 2017 to 2018 (cf Section 3.4.2 current research time horizon), but this first level of mapping has potential value for developing rare-use cases that will be important to the SABI.

Knowledge-mapping is a form of collaborative research. The case study strategy of this study has an interactive, collaborative and humanistic component. According to Wardrop, Zhang,
Rau and Gray (2015), humanistic research involves active input by research participants and sensitivity to the participants in the study. Sensitivity is essential in the case of financial institutions. This study collects data from participants seeking to build rapport and credibility in the blockchain phenomenon.

Knowledge-mapping is a form of humanistic research. Ibimina (2004:2) explains, humanistic research entails qualitative methods. This research has a case study strategy which uses an in-depth interview to collect data. In-depth interview is a qualitative approach that is useful to identify knowledge categories and understand the knowledge gaps identified in applications.

### 3.4.1 Methodological choices

The research methodological choices outlined in the research onion include the mono method, multi method, and mixed method (Saunders et al, 2009). As the name suggests, the mixed method requires a combination of quantitative and qualitative methodology. A wider selection of methods is used in the mixed method, explain Creswell (1994), and Bryman (2007). This approach is where the research is divided into separate segments with each producing a specific data set. Each is then analysed using techniques derived from quantitative or qualitative methodologies (Denscombe, 2008:270).

This study gathers data about the knowledge categories and gaps of blockchain knowledge in a bank, that is, the SABI. Knowledge-mapping will help SABI revolutionise its application of blockchain technology. The methodological choices link to the interpretivist research approach, which considers the purpose of knowing “the world of human experience” (Cohen & Manion, 1994:36). Creswell (1994) adds, “interpretivist researchers discover reality through participants’ views, their personal backgrounds and practices”. Also, Mertens (2005:12), and Cohen and Crabtree (2006), describe interpretivist research as the pursuit of expanding an understanding of the phenomenon. Therefore, the methodological choices of this study consider the situation of SABI and selects a mixed method. For example, quantitative data may be used to support and expand upon qualitative data and efficiently heighten the information (Mackenzie & Knipe, 2006).

The reason for choosing a combination of the quantitative and qualitative approach is that it encompasses the series of gathering, analysing and incorporating quantitative and qualitative
data from knowledge bearers in SABI’s core banking team and individuals in the team that implemented blockchain technology use cases. This approach of research methodological choice explains the integration of quantitative and qualitative data collection and provides a clear understanding of the research problem. It provides a comprehensive source of data, that is, SABI’s blockchain knowledge bearers who are well-versed in blockchain and cryptocurrency.

The methodological choices influence aspects of research design such as the procedure for the sampling data. The combination of quantitative and qualitative methods also means a combination of technical management and other members from the SABI’s foundry of blockchain knowledge, which means that the researcher contacted experts and networked at the Blockchain Africa Conference (2017) held in Johannesburg. This was done in order to ensure that research participants had a combination of skills in the domain that was valuable for the study. For example, knowledge ranged from a foundational knowledge of economics, bitcoin mining, implementing new technology for strategic innovation in financial segments, and systems architecture. These methodological choices were made in order to gain insights into the knowledge gaps identified in the bank and how the use of blockchain technology would change existing operations models. For example, quantitative data included close-ended checklists to answer the research question of a study that has a cross-sectional time horizon.

3.4.2 Time horizon

Time horizon refers to the framework within which the project is intended for completion, explain Saunders et al (2009). Two types of time horizon are specified: the cross-sectional and the longitudinal study (Brewer & Hunter, 1989). The cross-sectional time horizon is already established and is where the data must be collected. This is called the time collection, where the data is collected at a certain point (Flick, 2011:296). This is used when the investigation is concerned with the study of a phenomenon at a specific time. This study’s knowledge-mapping strategy is a cross-sectional study.

This cross-sectional study involves studying a homogenous group of participants, bearing knowledge of blockchain technology on fundamental characteristics, but at varying levels of knowledge at a distinct point in time. The research data, first the quantitative, then the
qualitative, was collected from individuals, which consisted of different factors of knowledge on blockchain technology. These factors may have been influenced by age and gender, though the study did not attempt to correlated knowledge of blockchain technology with age/gender.

The benefit of a cross-sectional study design allows for comparisons with many different variables at the same time. This method was used to gather preliminary data to support further research on the knowledge gaps for blockchain in banks. The cross-sectional time horizon provides information about what was happening in the population that opted to be part of the study, which was from August 2017 to September 2018. The questionnaire was distributed before the interviews were conducted with technical managers from the bank. The cross-sectional study involved 33 research participants as the sample of SABI’s blockchain knowledge bearing population, represented by people with different levels of knowledge at a specific point in time.

Time horizon does not depend on a specific research approach or methodology (Saunders et al, 2009). According to Saunders et al (2009), research can be a “snapshot” taken at a time. This study is a cross-sectional research of a phenomenon at a specific time; it investigates the gaps of knowledge between two groups of respondents. The two groups were differentiated by their level of engagement with SABI’s blockchain foundry or workflow team (cf Section 3.7.1).

### 3.5 Data collection and analysis

According to Nyame-Asiamah and Patel (2009:1), research data collection refers to the methods proposed for obtaining data for investigating a particular research problem. This section entails an explanation of methods and justification for selecting a population sample, sample size, data collection and data analysis techniques for this study. Data collection and analysis depend on the methodological approach used, taking into consideration the research philosophy (Bryman, 2007).

Research philosophy suggests the beliefs regarding the nature of certainty investigated and is the underlying meaning of the nature of knowledge (Bryman, 2012). As mentioned earlier, the research philosophy that will inform the research process is interpretivism. The research approach is inductive as a new theory is developed around knowledge gaps on blockchain technology in banks. Sequential data collection by means of an online questionnaire and in-
depth interview. Interviews with individuals were conducted face-to-face and there were interactions through audio recordings and email. The process is recorded to contribute to the study’s overall reliability and validity (Saunders et al, 2009). This approach in research yields a certain class of data that was divided into two types – primary and secondary data.

3.5.1 Primary data
Primary data details are derived from first-hand resources. First-hand resources were obtained from respondents through an online questionnaire and face-to-face interview. Data derived from statistical collections such as the questionnaire constitutes primary data. The participants’ answers were based on the knowledge that they had on blockchain technology in different aspects of the bank. Data derived from the interview was analysed on the level of knowledge of the technical managers and what they knew about blockchain technology and how it would affect operational business models in financial institutions. The primary data is therefore best understood as the data that is being analysed as itself, rather than through the prism of another analysis.

3.5.2 Secondary data
Secondary data is derived from the work or opinions of other researchers (Newman, 1998; Mbokane, 2003). One of the advantages of this data is that it is easily available and so less time is required to gather all the relevant information. For this study, the secondary data came from the SABI’s internal and external sources and was derived from its implementation of blockchain. The internal sources of secondary data used for this research included SABI company information based on information systems and business processes. The external sources of secondary data used for this research included SABI’s presentations and research group discussions at the Blockchain Africa Conference (2017). Internet articles on blockchain technology were used in combination with published books and scientific journal articles to develop the conceptual framework for this study in Chapter 2.

3.6 Research design
The research design is the explanation of how the research process is put to practice. The outline includes the factors that relate to the applicable methodology being implemented for the research, the analysis retrieved from the nominated respondents, and the manner of evaluating, analysing and reporting data (Flick, 2011:296). There are numerous diversified research designs, a few of which are the descriptive, explanatory and exploratory.
This study is an exploratory research. Exploratory research has been chosen as it portrays the initial research into a theoretical idea (Kowalczyk, 2015). The outcome of this exploratory study is an examination of the knowledge-mapping of blockchain technology applications for a banking institution.

Exploratory research is typically used to inform further research in a subject area (Neuman, 2003). An exploratory approach is preferred in order to explore the research question as the knowledge categories have to be defined. Exploratory research gives rise to an idea and an observation based on the future research. Research should identify knowledge gaps between systems and people by practising and gaining a greater understanding about blockchain technology applications in banks. Exploratory research establishes the groundwork, says Kowalczyk (2015), that will guide future studies in blockchain applications and determine observations that can explain new theories.

The exploratory research approach had two critical factors to consider – it is a topic that has not undergone much research and a knowledge map does not yet exist for blockchain technology in the SABI. This approach was used to determine the nature of the problem, which were the knowledge gaps, and not intended to provide conclusive evidence but to gain a better understanding of the problem as it applies to the SABI.

3.7 Sample size
The sample size suggests the number of respondents nominated from the general population sample size that was consumed in the research (Newman, 1998). Sequential data gathering was used as it is a sequence that combines quantitative and qualitative data derived from the research.

The number of respondents chosen from the overall population were 33 participants for the online questionnaire, and seven technical individuals who were interviewed from the SABI. The study practised a sequential approach. The quantitative data was collected first and then the qualitative data. The sequential approach allowed for the first results to inform the second.

The questionnaire was given to a specific group of people who have experience in buying and selling cryptocurrency, and knowledge of blockchain in the FSI. The first data collection method was to gather information by distributing the questionnaire to individuals, an analysis
of the respondents’ outlook on blockchain technology and their level of awareness if banks had to adopt the technology. The second data collection method was to conduct an interview with experienced staff members in the SABI who were trying to implement blockchain technology in the operating models and systems of the institution.

One of the seven individuals were from the SABI’s foundry that headed the disruption and innovation unit for the bank. The knowledge base of the interviewees ranged from bitcoin mining, implementing new technology for strategic innovation in financial sections, systems architecture on blockchain and a foundational knowledge of economics. The first range of collecting and analysing data was quantitative data followed by qualitative data collection and analysis to explore knowledge of blockchain technology. The research strategy was useful when developing the sample size, the sample is SABI’s blockchain knowledge bearers. Although Flick (2011:296) says the larger the sample size, the more reliable the research outcome, this study’s sample size is 33 questionnaire respondents and seven interviewees.

3.7.1 Sampling method
The study entails research aimed at understanding commonalities in a homogenous group. The sample was made up of individuals who possess knowledge about the use of blockchain technology that could potentially alter current operations models in financial institutions. Experts are defined in this study as individuals who have a thorough understanding in at least four of the five following knowledge areas:

1. Information management and knowledge management.
2. Information architecture supporting financial business models that can be advanced with innovation.
3. Workflow and automation technology systems.
4. Blockchain and cryptocurrency (Bitcoin) ecosystem.
5. Innovation on digital assets and distributed ledger platforms.

Expertise in the above areas was observed by obtaining the perceptions of:

1. Managers, system architects and analysts in financial departments such as payments and the workflow team in the core banking area of financial organisation.
2. Cryptocurrency investors, miners and Bitcoin payment users.
3. Developers adopting the foundational technology.
4. CEOs and executive leaders in the blockchain and Bitcoin community networked from the Blockchain Africa Conference.

5. Blockchain foundry members.

The sampling methods helped to identify the knowledge gaps in blockchain technology in the bank and the knowledge required to integrate foundational technology in SABI’s operating models and existing systems. The identification of the sources of expertise was complex and necessitated a snowball sampling.

The non-probability snowball sampling is a purposive sampling technique which supports initiatives intended for identifying and locating members who suit the desired expert population (Saunders, Lewis & Thornhill, 2012). Purposive non-probability homogeneous sampling was the technique employed to gain an in-depth understanding from the perspective of knowledge of Bitcoin and an understanding of the foundational technology of blockchain as a phenomenon.

As mentioned above, the number of respondents was 33 participants for the questionnaire, and seven technical individuals were interviewed from the SABI. The interview comprised seven individuals in a core banking team at the bank. This team is the workflow engine for the entire bank. The information was analysed and gathered to perform knowledge-mapping. Both data collection instruments, questionnaire and interview, were aimed at obtaining insights on what knowledge gaps exist and how the use of blockchain technology will change the existing business operations models of a financial institution. Homogeneous sampling helped to describe a subgroup in depth to decrease disparity, clarify analysis and help conduct face-to-face interviews for valid information. The participants shared their characteristic knowledge of blockchain, but transmitted it in different ways.

The sampling method and sample size were carefully chosen keeping in mind the advice of Saunders et al (2009) in terms of gathering data from a representative group or units of observation to reach data saturation. Although Guest, Bunce and Johnson (2006), estimate that 10 in-depth interviews suffice to reach data saturation. This study has seven interview participants due to the novelty of blockchain technology, which meant that there were not many experts available. This does not mean that there is a lack of knowledge; it means that because cryptocurrency usage and current applications for the foundational technology of
blockchain is new, there were a limited number of experts in Gauteng. Gauteng is the geographical location of the SABI’s technical workflow team.

3.7.2 Sampling motivation
The researcher’s decision to use the employees in the financial institution with expert knowledge on blockchain applications helped to explore and conduct in-depth interviews with these employees. An understanding was derived of how they view the implications and impacts, the future and viability of evolution based on the blockchain technology, their expectations, debates, concerns, and knowledge of current situations in adopting the new technology application. The study had to collect data from experts with knowledge of the new technology to gauge the opinions of respondents about using and engaging with the new technology applications and their outlook on the implications of it when it is implemented in financial organisations. This led to the data set to retrieve a variable that describes such experts. The final report includes statistical information on the association between perceptions of the consequences on how the use of blockchain technology will change existing operations models and fill knowledge gaps that exist in financial institutions. Data collected through the interview brings about a greater awareness of the meaning of the data collected during the quantitative phase, which provides generalisability since the qualitative phase gives a rich context to the findings.

The intricacy of using mixed methods necessitates a careful consideration during the research planning. This study’s time consideration of data collection was first the quantitative, and second, the qualitative data collection. The second phase was used to aid in the interpretation of data collected in the first phase.

In the qualitative element of the mixed method, the population comprised recognised experts in the field of blockchain technology. Interviews, explains Mouton (2013), are useful for the gathering of rich, in-depth information. Experts were defined as SABI employees either involved in blockchain strategies or those with a greater knowledge of blockchain applications in the financial institution. “Greater knowledge” means that the individuals qualified if they had the requisite knowledge and experience in managing information systems, managerial decision-making in financial institutions, relevant credentials related to IT considered as a minimum tertiary degree, and practical knowledge of blockchain technology.
As mentioned earlier on, “snowball sampling is commonly used when it is difficult to identify members of the desired population” (Saunders et al, 2009). In this study, a form of snowball sampling was necessary, not because the SABI’s experts were difficult to find due to their incognito status. Rather, due to the researchers’ junior status in the organisation it was necessary to be introduced to the experts in the SABI, which added to the difficulty of finding experts. In other words, the SABI’s experts identified people who fitted the required criteria and introduced the researcher to colleagues which simulates snowball sampling. Thus, snowball sampling was conducted as the interest raised from sampling people who knew others with a similar knowledge who, in turn, knew people who could assist with the technicality on the foundational technology. The gaps were discussed from all angles as the topic is new.

3.7.3 Data collection techniques

Questionnaires typically collect quantitative data and interviews typically collect qualitative data (Bryman, 2007). A questionnaire was used to collect data of variables identified in the conceptual framework. The link to the online questionnaire was sent to 33 research participants who fitted the criteria and possessed knowledge about new technology. An interview was conducted with seven experts in the SABI in managerial positions and experience in cryptocurrency mining, implementing new technology for strategic innovation in financial segments, systems architecture on blockchain, and a foundational knowledge of economics.

In mixed-method research, Saunders et al (2009) explain how quantitative and qualitative analysis procedures are carried out in parallel or sequential, but not in combination. This study’s data collection phases were sequential, with separate data analysis techniques. First there was online searching to conceptualise blockchain technology, second the online questionnaire, and third the interview with experts.

3.7.4 Data analysis techniques

The study separately analysed the collected data using the respondents’ questionnaire and interview findings to construct a sequential narrative data analysis. Narrative analysis is an inductively based research procedure (Saunders et al, 2009). The procedure began by defining the core facts and information from the amount of data gathered and expressed in a method to enhance meaning and insights by these various methods. The qualitative data analysis was
fully combined into all viewpoints by including an analysis of every face-to-face interview. Each step was carefully planned; first sending out the questionnaire and analysing if there was knowledge about blockchain technology, then the face-to-face interview was conducted to investigate the knowledge of the technical experts. Triangulation of data occurred by comparing the findings of the questionnaire and interview as well as the online searching in order to identify categories of knowledge and/or gaps in knowledge.

3.7.4.1 Online searching

Though online searching is not a data analysis technique, online searching and analysis of the quality of Internet sources is an analysis technology. The analysis of the quality of online information is crucial in order to build a reliable conceptual framework. In this study, online searches served to gather information from electronic theses, dissertation collections and current websites to find relevant information on the topic of blockchain technology. The literature review helped to attain the cutting-edge concepts of the current trends in technological advancements. Blockchain is a relatively new technology and findings about it are mostly published online, blogged, researched and examined via e-papers. Although there are scholarly articles in peer reviewed journals on the topic of blockchain technology, knowledge-mapping of the foundational technology aspects of blockchain is lacking. Thus, the researcher analysed information in order to identify categories of blockchain knowledge.

3.7.4.2 Online questionnaire

An online questionnaire was created to identify knowledge categories and understand knowledge gaps from a less technical view about cryptocurrencies and blockchain technology. The aim was to gauge what level knowledge individuals have on the foundational technology and the feasibility of implementing blockchain within the financial sector. The data obtained from the online questionnaire was analysed to identify knowledge categories and understand the participants' views on the current uses of blockchain, and to elicit their opinions about other possible application areas that could contribute to implement the foundational technology. Learnings from the areas helped to identify the knowledge gaps in the bank. The online questionnaire was sent out to individuals that have attended the Blockchain Africa Conference, affiliated with the SABI, with a knowledge interest in blockchain technology, cryptocurrency investors, miners, foundry members, and other individuals with knowledge of blockchain technology. The questionnaire maintained the anonymity of all responses and
disabled online IP tracking. The data was statistically analysed with the SurveyMonkey tool (cf Section 4.2 and Section 4.2.1).

3.7.4.3 Interview with experts

Interview data analysis was as per the recommendations of Saunders et al (2009), who described how to conduct face-to-face interviews to elicit the opinions from the interviewees and provide an analysable outcome. This was to gain an understanding of the participants in the SABI, that is, of their knowledge of blockchain technology. The data from the face-to-face interviews was with the experienced individuals employed by the bank, that is, they were experimenting with the foundational technology in the banks’ operating models and systems. The interviewees had to have knowledge of cryptocurrency mining, implementing new technology for strategic innovation in financial segments, systems architecture on blockchain, and a foundational knowledge of economics. This would ensure that the analyses conducted on the experts’ knowledge would address the research question. Section 4.2 and Section 4.2.2 describe in further detail the technique used to obtain the point of view of the experts on blockchain technology.

3.8 Reliability and validity

The major concern in ensuring the reliability of this study was participant bias since the sampling technique was purposive, which meant that participants had to represent a certain level of blockchain knowledge. Respondents might not give accurate views on the realistic state of the impact of cryptocurrencies, for example Bitcoin, as it is not being perceived as a major threat for now and some financial institutions might perhaps not even regard it as a threat that must be dealt with immediately, which might skew their responses.

Also, legislation such as the Protection of Personal Information (POPI) Act, restricts the access of information to answer some of the questions raised. This is not a validity concern, since instances of the experts’ perceptions portraying knowledge versus the reality of the investigation when implementing blockchain was clarified using the overt quinary questioning technique. This means that the flexibility of the interview data collection technique allowed the researcher to ask questions such as to contextualise, clarify, qualify, challenge and course correct the knowledge-mapping strategy during the interview.
3.9 Ethics

The researcher is an employee of a financial institution and had direct contact with the field of research. In addition to the interview and questionnaire, contact with the field of research also included observation of data relating to the underlying technology and the value it would bring to the study’s case institution. The researcher applied the University of Johannesburg code of research ethics, which protects the anonymity of the case institution and confidential data was not identified.

To conduct research that is valid and uncompromised means that it must be conducted in line with certain ethical standards. Upholding ethical standards allows researchers to be more confident as all the methods are honest, direct and undertaken with an integrity that will make querying the results of the research difficult. The online questionnaire and interview remain highly confidential and allowed voluntary participation in the research study as outlined below.

3.9.1 Access

Before turning to a financial institution as a research site for observation and data-gathering purposes, the researcher had to formally request access from the organisation, specifically the core technology solutions department that deals with workflow solutions and payments in the bank (cf Annexure B). To make use of a financial institution’s employees and users of the foundational technology for a source of information without access is unethical, therefore it was first priority to gain access to the SABI as a source of primary data (cf Annexure A).

3.9.2 Informed consent

These include the guarantee that any party or participants who will be intended as units of observation utilised for data-gathering purposes must have a full and clear understanding of the study’s aims and objective and what will be sought from participants (University of Johannesburg, 2007). The study required sensitive information from a financial institution for the end results. The researcher adhered to the parent higher education institution’s code of research ethics which protects the anonymity of the research site and participants (cf Annexure A and Annexure B).
3.9.3 Delineation of study

Foundational technology leads to many operational encounters for financial institutions of which this study only had knowledge-mapping for the aim of the study (cf Section 1.2 and Section 1.3). Several factors might limit this research. It is still early days for blockchain technology to boast of any expertise in the subject matter. The value of the gaps can only be determined by trial and error on an application and the operating models at the bank. The learnings of the implementation will provide a deeper understanding of the foundational technology. The learnings will identify the gaps and address why this foundational technology will be referred to as the next industrial revolution in financial institutions. The know-how of experts implementing real use case scenarios to discover strategies and gain insights into the future of blockchain in terms of innovation and disruptions of existing traditional systems and processes in the financial organisations is not limited, but the number of experts is limited.

This study incorporated knowledge-mapping from the knowledge sharing at the Blockchain Africa Conference (2017), attended by the SABI’s workflow team, research group and other SABI individuals, including clients of the SABI, with a knowledge interest as well as the views of specific SABI experts in the Gauteng geographic area, which is the technical hub of the SABI. Thus, this study was restricted to the perceptions of people who had knowledge, albeit at varying levels, of how to incorporate blockchain in financial institutions instead of causing banks to become obsolete. These specifications meant the disclosure of sensitive information, such as the SABI’s blockchain use cases. The study’s case institution only provided limited access to units of observation as much of the information was confidential. Another limitation was that there are not many scholarly papers on the topic of blockchain knowledge-mapping, so new theoretical observations and conclusions will be derived from quantitative and qualitative data analysis that relied on this study’s conceptual framework in Chapter 2. A conceptual framework is one phase of an inductive approach and this study’s delineation iterates its inductive approach.

3.10 Chapter summary

This chapter describes the methodology and design of the research study. The chapter begins by restating the research problem and provides a philosophical positioning of quantitative and qualitative research. The study is interpretive in nature and designed as a mixed-method research. It is a case study with a knowledge-mapping strategy. A defining characteristic of case study research is the ability to use a combination of methods to collect data. As such,
this study employs data collection through a questionnaire, semi-structured interviews, and document analysis.

The fundamental reason for choosing the questionnaire was to garner a substantial view on knowledge of how blockchain is being implemented in a financial institution and the potential implications this holds for the financial industry. The aim of the questionnaire was to help the SABI focus on an objective view distilled from knowledge-sharing around blockchain. The second phase resulted in a personal interview with experts in the SABI, which is one of the major financial institutions in South Africa.

The questionnaire was conducted to allow for the statistical analysis of experts’ views and comparisons between knowledge areas identified as per statistical analysis. The interview was conducted to allow for thematic analysis of rich data obtained from individuals in possession of knowledge of blockchain technology at the financial institution. Interview participants were asked to provide detailed information on their professional backgrounds and experience with blockchain technology. This allowed for a description and comparison of results across hierarchical levels and the self-assigned competence levels of respondents.

The questionnaire was designed to obtain respondents’ knowledge-based responses about the adoption of blockchain over time. This was necessary to map knowledge and construct an overview of the most significant direction that blockchain developments will take for the SABI. It has to be noted that the questionnaire responses presented SABI’s employees’ knowledge on blockchain technology as well as clients of SABI with a blockchain knowledge interest and experience of mining cryptocurrency. In this manner, the research methodology created a balanced design that would best assist an objective analysis of SABI experts’ knowledge regarding the blockchain as well as others’ knowledge of blockchain technology. The population of the study was homogenous, the common denominator was individuals with a SAFI affiliation and blockchain technology knowledge interest. In review of the study’s reliability and validity, this chapter described issues relating to the data collection procedures and the ethical considerations. The next chapter presents the analysis and results.
Chapter 4

Analysis and discussion

4.1 Introduction

This chapter presents the results of the data analysis. Data was collected and processed to address the research question: How can the use of blockchain technology change existing operations models and fill knowledge gaps that exist in a banking institution?

The research objective was to map knowledge to identify and fill the knowledge gaps in a financial institution. To create a knowledge map, the unit of analysis was a knowledge of how the use of blockchain technology changes the existing operations models of financial institutions. The analysis contained the respondents’ knowledge about blockchain technology and how it can be used in financial institutions. Furthermore, respondents elaborated on blockchain technology features that could improve banking products, services, business models and delivery mechanisms using blockchain technology.

The findings presented in this chapter demonstrate the potential for developing and merging the theory and practice of blockchain in a South African Banking Institution. The two methods of data collection used to gather descriptive information was obtained by distributing an online questionnaire and conducting in-depth face-to-face interviews. These methods were most suited to operationalise the research objective. Data analysis and research results are useful for mapping knowledge to provide meaningful guidance on the use of blockchain in the SABI’s business models. This chapter reports the results by firstly presenting the analysis of data from the questionnaire and secondly, the data collected from the interviews.

4.2 Data analysis

This section reports the data analysis and the interpretation and narrative reporting of the results of this study. Quantitative data included close-ended information and allowed checklists for the answering of the research question for the study. The data collection method was to gather information by distributing an online questionnaire to individuals. The participants’ knowledge revolved around new technology, clients of the bank, and individuals who owned cryptocurrency. The knowledge of the interviewees included cryptocurrency mining, implementing new technology for strategic innovations in financial segments,
systems architecture on blockchain, and a foundational knowledge of economics. The aim of the analysis is to gain insights of the knowledge gaps identified in the bank and knowledge of how the use of blockchain technology would change existing operations models.

4.2.1 Quantitative analysis and interpretation of results of structured questionnaire

The research strategy was knowledge-mapping. In the context of knowledge-mapping, the focus of conducting the questionnaire was to gather facts and relevant information on how the use of blockchain technology would change existing operations models and fill the knowledge gaps in a financial institution’s knowledge of blockchain and cryptocurrency. Respondents helped to identify the knowledge areas of primary drivers. These drivers are defined and explained in relation to the SABI’s market and what challenges are affected when implementing blockchain to existing systems or business operating models and how they will converge in the blockchain ecosystem.

Data was collected from respondents who had a knowledge of blockchain, an interest in cryptocurrency investments, and experience in the business operations of a financial institution in South Africa. A total of 33 respondents shared their knowledge, of whom only two had experience in Bitcoin mining. Section 3.7 describes the research sample; the total targeted sample responded to the online questionnaire and respondents answered all questions, which means the response rate was 100%. None of the responses had incomplete data that had to be discarded and all were correctly answered and addressed for the interpretation of results. Computer-assisted quantitative data analysis of questionnaire responses was used for the graphic presentation of results. The evidence of the responses on the questionnaire was stored on a SurveyMonkey account for traceability of findings.

The responses for each question were calculated to find the highest frequency of occurrence, that is, the number of times that a response occurs. The statistical analysis was univariate analysis, which includes measures of central tendency. Measures of central tendency were most suitable for knowledge-mapping where it was important to refrain from making statements such as “some”, “most”, or “usually”. Instead, this study applied the guideline of Maxwell (2010:475) to utilise a quantitative reporting manner, namely using frequency distributions to summarise the distribution of responses on a single question (cf Appendix D). This approach was best suited to reach a result based on the respondents’ actual knowledge and lived experiences. The SurveyMonkey graphic interpretations were attached
to the results as they were automatically generated by the computer-assisted data analysis per question. The findings are presented below in the same order as the questionnaire. The report of findings has an integrative approach, in other words, the analysis is followed directly by an interpretation.

**Question 1: Please specify your gender (Figure 4.1).**

![Figure 4.1 Gender distribution (own source)](image)

In Figure 4.1 the question was posed as part of a demographic question and was aimed at assessing who had been surveyed and showed an interest in blockchain technology.

**Table 4.1: Gender distribution**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>81.82%</td>
<td>27</td>
</tr>
<tr>
<td>Female</td>
<td>18.18%</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
**Finding:** Table 4.1 shows a gender predominance. Most respondents (81.82%) who had a vested interest in blockchain technology were male.

**Interpretation:** The gender disparity could be ascribed to various factors. However, this study did not investigate, for example, the gender gap in the technology industry, the representation of females in the financial industry or perhaps the theory that women are more risk-averse than men when it comes to investing on considerable risk portfolios such as cryptocurrency *(cf Section 1.6).* Therefore this interpretation is an assumption and not a research finding.

Next, Figure 4.2 illustrates, *Question 2: Please specify the age group.*

![Figure 4.2 Respondents’ age groups (own source)](image)

In Figure 4.2, the question was posed as part of a demographic question and was aimed at assessing the age distribution of respondents with an interest in blockchain technology.
### Table 4.2: Distribution of age group

<table>
<thead>
<tr>
<th>Age group</th>
<th>Frequency</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 years or younger</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>21-34 years old</td>
<td>84.85%</td>
<td>28</td>
</tr>
<tr>
<td>35-54 years old</td>
<td>12.12%</td>
<td>4</td>
</tr>
<tr>
<td>55 years and above</td>
<td>3.03%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Finding:** In Table 4.2, by comparison, some of the respondents (12.12%) were between the ages of 35 years and 54 years, whereas most respondents (84.85%) represented the age group 21 years to 34 years.

**Interpretation:** This comparison indicates that, in the SABI, an interest in and knowledge of the topic is more likely to be present in people in their 20s and early 30s. Very few of the respondents (3.03%) were over the age of 55 which means that the knowledge of cryptocurrency and blockchain technology is more likely found among people in their early and mid-career. However, this finding cannot be generalised to the FSI. The finding pertains to the SABI only and illustrates that the age groups from 21 years to 34 years developed some level of knowledge on blockchain technology.

![Figure 4.3 Cryptocurrency ownership (own source)](image_url)

**Finding:** Figure 4.3 illustrates the result of Question 3: Do you own any Cryptocurrency? Although many of the respondents (69.7%) did not own any cryptocurrency, a significant group of respondents (33.3%) owned at least one type of cryptocurrency.
**Interpretation:** Clients and employees of SABI own some sort of cryptocurrency, which shows that participants do have a knowledge of cryptocurrency investing. A general assumption would be that individuals do not invest money until they understand the investment, however the research did not test respondents’ enthusiasm to investment.

**Table 4.3: Cryptocurrency ownership**

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Frequency</th>
<th>Open response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>11 (33.3%)</td>
<td>Bitcoin, Ethereum, Litecoin, Dash, Monero, Zcash, Bitcoin Cash, NEO, Numeraire, NEM, Bitconnect Coin, IOTA, OmiseGO, Lisk, Stratis, Steem, PIVX, TenX, Golem, Metal, Saicoin, Civic, Gnosis, B3 Coin, Dogecoin and USD Teather</td>
</tr>
<tr>
<td>No</td>
<td>23 (69.7%)</td>
<td>• Don’t know which cryptocurrency to buy&lt;br&gt;• Don’t know how to buy or invest in cryptocurrency, it’s too complicated&lt;br&gt;• Concerned it will crash, it’s hype for just a certain period&lt;br&gt;• Expensive&lt;br&gt;• Security on the investment, high risk losing to low liquidity or hackers, absence of regulatory body, presence of cybercrime&lt;br&gt;• Cryptocurrencies like Bitcoin are dangerous, it creates a platform for criminal activities, it is a scam (sic)</td>
</tr>
</tbody>
</table>

**Finding:** Table 4.3 shows that respondents who had cryptocurrency owned Bitcoin, Ethereum and Litecoin as well as Dash, Monero, Zcash, Bitcoin Cash, NEO, Numeraire, NEM, Bitconnect Coin, IOTA, OmiseGO, Lisk, Stratis, Steem, PIVX, TenX, Golem, Metal, Saicoin, Civic, Gnosis, B3 Coin, Dogecoin and USD Teather (some answers are verbatim responses to the open section of this question). Also, an open question inquired of respondents who did not own cryptocurrency to provide a reason for not doing so.

Respondents who did not own cryptocurrency said they would not invest in cryptocurrency due to indecision (knowledge of cryptocurrency multiplicity), process (knowledge of cryptocurrency purchasing avenues), risk (knowledge of cryptocurrency market), capital (knowledge of cryptocurrency investment principles) and security (knowledge of cryptocurrency investment security). Respondents mentioned that there was no central regulatory body overseeing the Bitcoin operations, which made most investors afraid of investing in the network.
Interpretation: Figure 4.3 and Table 4.3 show the role of blockchain knowledge to understand cryptocurrency transactions and/or investments. For example, a respondent said that “cryptocurrencies like Bitcoin are dangerous, it creates a platform for criminal activities” (sic). This comment underscores the comments of two other respondents with a similar view. Three other respondents echoed the belief that Bitcoin promotes effortless cybercrime. Other reasons given for not owning cryptocurrency included that it was too volatile, did not have long-term value, and was “a scam” (sic).

If most of the respondents (69.7%) had not bought cryptocurrencies like Bitcoin and Ethereum because they did not know which currencies to invest in and did not know how to go about buying cryptocurrency, this means there is a potential gap in terms of the:

- Knowledge of cryptocurrency multiplicity
- Knowledge of cryptocurrency purchasing avenues
- Knowledge of cryptocurrency market
- Knowledge of cryptocurrency investment principles
- Knowledge of cryptocurrency investment security

Cybercrimes are not new, yet in the era of cryptocurrencies, banking institutions will have to build a knowledge base that deals with the issue of Machine Learning Computational Logic (cf Section 2.8.5).

Next, Figure 4.4 presents the data analysis of Question 4: Did you know that the technology platform (blockchain) supports Bitcoin (cryptocurrency), which can be used for any type of digital transaction, not just Bitcoin? To allow respondents to interpret the question, these “did you know” knowledge qualifiers applied:

- **Extremely likely**: Understand the full logic of how the blockchain technology works.
- **Very likely**: Yes, but need to do more research on the know-how of digital transacting on blockchain.
- **Somewhat likely**: Just heard of it, not much knowledge on the application.
- **Not so likely**: Just know about it because of the recent hype.
- **Not at all likely**: Nil
Figure 4.4: Awareness level of knowledge of the blockchain technology platform (own source)

Finding: Figure 4.4 illustrates the awareness level of respondents in terms of their own knowledge that the technology platform (blockchain) supports Bitcoin (cryptocurrency), which can be used for any type of digital transactions, not just Bitcoin.
Table 4.4: Knowledge of the blockchain technology platform

<table>
<thead>
<tr>
<th>Qualifier</th>
<th>Frequency</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely likely – Full logic of how the blockchain technology works</td>
<td>24.2%</td>
<td>8</td>
</tr>
<tr>
<td>Very likely – Yes, but need to do more research on the know-how of digital transacting on blockchain</td>
<td>39.4%</td>
<td>13</td>
</tr>
<tr>
<td>Somewhat likely – Just heard of it, not much knowledge on the application</td>
<td>24.2%</td>
<td>8</td>
</tr>
<tr>
<td>Not so likely – Just know about it because of the hype recently</td>
<td>3%</td>
<td>1</td>
</tr>
<tr>
<td>Not at all likely – Nil knowledge</td>
<td>9%</td>
<td>3</td>
</tr>
</tbody>
</table>

Finding: The results in Table 4.4 show that some of the respondents (24.4%) perceived their level of awareness as “extremely likely” by indicating that their blockchain knowledge allowed them to distinguish between the “platform” and the “currency”. Many of the respondents (39.4%) perceived their level of awareness as “very likely” although they would need to do more research on the know-how of digital transacting on blockchain. Some of the respondents (24.2%) said they had heard of the technology. Their level of awareness was “somewhat likely”, for example, their knowledge on the application and back-end processing was limited. One respondent (3%) perceived a level of awareness that was “not so likely”.

Interpretation: The results in Figure 4.4 and Table 4.4 indicate a knowledge gap in terms of the know-how of digital transacting on blockchain. The research design targeted people with SABI affiliation with a knowledge of blockchain technology or a knowledge interest, such as clients of SABI attending a knowledge sharing event. The respondents to the questionnaire section of the empirical research were not necessarily experts. One respondent only knew about Bitcoin/blockchain due to the recent hype on the topic and would not have had a sufficient knowledge base to differentiate between the platform and the currency. Three of the respondents (9%) indicated that they had no knowledge at all to distinguish between the blockchain technology platform and the cryptocurrency. This shows that the technology is new to individuals and that there is a need for knowledge-mapping. Managing the know-how of digital transactions on blockchain needs to be conducted on an individual and an organisational level.
Figure 4.5 presents the data of Question 5: Which of the following blockchain start-ups/platforms do you recognise? The question was posed to establish if the respondents had the knowledge of the cryptocurrency exchange that would allow a person to swap fiat money (rand, dollars, euros, etc.) for cryptocurrency, or cryptocurrency for cryptocurrency, or cryptocurrency for fiat money. The results presented in Figure 4.5 and Table 4.5 have significance because a knowledge of these exchanges will spark the innovation that is lacking in the traditional financial system.

![Survey Results](image-url)
**Figure 4.5 Blockchain start-ups/platforms (own source)**

**Finding:** Figure 4.5 illustrates that the three most recognised blockchain start-ups/platforms in South Africa are:

1. Ethereum (57.6%)
2. Ripple (33.3%)
3. Coinbase (27.27%)

**Table 4.5: Blockchain start-ups/platforms**

<table>
<thead>
<tr>
<th>Platform</th>
<th>Frequency</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethereum</td>
<td>57.6%</td>
<td>19</td>
</tr>
<tr>
<td>Ripple</td>
<td>33.3%</td>
<td>11</td>
</tr>
<tr>
<td>Coinbase</td>
<td>27.27%</td>
<td>9</td>
</tr>
<tr>
<td>BitPay</td>
<td>21.21%</td>
<td>7</td>
</tr>
<tr>
<td>Microsoft Azure Baas</td>
<td>18.18%</td>
<td>6</td>
</tr>
<tr>
<td>CounterParty</td>
<td>9.09%</td>
<td>3</td>
</tr>
<tr>
<td>Hedgy</td>
<td>3.03%</td>
<td>1</td>
</tr>
<tr>
<td>R3 Cordo</td>
<td>3.03%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Finding:** Table 4.5 lists the blockchain start-ups/platforms in order of most-recognised to least-recognised, which indicates that some respondents (18.18%) did not recognise any of the names Ethereum, Ripple, Coinbase, BitPay, Microsoft Azure Baas, CounterParty, Hedgy and R3 Cordo. However, respondents were also given the option to specify other blockchain start-ups/platforms. The mentioned names were as follows:

- Civic, a decentralised identity management platform
- Consensus
- CREAM
- Gnosis, a multi-domain prediction market
- Golem, a decentralised super computing platform
- Hyperledger or Nexledger
- IOTA, the Tangle network alternative to blockchain technology for Internet of Things (IoT) applications
- LiteCoin or ZCoin
- Luno
- NEO, the Asian competitor of Ethereum
- Numeraire, a staking coin used to stake confidence in Machine Learning models uploaded to the Numerai AI-powered hedge fund
- OmiseGO, the crypto wallet platform
- Qtum, a next-generation blockchain platform
- Sia, a decentralised cloud storage platform
- Steemit, a decentralised social media platform for bloggers and vloggers, where content providers get paid in the cryptocurrency, Steem, every time their content is liked
- Stratis, a next-generation blockchain platform, offering integration API using C#
- Syscoin, a decentralised e-commerce platform
- Teather, a fiat currency-pegged cryptocurrency
- TenX, the crypto debit card platform

From the above list, some respondents (18.8%), said that Luno was the most mentioned blockchain platform. In terms of knowledge-mapping, it is significant to note that respondents illustrated their knowledge of blockchain technology by mentioning Luno as a platform as it was omitted from the questionnaire’s list of names on purpose in order to map knowledge.

**Interpretation:** Respondents recommending blockchain platforms showed that they had a knowledge and understanding of blockchain technology. In Section 2.2, the literature review has shown that organisations need to introduce a systematic approach to transferring knowledge from external and internal sources to the places where this knowledge should be applied. The above analysis of data collected in response to Question 5 indicates that respondents possess a knowledge of blockchain platforms which will serve as an advantage in selecting the preferred platform and gaining the information to be shared in terms of the know-how in specific situations.

Some of the specific situations are mentioned in **Question 6: Do you understand the blockchain technology concept that supports the phases such as inception, verification and security of blockchain transactions?**
Table 4.6: Understanding the blockchain technology concept

<table>
<thead>
<tr>
<th>Knowledge associated with phases</th>
<th>Frequency</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>I understand the conception phases</td>
<td>18.18%</td>
<td>6</td>
</tr>
<tr>
<td>Only understand certain phases</td>
<td>48.49%</td>
<td>16</td>
</tr>
<tr>
<td>Not at all</td>
<td>30.30%</td>
<td>10</td>
</tr>
<tr>
<td>Please specify which phases you are more familiar with</td>
<td>3.03%</td>
<td>1</td>
</tr>
</tbody>
</table>

Finding: The analysis displayed in Table 4.6 shows that some of the respondents (18.1%) understood the conception phases of blockchain technology. Almost half of the respondents (48.5%) said they only had knowledge of certain phases and not all the blockchain technology. Other respondents (30.3%) indicated that they did not have the knowledge background on the blockchain phases. One respondent (3%) had specified cost metrics knowledge. Six of the respondents (18.18%) understood the phases of blockchain technology.

Interpretation: If only six respondents have a conceptualisation of blockchain technology's conception phases, then there is a need to research and fully understand each phase to build
a knowledge base of the phases and processes of inception, verification and the security of blockchain. It is important to conceptualise blockchain technology and to develop an in-depth clarity on each phase and how it affects the technology. On the other hand, almost half of the respondents (48.49%) do understand some of the phases, which means that the SABI has a potential knowledge base and knowledge-mapping could be of benefit to the bank.

In Section 1.3, the contextualisation of blockchain technology’s foundational nature, and Section 2.2 and Section 2.5, the literature review of the “science of blockchain” according to Wattenhofer (2016), demonstrates that organisations must understand the phases of blockchain. If not, a lack of knowledge will have an adverse effect on processes, systems and governance frameworks if a financial institution implements blockchain technology with little knowledge of its phases.

An interpretation of the above findings so far, interpreted in the context of the literature review in Chapter 2, is that the SABI must capture and share the tacit knowledge related to the foundational technology. Blockchain content repositories should be created to gain the potential for improved quality, productivity and cost metrics.

The interpretation of the data analysis in Table 4.6 indicates that knowledge gaps do exist and must be removed if the SABI’s blockchain is to succeed when it is implemented.

Further below, Figure 4.7 illustrates the respondents’ views on the reasons why a financial institution might have an internal resistance in adopting blockchain technology. The respondents’ lack of understanding on the functionality of blockchain technology increases the challenges. This creates a source for knowledge-mapping and identifies the gaps created. Table 4.7 presents an analysis of the responses.
Question 7: In your opinion, what would be the banks’ reasons for the internal resistance in adopting blockchain technology?

![Figure 4.7: Reasons for the internal resistance in adopting blockchain technology (own source)](image)
Table 4.7: Internal resistance in adopting blockchain technology

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulatory and compliance</td>
<td>72.7%</td>
<td>24</td>
</tr>
<tr>
<td>Support</td>
<td>39.4%</td>
<td>13</td>
</tr>
<tr>
<td>Privacy and security</td>
<td>54.6%</td>
<td>18</td>
</tr>
<tr>
<td>Lack of internal buy-in</td>
<td>33.3%</td>
<td>11</td>
</tr>
<tr>
<td>Lack of network</td>
<td>18.1%</td>
<td>6</td>
</tr>
<tr>
<td>High additional costs</td>
<td>21.2%</td>
<td>7</td>
</tr>
<tr>
<td>Lack of knowledge and technical know-how on blockchain</td>
<td>51.5%</td>
<td>17</td>
</tr>
<tr>
<td>Use of blockchain is known for assisting illegal transactions</td>
<td>27.3%</td>
<td>9</td>
</tr>
<tr>
<td>New cultural and change adoption</td>
<td>45.5%</td>
<td>15</td>
</tr>
<tr>
<td>Distrust blockchain application</td>
<td>18.1%</td>
<td>6</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>21.2%</td>
<td>7</td>
</tr>
</tbody>
</table>

**Finding:** In Table 4.7, the results indicate that the major factors for the banks’ reasons for the internal resistance in adopting blockchain technology are regulatory and compliance as stated by most respondents (72.7%). Many others (54.6%) cited privacy and security as reasons for resisting blockchain adoption. In other cases (51.5%), the reason was the lack of knowledge and technical know-how on blockchain application in a financial institution. New cultural and change adoption was mentioned by respondents (45.5%) as a factor in resisting the adoption of blockchain technology.

Other reasons specified by respondents included:

- Risk of trading in cryptocurrency
- Investment banks in SA want to remain risk-free and avoid speculative trading
- Limited internal use cases outside the domain of decentralised applications
- Lack of how to use it in the bank
- There is no incentive for process transactions internally, so why not use a distributed database? *(sic)*

**Interpretation:** Known challenges and impediments on implementing technology in banks create gaps that require knowledge-sharing and information collaboration on the new
technology (cf Section 1.3, Section 2.3, Section 2.5 and Section 2.8). Knowledge-mapping, which includes the reasons for the internal resistance in adopting blockchain, will allow the SABI to develop innovative approaches in terms of human capital development. Knowledge-mapping, which includes the reasons for the internal resistance in adopting blockchain, will also allow the SABI to create operational and organisational structures within the institution to counter the known areas of resistance to adopting blockchain technology. The same interpretation is likely to apply to knowledge-mapping of blockchain drivers, as in Question 8.

**Question 8: What are the major anticipated blockchain drivers that will impact a financial organisation in the near future?**
Data analysis in Figure 4.8 helps to identify the drivers to facilitate blockchain technology-enabled change to the existing operations models of a financial institution. Like the previous question, the respondents’ account of blockchain drivers is an indication of a lack of knowledge. Moreover, it might lead to the identification of knowledge gaps.

Table 4.8 presents the data analysis of Figure 4.8. The percentages in Table 4.8 show the type of drivers that will aid financial institutions if blockchain technology is fully implemented in the institution. Responses indicate that each of the drivers has the potential to assist in new business models, which the literature review indicates might lead to efficiency gains for the economy in the financial sector (cf Section 2.2 and Section 2.5).

Table 4.8: Anticipated blockchain drivers that might affect financial institutions

<table>
<thead>
<tr>
<th>Driver of blockchain</th>
<th>Frequency</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce total cost of ownership</td>
<td>72.3%</td>
<td>24</td>
</tr>
<tr>
<td>Faster transaction clearing and settlement</td>
<td>69.7%</td>
<td>23</td>
</tr>
<tr>
<td>Easy management of record-sharing systems</td>
<td>54.5%</td>
<td>18</td>
</tr>
<tr>
<td>New revenue opportunities</td>
<td>45.5%</td>
<td>15</td>
</tr>
<tr>
<td>Easy to create electronic transactions on your own</td>
<td>42.4%</td>
<td>14</td>
</tr>
<tr>
<td>Lower administrative costs</td>
<td>39.4%</td>
<td>13</td>
</tr>
<tr>
<td>Reduce duplicate record-keeping</td>
<td>27.3%</td>
<td>9</td>
</tr>
<tr>
<td>Uniting employees and agreeing on the communication and data standards</td>
<td>12.1%</td>
<td>4</td>
</tr>
</tbody>
</table>

Finding: Table 4.8 presents the respondents’ views of anticipated blockchain drivers that will affect financial institutions. The majority of respondents (72.3%) elected the driver – reduce total cost of ownership. Also, a significant number of respondents (69.7%) believe faster transaction clearing and settlement will be a driver once blockchain has been implemented.

More than half of the respondents (54.5%) predicted that blockchain would assist in the easy management of record-sharing systems. These findings support the literature review finding that all transactions taking place in the economy are registered internally in the proprietary ledgers of individual market participants (cf Section 2.2 and Section 2.5).

Analysis of Table 4.8 shows that 42.4% of respondents anticipate that a blockchain driver is an easy electronic transaction for a better customer experience. Also, lower administrative
costs in the bank’s operations will be cut down as stated by a large number of respondents (39.4%). As shown above, some respondents (27.3%) reason that a reduction of duplicate transactions will be a driver. These findings support the literature review that fewer errors occurring in the systems will be quicker to identify (cf Section 2.5 and Section 2.7).

**Interpretation:** Table 4.8 supports the literature review findings (inductive approach), that blockchain’s full potential truly takes effect when accounting stretches past the boundaries of this ecosystem. For example, many respondents (45.5%) believe that new revenue opportunities will support the banks as blockchain will offer a quick and efficient on-boarding process that enables banks to essentially “plug and play” into the network for existing and future systems (cf Reed 2016a; Reed 2016b; Section 2.5 and Section 2.6).

In Table 4.8, the least number of respondents (12.1%) believe that if blockchain is implemented, it will unite employees and there will be agreement on the communication and data standards. According to the literature review, this might be purely based on the assumption that the change and innovation in using new technology might lead to issues arising among employees in the workplace (cf Section 2.8; Moskowitz et al, 2015).

The above data analysis and interpretation identified some of the drivers on how blockchain technology will change existing operations models and fill knowledge gaps. The most popular driver was the issue of faster transaction clearing and settlement.
Question 9: When do you think blockchain technology will be adopted in the financial services industry?

Figure 4.9: Blockchain technology adoption time frame in the financial services industry (own source)
Table 4.9: Adoption time frame of blockchain technology in the financial services industry

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the next 1-3 years</td>
<td>42.4%</td>
<td>14</td>
</tr>
<tr>
<td>3-5 years</td>
<td>18.1%</td>
<td>6</td>
</tr>
<tr>
<td>More than 5 years</td>
<td>30.3%</td>
<td>10</td>
</tr>
<tr>
<td>Not too sure, cannot predict</td>
<td>6.06%</td>
<td>2</td>
</tr>
<tr>
<td>Never</td>
<td>3.03%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Finding:** In Table 4.9, data analysis shows that most respondents (42.4%) believe that blockchain technology adoption would occur in the next one to three years. The definition of adoption in the questionnaire was “to be fully implemented in South African financial institutions and making a difference”. The second-highest number of respondents (30.3%) believe that it would take more than five years to be fully integrated in South African banks. Some respondents (18.1%) reason that it would take between three and five years to be adopted.

Figure 4.9 and Table 4.9 further illustrate that two respondents (6%) said it was too uncertain to predict the adoption time frame of the new technology being implemented in South African financial institutions. One respondent (3%) believed it would never be deployed in a bank.

**Interpretation:** The notion of respondents in the “more than 5 years” category is supported by the data analysis of Question 10 (cf Section 4.2.1), and Question 3 and Question 8 (cf Section 4.2.2), which link the time frame to the issue that there is not much regulation and actual grounding for an immediate implementation in the banks. However, an interpretation of the literature, other than South African literature, suggests a shorter time frame (cf Section 2.6 and Section 2.7).

It should be noted that the predictions of the respondents to this study’s questionnaire were not evidenced. Rather, the gauging of respondents’ predictions had the sole purpose of knowledge-mapping. Financial institutions will benefit once knowledge repositories have been identified and knowledge gaps have been filled. Gaining an insight into the respondents’ predictions presents an opportunity to map knowledge. For example, one person might predict that the consumers’ demand will accelerate a financial institution’s adoption of
opportunities to reduce transaction costs and the amount of paper that it processes. Another person might predict that blockchain will make banks increasingly profitable and valuable based on that person’s knowledge of how central banks will deal directly with individuals soon. Both predictions present potential knowledge repositories and knowledge gaps.

**Question 10: Do you think that blockchain should be regulated to assist financial institutions?**

![Figure 4.10: Blockchain regulation (own source)](image)

**Finding:** Figure 4.10 illustrates that most respondents (66.7%) believe that blockchain technology should be regulated. In the qualitative data analysis, the response to interview questions expands on this question i.e. the regulation of blockchain technology (*cf* Section 4.2.2).
Table 4.10: Blockchain should be regulated to assist financial institutions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>66.7%</td>
<td>22</td>
</tr>
<tr>
<td>No</td>
<td>21.2%</td>
<td>7</td>
</tr>
<tr>
<td>Don’t know, not too sure how it will assist</td>
<td>12.1%</td>
<td>4</td>
</tr>
</tbody>
</table>

Finding: In Table 4.10, some respondents (21%) believe that no regulation would assist with the implementation of blockchain in a bank, while four respondents (12%) state that they are uncertain if it would indeed play a role.

Interpretation: Most respondents believe that blockchain technology should be regulated. As mentioned above, the question concerning regulation and how it will be possible since the technology is built to have no regulation and to eradicate the intermediary, is further explored in the next section.

The above quantitative analysis and findings are the result of data collected by means of the online questionnaire that was sent out to individuals that have attended the Blockchain Africa Conference. These respondents are affiliated with the SABI, they have a knowledge interest in blockchain technology, cryptocurrency investors, miners, foundry members, and other individuals with knowledge of blockchain technology. The knowledge levels of the 33 respondents ranged from a knowledge interest to expert knowledge.

Next, the qualitative analysis was conducted to gain information on the status of the experts’ knowledge on the new technology of blockchain. Interviews were carried out among seven professionals, managers at the Chief Information Officer level, IT analysts and quality assurance departments in core banking segments to assess the opportunities and risks associated with using blockchain technology for financial services and to find an answer to the research problem.

4.2.2 Qualitative data analysis of interview with experts

This section begins with a brief reflection of what was said in Chapter 3 in order to explain how the researcher ensured the triangulation of data. The analysis is of data collected from the experts in a narrative form that includes the description and analysis of data scripted as the interview was conducted. Qualitative research tries to achieve a clear understanding of
the problem under review in a more complex way than a general way. To supplement the results and fill the gaps left in the questionnaire, the qualitative approach was used among experts in the field of blockchain in the SABI. The multi-method research design is useful for triangulation purposes. For example, whereas the quantitative data analysis was of the views of experts together with the views of others with a knowledge interest – not expertise – in blockchain technology, the qualitative data analysis focuses on the views of experts only. Since both the questionnaire and interview data collection methods have a knowledge-mapping agenda, the findings of the questionnaire can be compared to the findings of the interview, which can be compared to the literature review. For example, from the quantitative data, a finding was that most respondents believe that blockchain technology should be regulated. In this section, here the quantitative finding is now compared to the finding of the qualitative data analysis. The finding, quantitative and qualitative, is then measured against the literature review, that is, if literature is present. This technique allows for more substance for the triangulation of data.

The experts who participated in the interview held senior positions such as the Chief Information Officer, systems analysts and business analyst – business models, technical developers, solutions architects – processing models. All respondents were assured beforehand that their anonymity would be protected and that their participation in this study was voluntary. The information gathered from the various respondents was analysed to identify similarities and patterns. The results collected from the respondents provided an insight and understanding of the direction of blockchain technology applications for a banking institution such as the SABI. These results are used for knowledge-mapping.

The interviews were recorded and transcribed. Note-taking during the interviews was added to the transcribed results. Notes and transcribed results were scanned and saved on an electronic mail folder for safekeeping. The researcher utilised the case organisation’s electronic mail infrastructure to create a safe repository of communication with research participants.

The interview schedule was sent to the experts before the actual interview (cf Annexure C). This helped with conducting an organised interview and achieving content-rich data based on the interviewees’ knowledge. During the interviews, respondents went off the topic when some interview questions were posed. The governing research question was mentioned to
remind the respondents of the research purpose. Answers to questions were transcribed and saved on an electronic file.

The analysis presents the responses, and a final email of all transcribed responses was sent to the experts to verify all points discussed and to ensure that no important information was missed. The seven people in the different sectors of the financial institution in core banking will be referred to as:

- **Respondent A** – Chief Information Officer (1)
- **Respondent B1** and **Respondent B2** – Systems analyst and business analyst (2)
- **Respondent C1** and **Respondent C2** – Technical developers (2)
- **Respondent D1** and **Respondent D2** – Solutions architects (2)

The purpose was to find out how experts with the relevant background knowledge on blockchain in the financial institution would respond to the question on how the use of blockchain technology would change existing operations models and fill knowledge gaps in a banking institution. It entailed discussing the system processes, legacy systems and business operations for payments in the bank. The respondents’ view on the future direction of blockchain technology in banks was imperative for the interview. The method of analysis was the thematic analysis of interview data and it was analysed according to the Core Banking Application (CBA) pillar canvas, illustrated in Figure 4.11.
Figure 4.11: Qualitative data analysis technique (own source)
The process of qualitative data analysis entailed many readings of the interview transcripts to create Figure 4.12 at the end of this process. An analysis of all topics discussed during the interviews follows next.

**Question 1:** Is it important to define the difference between Bitcoin and blockchain in relation to each other? Please explain your first encounter in dealing with these technologies for one of the pillars in the core banking segments?

All respondents were aware of the difference between blockchain and its functionality and the cryptocurrency, Bitcoin. They all understood that blockchain was the technology behind Bitcoin. All shared knowledge of the principles of peer-to-peer systems. All respondents explained how users can transact directly without needing an intermediary. All their knowledge consisted of how transactions were verified by network nodes and recorded in a public distributed ledger called the blockchain. All respondents highlighted that the underlying blockchain technology of the different cryptocurrencies had the potential to disrupt the banking sector by taking over functions such as verifying payments in core banking.

Below is a discussion of the respondents’ first encounter in dealing with these technologies for one of the pillars in the core banking segments:

According to Respondent A, in the past two years (2015 to 2017) the individual started having several encounters with blockchain technology. In relation to various core banking aspects, the main segments and technologies that were affected were the sharing of core banking data with third parties over distributed networks, the investigation of workflows across third parties, reconciliation systems with financial intermediaries and setting up a Bitcoin exchange.

Respondent B1 shared the experience by stating: “*We have not made use of blockchain platforms in the core banking segments yet. However, one application would be to create a new decentralised version of the workflow platform that could be used in cases where an inter-branch/interbank shared transaction ledger would be useful, or in cases where smart contracts would be triggered by workflow events*” (sic).
Respondent B1 said another important project that every bank needed to launch, sooner rather than later, was a regulated decentralised exchange, and appropriate products for cryptocurrency users. Outside the bank, Respondent B1 had “worked with community members participating in the development of a proof-of-stake cryptocurrency called B3 Coin, to experiment with mechanisms to implement deflationary circulating supply through blockchain-wide coin decay, coupled with a Proof-of-Burn consensus algorithm” (sic).

Respondent B2’s first encounter was: “a business analyst introduced to blockchain by business-to-business, e-commerce in core banking as it was having common practice amongst these segments” (sic).

Respondent C1 and Respondent C2, had extensive encounters in terms of trading and capital markets and back-end processing. Respondent C1 had an opportunity to tackle forex, which had exposed the concepts of blockchain and how the implementation would affect payments. Respondent C1 mentioned that their first awareness about blockchain came about after many talks and presentations about the financial organisation being at risk. This led to in-depth research and experimentation based on blockchain in the core banking sector. In April 2017, the financial institution’s reasoning was that: “it represented an alternative idea to monies as its offering is known to the first digital currency being real on the market” (sic). Respondent C1 and Respondent C2 explained how research had sparked an idea on the future shape of money and Respondent C2 had invested in Bitcoin to check out the functionality and the hype around the cryptocurrency. Respondent C2 shared that “The technology and how it will affect banks in South Africa will be exponential” (sic).

Respondent D1 and Respondent D2 explained that their first encounter was through a settlement system using blockchain technology – it was to investigate if blockchain could be used for cheap and quick settlements.

**Question 2: Do you think that financial institutions will adopt a cryptocurrency known to be a third form of money?**

All respondents said YES, and three believed that it was unavoidable. All respondents explained that cryptocurrency exchange from a banking perspective provided validity and assurance to the “ecosystem [that] already has critical mass in adoption”, according to Respondent D1. It would be in the best interests of the banking sector to use existing
cryptocurrencies for payments and settlements between banks and other financial institutions, or to create specialised cryptocurrencies, like Ripple, for this purpose. The respondents were aware that these factors had to be considered, namely “lower transactions complexity and lower fees due to not requiring third-party clearance and verification” and the advantage of “enhanced auditing and security”.

Respondent A said that if all financial institutions used the “same shared blockchain platform for payments and settlements, like in the case of Ripple for instance, being a 100% accurate and auditable, hack-resistant, record of every transaction executed by all customers of these institutions, accurate to 8 decimal places”. (sic)

All respondents mentioned that forex played the greatest role in the core banking department. According to Respondent A: “It involves international money exchange and will seek to gain profits from this cryptocurrency to sustain its business model; third form of money will create an advantage to core banking [...]. This would also aid in [SABI’s] more awareness, accuracy, and govern the monetary policies [SABI] wish to implement regarding blockchain and cryptocurrencies. By creating third form of money it would generate [an] additional constant financial system without the need for communal self-assurance in banking sector. Main reason – it will promote increased financial inclusion with blockchain/Bitcoin involvement on payments” (sic).

According to all respondents in the B, C and D groups, they felt that financial institutions such as banks would issue a cryptocurrency. They said the only way for financial institutions such as banks to adopt cryptocurrencies would be when the central bank of the country issued a fiat-backed cryptocurrency. The central bank would be the only source or entity to issue the cryptocurrency, which could be used locally by banks and other financial institutions.

Respondent C1 said that money was already digital by explaining: “When exchanging money using blockchain, it’s nothing but digits in a database and it’s anonymous. Bitcoin’s database is secured by the most powerful computer network in human history. In a financial institute, what is securing bank’s database? Scarcity – no need for third form of currency. The more there is of something, the less it’s worth. Bitcoin is limited to 21 million units. Fiat currency can be infinitely inflated, effectively stealing purchasing power from the people who have worked to earn it. The best thing of Bitcoin is that one of the great promises of this technology
is anonymity – the transactions are recorded and made public, but they are linked only with an electronic address” (sic).

Question 3: What is the most meaningful debate for financial institutions between Bitcoin/blockchain?

Each respondent had an individual view on the debate about the benefits for the SABI in the long term. Respondent A thought that: “Bitcoin is irrelevant [but] cryptocurrency, as an alternative currency, must be accounted for” (sic). Respondent A explained: “Currently, it can be done with financial institutions involved and the risk of disintermediation of the financial institution and missed opportunity to generate revenue is too great to ignore” (sic).

The respondent’s knowledge coincided with that of “Mastering Blockchain” Bashir (2017), that there are no underlying financial fundamentals for the valuation of Bitcoin, and that it cannot be traded with any certainty. However, despite this, it has value by way of critical mass (Bashir, 2017:7). Financial institutions may avoid it, but it will retain value to users until the integrity is compromised (cf Reed 2016a; Reed 2016b; Section 2.5 and Section 2.6). Respondent A explained that the “technology for blockchain is far more meaningful and other reserve banks/financial institutions have already adopted it to some degree. The evolution of the transactional efficiency [and related cost] of a distributed network that maintains transactional integrity will make this a non-debate. It will likely be a minimum-entry criterion for [financial institutions] to remain competitive” (sic).

Respondent B1’s knowledge was portrayed by providing an institutional view and the respondent’s personal view: “The financial services industry [...] argue that cryptocurrencies are examples of blockchain applications, which offer little value to customers, promote illicit activity and risk being shut down by governments. There is also a belief among some in the financial services industry that blockchain platforms do not require integrated cryptocurrencies to be of value” (sic). Respondent B1 expressed personal counter-arguments to these points as follows (verbatim numbered list):

1. “Cryptocurrencies are extremely valuable to customers as they provide cost-effective means to transact with anyone, globally, cost-effectively and without the complexity of regular international fiat currency transactions. Well-designed cryptocurrencies like Dash, Monero and even Ripple, also tend to exhibit deflationary properties not seen in
traditional fiat currencies. It is believed that the demand for cryptocurrency usage and related products will grow over time.”

2. “While cryptocurrencies do make it more challenging for auditors and investigators to track money-laundering and other illegal activities, cryptocurrencies are here to stay whether anyone likes it or not. Therefore, it is much more constructive for regulators and authorities to work as closely as possible with cryptocurrency exchanges and developers to build infrastructure that aids in investigation and regulation.”

3. “Cryptocurrencies are technically immune from government interference. It is not that cryptocurrencies will not be shut down by governments, it is that cryptocurrencies cannot be shut down. There is no technical way to do it. The best governments can hope for is to develop effective regulation of gateway exchanges and ICOs [initial coin offerings]”.

4. “Blockchain platforms serve two high-level classes of use case: decentralised applications, where one wishes to create software systems resistant to external manipulation and interference. The P2P network layer of a blockchain platform is typically powered by shared computational resources offered by anonymous nodes in the network. Those anonymous nodes need to be incentivised to contribute computational resources to the network, and the blockchain’s cryptocurrency is the mechanism through which compensation is offered to contributing nodes through a trust-less consensus governed by the blockchain itself. And use cases involving transactional processes, which may be optimised by removing the need for third-party validation and/or witnessing. If a use case application does not benefit from being decentralised, or there is no need for trust-less interaction between anonymous parties, then there is no need to use a blockchain platform. A regular client server-based database application architecture will do.”

Respondents B2 and D2 said that the main debate arose from the overall distinction of the unregulated Bitcoin/cryptocurrency versus the regulated transactions of blockchain. Respondent B2 said: “Blockchain will create a fiat-backed cryptocurrency to be used within the country, which can be regulated by the central bank.” Respondent D2 said: “Bitcoin is unregulated, and it is excessively used within multiple countries hence the central bank and
exchange regulation rules will not allow banks to use these currencies. Bitcoin transactions can’t be tracked hence it poses AML [anti-money-laundering]” (sic).

Respondent C1 explained that the debate was whether to adopt Bitcoin as an accepted form of value for exchange versus having a custom implementation based on blockchain as a form of money/value. Respondent D1 said: “Absent a major change to the underlying Bitcoin code”, and “subject of a fierce debate among [Bitcoin] supporters”, the respondent believed that the cryptocurrency would be “too illiquid to use for normal day-to-day purchases [...] mostly be a store of value, a bar of gold instead of a Visa card” (sic).

Question 4: What properties of blockchain can be useful right now for financial institutions?

All respondents mentioned certain properties of blockchain technology that could be useful to financial institutions. Respondent A mentioned a “distributed data network that maintains transactional integrity with the transactional efficiency of a tradition networked application”. Respondent B1 said: “In the case of inter-bank transactions, the shared ledger of a blockchain – provided it is publicly accessible – offers a shared, standardised, and extremely accurate source of transactional reference data for auditors, regulators and investigators” (sic).

Respondent B1 mentioned lower fees and transaction complexity. Respondent B2 said: “Payment and settlement may be executed in a trust-less manner directly between participating parties without the need for third-party facilitation, validation and witnessing.” Respondent C1 mentioned the “reduction in cost may be kept as savings by the bank, or passed on to customers”. Respondent C2 explained: “More progressive [institutions] offering decentralised safe storage of funds using decentralised exchanges as core banking platforms, [these institutions] open their product offering to fan entire new market of potential customers that is global by default and not confined to the traditional segments of the local economy within which a bank normally operates” (sic).

Respondent D1 and D2 had similar answers. They said:” Blockchain can store any kind of digital information, including computer code that can be executed once two or more parties enter their keys. Blockchain technology enables users to have smart contracts” (sic).

The respondents explained that code could be programmed to create contracts or execute financial transactions once a certain set of criteria had been achieved, for example, “delivery
of products could signal a form of notification”, according to Respondent D1. Respondent D2 said: “The bank can gain by using blockchain for smart contracts. Value can be derived if blockchain is used to manage audit processes in the institution. Blockchain would allow the independent verification of one client by one organisation to be accessed by other organisations so the KYC process wouldn’t have to start over again. In summary [of what are the useful properties of blockchain technology]: distributed ledger, quick and cheap settlements, cryptographic security and anonymity” (sic).

Question 5: Which core banking department will adopt blockchain application quicker than other departments?

Respondent A’s prediction was that intra-bank transfers – SWIFT – would be the first to adopt blockchain application. Respondent B1 believed that eventually: “Once the hype has died down, departments responsible for inter-bank and international payment and settlement, will find value in the adoption of blockchain-based applications” (sic). Respondent B2 predicted that: “Departments responsible for integration with primarily external parties, where third-party participation may be eliminated, will also eventually find value in the use of blockchain-based applications, and/or decentralised ledger products, like R3’s Corda, that may or may not employ the use of blockchains” (sic). Respondent C1, Respondent C2 and Respondent D1 agreed on forex and PoP – Points of Presence and payments system of core banking. Respondent D2’s prediction was intra-bank transfers.

Question 6: How will blockchain affect the Internet of Value-Exchange for Core Banking Applications?

Many of the respondents needed clarification on the meaning of the Internet of Value-Exchange, but could respond with ease to this statement: “Some people may refer to blockchain as the Internet of Value-Exchange; what is your interpretation of ‘Internet of Value-Exchange’ and the implications?” The question was posed in this manner for the purposes of knowledge-mapping. Giving the respondents a chance to interpret the phrase and consider its implications would provide an opportunity to collect accurate data.

Respondent A said that: “Within core banking building infrastructure, for the Internet of Value in blockchain needs to be executed as there are two lenses to consider the coming changes
through. The first is the technical side, the issues that occur when a new technology is placed in an old infrastructure, which will then gradually change to accommodate the new technology. The second is the social aspect, and this will be quite far-reaching, as money is a technology used by all of society’s participants” (sic).

Respondent A’s prediction was: “At some point, cryptocurrencies will be easy and safe to use, to the point that mainstream users will not even notice the difference between them and fiat money currencies. [However], the technology is not ready, though many are laying its groundwork [referring to the names of] engineers and architects writing software and building its future infrastructure [and mentioning in general] writers and journalists learning and writing more about the challenges and opportunities. Lawmakers are trying to understand its implications. It is only the initial stages. One thing about the Internet of Value: everyone who wishes to can play a role” (sic).

Respondent B1 said: “If financial institutions implement decentralised exchanges, in place or alongside, their existing core banking platforms, then Value-Exchange will become quicker, cheaper, safer and easier to audit” (sic). Respondent B2 said: “Banks must consider what future is forecasted for the next 40 years from today” (sic).

Respondent C2 stated that blockchain would serve as a disruptive technology, which confirmed the opinion of Respondent C1, namely: “Competitors will compete profits away based on the competitors being early adopters and financial institutions playing catch-up. The chasm is yet to be crossed and the effect on Core Banking Applications is therefore volatility. A fast exchange of value will [render] existing Core Banking Applications obsolete in the future” (sic).

Respondent D1 explained: “Core Banking Applications are hardly going to be fazed by the mass adoption of blockchain. [However], the operational processes within these core systems might experience a significant improvement in efficiency in terms of execution on a business-as-usual scenario. This is like any form of technology stack changes that happen in the bank, such as changing from Cobol programming to Java, now Node JS, or any type of scripting languages” (sic). Respondent D2 said: “There will be bigger impacts to core banking products from adopting cloud services and mobile computing platforms” (sic).
Question 7: What will be a potential business case for implementing a blockchain in financial institutions? Please discuss one business use case that is most likely to be adopted in core banking.

Respondent A did not discuss a practical use case but said: “It affects departments in core banking such as SWIFT, crypto exchanges that will need to derive a potential use case for the implementation to be effective.” Respondent B1 explained: “The most valuable blockchain use case in the financial services industry right now, from a customer’s point of view, would be a decentralised exchange. Decentralised exchanges ‘are’ the new banks. Existing banks and financial services companies can capitalise on this opportunity and build new core banking platforms, on top of other decentralised exchanges, or decentralised exchanges that they design and build themselves” (sic). Respondent B2 and Respondent C1 stated what all banks and financial institutions should be focusing their blockchain efforts and resources on.

Respondent C2 mentioned various options from a developing technical perspective, adding: “A business case would be an improved audit by implementing a blockchain-based database such as Big Chain. This provides features such as decentralisation, immutability — (gesturing and emphasising that this was most important) and the ability to treat anything stored in the database as an asset.”

Respondent D1 said: “Core banking is most likely to adopt blockchain by means of smart contracts which will be a complementary asset to IoT. Back-up saving on costs, no lost details use case that would address this issue within core banking. International bill of lading digital documentation avoiding different parties involved” (sic). Respondent D2 said: “Asset transfer on a transparent ledger within the banking community in a bank. There will be no need to do KYC or other ownership transfer-related delays as the transfer of ownership is transparent” (sic).

Question 8: What are the main challenges faced by a core banking segment implementing blockchain technology?

Respondent A said that the major challenges were: “Integrity of blockchain system, intra-country data ownership, regulation and governance of transactions”. Respondent B2 echoed Respondent A’s reply and added that there were many challenges: “On a broader topic of how it will affect banks soon to begin with, the challenge is to ensure that blockchain platforms are
in fact suitable for selected use cases” (sic). Respondent B1 said: “The technical effort required to successfully and safely deploy blockchain applications is considerable. There also tends to be a gap in awareness among both IT and business, regarding the range and scope of decentralised application platforms available. Most people only know about blockchain platforms, and even then, current general awareness tends to only include Ethereum and Ripple, and more recently JP Morgan’s Quorum” (sic).

Respondent B2 explained: “There are other more advanced decentralised application technologies that offer improvements over blockchain, such as Tangle networks, invented by IOTA, and hash graphs invented by Swirlds. For instance, for decentralised ledger applications, hash graphs are better than blockchains, and so one might consider using the Swirlds hash-graph platform, rather than the Ethereum blockchain platform. Or even R3’s Corda decentralised ledger. Similarly, where a blockchain [is considered] an appropriate technical solution for a use case, there are much more advanced blockchain platforms available, other than Ethereum, such as Lisk, or even NEO in an Asian market context” (sic). Respondent B2 said in summary: “Change is the ultimate challenge to all customers and employees of the bank.” Respondent C1 said the main challenges were: “Risk concerns in delving into an unknown domain, lack of understanding of how blockchain fits into Porter’s Five Forces, collaboration within the segment to best understand how to implement the blockchain technologies.” Respondent C2 said: “New technology leads to costs of upskilling within the bank that will affect customers to employees utilising the new technology implemented.” Respondent D1 mentioned: “Mass adoption of the technology. The main challenge is regulating the cryptocurrency and how to use it beneficially within the banks for a great return on investment.” Respondent D2 underscored Respondent D1’s reply and added that the challenge was: “Regulation from SARB”.

The last comment from Respondent D2 brings the reporting of the interview data to an end. The above qualitative data reveals the respondents’ view on the use of blockchain technology in the context of a financial institution.

Next, Figure 4.12 presents a visualisation of the thematic analysis of interview data. The thematic analysis is done according to the CBA pillars as illustrated earlier in Figure 4.11. Data from the questionnaire and interviews were triangulated, for example, data analysis in Table 4.7 indicated that the three most perceived reasons for a financial institution’s internal
resistance to change were related to issues of regulatory and compliance, privacy and security, and a lack of knowledge and technical know-how on blockchain application in a financial institution. From the qualitative data analysis, it was evident that respondents had the issue of regulation foremost in their minds. Thus, “Regulation” is highlighted in Figure 4.12 as a major knowledge focus area. Identifying which stage a blockchain innovation falls into will help executives to grasp its challenges, the level of collaboration needed and the regulatory and legislative efforts required. The map will also suggest processes and infrastructure needed to facilitate adoption. Managers can use the map to evaluate the state of blockchain development in any industry and to assess investments in their own blockchain capabilities.

Regulation is a focus area prompted by the cryptocurrencies’ multiple operational implications for financial institutions (cf Chapter 2). The respondents in this study questioned the credibility of Bitcoin operations and were concerned about privacy and security, but they agreed that blockchain technology had captured the attention of financial institutions. Blockchain offers a platform for the sharing of a cryptocurrency and to its end users on a public/private network, its shared ledger for recording the history of transactions. Respondents debated the implementation and practice of blockchain in a financial institution. Various knowledge areas emerged from the interview responses; these areas were triangulated with data from the questionnaire. In Figure 4.12, an example of a knowledge area is “Customer first experience” positioned or contextualised in the CBA pillar, “Consumer Facing”.

Figure 4.12: Knowledge areas across Core Banking Application pillars (own source)

**Consumer Facing**
- Customer first experience
- Third form of money
- Integrity of blockchain system

**B2B Services**
- Bitcoin is irrelevant
- Security and fraud
- Payments system

**Trading & Capital Markets**
- Transactional integrity
- Cryptocurrency exchanges
- Regulated decentralised exchange

**Back-end Process**
- Distributed networks
- Reconciliation systems with financial intermediaries
- Settlement systems

**International Trade & Intermediaries**
- Bitcoin exchange
- Governance of transactions
- Interbank transfers SWIFT
- Intra-country data ownership

**Chief Information Officer**
- Customer change implications

**Solution Architects**
- Blockchain applications, little value
- Third form of money
- Adoption change

**System / Business Analyst**
- Payments system
- Decentralised Exchange

**Technical Developers**
- Smart contracts
- Third form of money

**KNOWLEDGE FOCUS AREAS**
- Third form of money
- Customer change implications
- Payments system
- Regulated exchanges
- Settlement systems
- Governance of transactions
Figure 4.12 is a first step towards knowledge-mapping, it is not a map of relevance to all financial institutions; it applies to the SABI, a South African banking institution. The inductive research approach leads to the following interpretation: Financial institutions will use the foundational blockchain technology for beneficial use for a great development on a new breed of transactional business applications designed to embed trust, transparency, efficiency and accountability into the process of sharing and transferring a broad range of assets in a business network.

Small businesses that use blockchain technology are not limited to one aspect of the functionality, it can range to offering payments in cryptocurrency; assist with transferring or exchanging of financial assets via a blockchain network more efficiently. It will allow greater collaboration and less risk to shareholders, compared with customary traditional practices. There is also a growing consensus among many industry experts in the financial services industry that blockchain technology will have a profound effect on the industry in the coming years. However, there are many implications for this new disruptive technology. A perspective on blockchain technology adoption should be addressed, bearing in mind its future implications on competition, regulation and technology investment priorities in financial institutions.

In summary, there is a certain amount of hype in the financial industry and there’s a clear indication that the hype surrounds blockchain, which is the underlying technology for cryptocurrencies such as Bitcoin. It poses several challenges to the banking sector by allowing rapid, protected and additional apparent transactions. Blockchain is the distributed ledger technology initially generated as a tracking database for Bitcoin transactions. Nearly all IT aspects will be almost consistently controlled by non-banks; other segments will be better within the structural ecosystem of a bank if they incorporate disruptors such as Bitcoin to the financial industry. In view of the impact of blockchain and the use of Bitcoin, consumers will benefit as the financial industry sectors will compete for innovations and the provision of customer experiences. Foundational technology creates the need for change and change is a business driver for many financial sectors that will be faced with this issue. A deep knowledge of this new driver must be developed.
Many knowledge areas have been identified and they signal a need to focus on knowledge production in the CBA areas. For example, by using information and knowledge management principles, knowledge-mapping in the banking industry will begin the process of addressing certain application areas that will provide a comprehensive understanding of digital currencies and its underlying technology, that is, the blockchain, and why this foundational technology will be partly responsible for an industrial revolution. The emphasis will be more management-oriented and there will be a greater emphasis on blockchain technology assisting inherent systems.

This will allow users, such as the employees of a financial institution, to discover strategies and gain insights into the future of blockchain in terms of innovations and disruptions of existing traditional systems and processes in financial institutions. The current situation for implementing blockchain technology in a financial institution is to design sound architecture and map correct processes. The correct approach will allow for the organisational readiness for change. It will become increasingly important to answer knowledge-mapping questions aimed at the accurate democratisation of finance. Regulation was identified as the main knowledge focus area. The knowledge focus areas include:

- Third form of money
- Customer change implications
- Payment system
- Regulated exchanges
- Settlement systems
- Governance of transactions

Blockchain is emerging as a potentially disruptive technical force that can convert the financial services industry by expediting transactions – it is quicker, inexpensive, more secure and transparent. The costs of implementing blockchain technology in banks will reap profits for the financial institutions. International payments are a prime example. The knowledge areas identified in the CBA pillar, “International Trade & Intermediaries” in Figure 4.12, illustrate what has been said by Laurence (2014) and Wattenhofer (2016), that true change in business sectors is not affected by new technology. Instead, it is down to the change in the business model that technology can affect (Reed, 2016a; Ranger, 2018). Financial institutions might need to implement new information and knowledge management strategies to reap the
benefits of foundational technology in their future business models. It will be difficult to enter the market once the foundational technology has formed a monopolistic environment (Young, 2015; Reed 2016a).

Figure 4.12 identifies knowledge areas in line with the explanations of Young (2015) and Adams (2016), that the early disruptors in financial services need to introduce greater transparency to compete. Foundational technology introduces greater transparency, freedom of exchange and greater choice (Young, 2015; Adams, 2016). According to O’Dwyer (2015), and Warner (2016), blockchain has set the wheels in motion for a revolution in many sectors.

Figure 4.12 identifies knowledge areas relating to systems. For example, current systems have been created on dependable inheritance solutions whereas new knowledge needs to be attained on how a foundational technology process will shift. Figure 4.12 presents a knowledge-mapping method to advance the blockchain landscape. It demonstrates results gathered from a section of the SABI’s core banking team. Knowledge-mapping is part of the process of achieving the SABI’s envisaged outcome to certify a fruitful change-over from centralised inheritance to fully distributed digital transaction processing.

Based on this study’s quantitative and qualitative data analysis of the knowledge of people affiliated with the SABI, it seems that the financial sector will experience increased competition as a result of blockchain technology, also referred to as the “Internet of Value-Exchange”. This notion is reflected by the words of Bashir (2017:7) that blockchain technology will transform the industry and “the balance of power within the relationship between the consumer and the providers of financial services will have fundamentally changed due to disruptors”. Knowledge-mapping will help financial institutions to find better alternatives to tackle the disruption caused by blockchain technology.

4.3 Chapter summary
This chapter discussed the research findings. The fundamental reason for the questionnaire was to obtain a substantiated view of the knowledge requirements on blockchain being implemented in financial institutions. Knowledge-mapping assists financial institutions by identifying knowledge areas and potential implications for the SABI, which it needs to approach proactively.
Firstly, the quantitative data analysis presented data that was useful for triangulation to identify knowledge areas during the second phase of data analysis. Secondly, the qualitative data analysis promotes SABI’s focus on relevant knowledge areas. This methodology has allowed a description and comparison of results across the CBA pillars of the SABI according to the knowledge of respondents, summarised in Figure 4.12.

In the statistics gathered by the questionnaire responses, the targeted sample contained a mix of respondents with varied levels of knowledge of blockchain technology, cryptocurrency and mining, ranging from a knowledge interest to expert knowledge. This approach was necessary to maintain an objective approach that could assist in mapping the SABI’s knowledge regarding blockchain adoption and potential risks that must be considered. In the rich data gathered by the interview responses, the targeted sample was SABI employees with expert knowledge. These respondents represented an informed view to foundational technology adoption over time, which gave a balanced perspective of direction in which blockchain developments will move for the financial services industry. Both the statistics data and the rich data was useful for knowledge-mapping and resulted in Figure 4.12.

Figure 4.12 lists knowledge areas in relation to activities across the five CBA pillars viz customer facing, business-to-business, trading and capital markets, back-end processing and international trade and intermediaries. The knowledge areas identified in each of the CBA pillars show which departments and products are most likely to be affected and which could be improved on to provide a competitive advantage or to gain an interest in adopting blockchain technology.

Figure 4.12 shows which knowledge areas will be most useful in terms of how blockchain technology will change existing operations models. The technique of knowledge-mapping presented in this chapter might possibly help the SABI departments to fill the knowledge gaps that exist in the institution with certain roles and responsibilities.
Chapter 5

Conclusion and recommendation

5.1 Introduction
This chapter concludes the study of knowledge-mapping of blockchain technology applications for a banking institution. A knowledge-mapping mindset engages such questions as, “What do you need to know?” and “What barriers or issues exist?” (Driessen, 2007:109-114). The previous chapter applied a mixed-method research methodology in order to execute the study’s blockchain knowledge-mapping strategy, which has resulted in the identification of knowledge areas across Core Banking Application pillars, illustrated in Figure 4.12. Figure 4.12 is a first step towards knowledge-mapping; it was based on quantitative and qualitative data collection and analysis to formulate a conceptually rich blockchain knowledge-mapping theory.

This chapter presents a blockchain knowledge-mapping theory that has been informed by Tandulwadikar’s (2016) “Blockchain in banking: a measured approach” and the account of Meszaros et al (2016) of how banks require blockchain technology, as a form of distributed ledger technology. The purpose of Chapter 5 is to summarise the research findings, present a new blockchain knowledge-mapping theory and interpret the limitations of the study. The study’s recommendation follows to reach a research conclusion and chart a direction for future study.

5.2 Summary of research findings
Blockchain technology has the potential to transform the financial services industry by making transactions faster, cheaper, more secure and transparent, as discussed in Chapter 2. There is a foundational view on how the financial markets are taking shape and what financial institutions need to consider as they move from initial investigation to pilot deployments in their core banking applications. The financial services industry needs to come together and set standards that enable interoperability to realise the full potential of blockchain across the financial system, as discussed in Chapter 2.
Chapter 4, the research findings, identify the knowledge areas across the Core Banking Application pillars in Figure 4.12, which shows that if a financial institution is planning to adopt blockchain technology, it must develop a series of knowledge areas first.

To develop its knowledge areas, a financial institution should begin by asking knowledge-mapping questions such as:

- “Given that existing systems are built on reliable legacy solutions, how will [banks] determine which process to move to a blockchain?”
- “What is our plan of action; experimenting, visualisation, strategy deployment, scaling, logical progression, in order to ensure a successful transition from [bank’s] centralised legacy to fully distributed digital transaction processing?”

The above considerations indicate that blockchain will introduce new ways of banking in the future. Respondents voiced concerns and debated the topic of regulation. Although the FSI might be wary of some cryptocurrency, this study shows that the distributed ledger technology of blockchain has captured the attention of a South African financial institution.

This is mostly due to the “foundational method” of “verifying and tracking transactions,” says Tandulwadikar (2016), stating that “instead of a trusted third party or a central bank, it relies on consensus among a peer-to-peer network of computers based on complex algorithms. Rather than being stored in a single database, blocks of time-stamped transactions are stored on all systems across a value chain.” This elimination of middlemen and decentralisation of trust has introduced many possibilities to make processes such as “cross-border payments, trading and settlement faster, more reliable and less costly” (Tandulwadikar, 2016).

This study identified the following knowledge focus areas—a third form of money, customer change implications, payments system, settlement systems, regulated exchanges and governance of transactions. The issue of “Regulation” was highlighted as a key knowledge focus area in the development of the Internet of Value-Exchange. The study had an inductive research approach and it developed a blockchain knowledge-mapping theory, namely:

*If the blockchain knowledge maps of financial institutions integrate knowledge across Core Banking Application pillars, then the financial services industry will create an Internet of Value-Exchange advantage for everyone on the network.*
The answers to the four sub-questions elaborate on the study’s blockchain knowledge-mapping theory:

1. **Why is the knowledge of blockchain technology necessary in the financial services industry?**

   The review of literature shows that financial institutions incur changes caused by blockchain technology, for example, knowledge of how the foundational technology exemplifies the storing of “data in multiple locations rather than one central location” (Blockchain Africa Conference, 2017), which means South African financial institutions should change the way they operate. New partnerships and collaborations among the FSI and other stakeholders will have to occur to leverage off the shift caused by blockchain technology.

2. **What is the perceived role of blockchain technology in changing the financial services industry?**

   The review of literature shows that knowledge of blockchain is an important key to unlocking blockchain's potential to create a new economy built on interoperability (Swan, 2015; Bashir, 2017). Financial institutions “need to get started by creating plans to enable blockchain technology to co-exist with their legacy run-the-bank systems” (Tandulwadikar, 2016).

   The findings of this study of participants’ knowledge of blockchain technology, indicate a debate among respondents which shows that blockchain technology is not a mature platform yet. The respondents’ knowledge of blockchain technology at the time of this cross-sectional study reflects Tandulwadikar’s (2016) notion that blockchain technology is “robust enough to replace existing banking systems”. For example, the interview findings indicate that blockchain technology is perceived by South African financial institutions as a technology that has a strong potential for payment transactions. It would also “reshape the current banking processes” and knowledge of blockchain technology will lead to “cost savings”, according to the SABI experts. In trade finance, knowledge of blockchain technology could give rise to accelerated digital transformation. The segments in core banking will improve on providing trust, security and quicker processing at reduced costs. The automation of contracts will help
with saving costs through lean processing by implementing or experimenting with use cases in the core banking areas. These core banking segments will require the knowledge-mapping of blockchain technology as it will help to build a solid foundation on concepts for implementation.

3. **What are the knowledge gaps in blockchain technology identified in a financial sector?**

   The review of literature shows that experiments will lay the foundation of blockchain’s application in the FSI (Meszaros et al, 2016; Tandulwadikar, 2016). This will start with the kind of standards and protocols that must be established for the building of a future blockchain or blockchains. It will be important for “financial institutions and technology providers [to] feed off each other’s ideas and experiments while identifying areas of focus and avoidance. This will allow banks to identify and build key skill sets and use the collective knowledge to create a blueprint that will ease the seemingly inevitable transition to a blockchain-driven future” (Meszaros et al, 2016).

   The findings of this study of participants’ knowledge of blockchain technology, point toward the challenges that will soon arise and the need to deliberate on the role of regulation. For example, financial institutions will have to deliberate on redefining business models, how to manage the transition process from the old phase to the new phase of processes that will ideally and efficiently incorporate blockchain solutions in banks. The key to achieving knowledge-mapping in a bank’s Core Banking Applications is for regulators to establish the legal framework it requires. Financial institutions should closely monitor future and current market developments where third parties are exploring the foundational technology.

4. **What current application areas will be utilised to assist possible future implementations for the blockchain technology in a banking institution?**

   The findings of this study of participants’ knowledge of blockchain technology highlight the view that distributed ledgers have applications that are real-time, open source platforms, and of most value for data transmission. These applications will be useful to financial institutions in terms of the lower cost of processing payments. In
the words of one of the respondents interviewed, “technology will only work if everyone adopts it” (verbatim).

An analysis of the SABI’s respondents’ knowledge of blockchain technology show that there is an interest for the investigation, experimentation, implementation and practice of blockchain technology in the South African financial services industry. Financial institutions will use blockchain’s foundational technology for its benefit, not only in a “narrow” sense but in terms of broader developments or applications. For example, a “business blockchain” does not have to be limited to currency exchange. Instead, financial institutions should see the application of blockchain technology across its Core Banking Application pillars and how it applies to the exchange of value in these areas:

- Customer-facing
- Business-to-business
- Trading and capital market
- Back-end processing
- International trade and intermediaries

In summary, the theory that has been developed by this study of knowledge of how the utilisation of blockchain technology changes existing operations models of financial institutions, emphasises the integration of knowledge across Core Banking Application pillars.

5.3 Limitations

This study was restricted to the investigation of only one of the more than five major financial institutions in South Africa. The researcher conducted interviews with the SABI’s blockchain experts in Johannesburg (Gauteng), which is the technological hub of the SABI, nonetheless it excluded experts situated elsewhere. Furthermore, there was a limited number of SABI’s acknowledged experts in the field of blockchain technology and cryptocurrency. As the population of SABI’s experts is relatively small, it increased the difficulty of finding respondents to participate in knowledge-mapping methodology.

The topics, “blockchain technology” and “knowledge-mapping” could have led to a financial institution imparting sensitive information and it could very well be that certain information was withheld during the qualitative data collection process. The implementation of blockchain in a financial institution such as SABI is mostly in its trial-and-error phase and
respondents might not have disclosed specific information. For this reason, Figure 4.12 makes reference to generic areas, nonetheless the illustration serves the purpose of achieving the research objective, namely to identify knowledge categories within CBA pillars that might yield crucial knowledge during the later phases of blockchain technology deployment in a financial institution.

5.4 **Recommendation**

This study recommends two initial steps to test the theory that the financial services industry will create an Internet of Value-Exchange advantage for any interested party when the blockchain knowledge maps of financial institutions integrate knowledge across Core Banking Application pillars. The first step is to identify blockchain knowledge gaps in the CBA pillars of financial institutions. The second step is to build knowledge repositories across the CBA areas of financial institutions.

The key recommendation to assist the SABI with blockchain knowledge-mapping is to:

- Avoid a narrow focus on currency exchange and to develop knowledge repositories of use cases for the foundational technology’s role in Value-Exchange.
- Engage with the issue of regulation and collaborate with the FSI and other role players to develop frameworks.
- Integrate knowledge areas across Core Banking Application pillars which could help the SABI to streamline its processes and reduce costs.
- Identify, acknowledge, and fill any blockchain knowledge gaps, not only to maintain a competitive advantage, but to leverage off competitive intelligence in terms of blockchain knowledge.

5.5 **Future studies**

This is only the early stages of the FSI’s adoption of blockchain technology and there are several opportunities for future studies. For example, a financial institution such as the SABI, has knowledge gaps to investigate. Tandulwadikar (2016) said: “Blockchain presents new ways of working and a new set of internal and external challenges,” which means that the FSI has to “overcome hurdles ranging from building a business case and handling government regulations to creating a cultural fit for adoption”. This study emphasises the need for business use cases of blockchain technology adoption.
Future studies should investigate how best to approach blockchain knowledge-mapping. For example, South African higher education institutions and business schools should develop business case studies with blockchain thought leaders. The way financial institutions handle challenges will shape their future path. The application of blockchain technology in financial institutions presents many opportunities for future knowledge-mapping studies.

5.6 Research conclusion

Technology generally advances traditional modes of operation and although some people perceive new technologies as disruptive, most people find technological developments useful in their day-to-day operations. The goal of this study was to map the existing knowledge of blockchain technology’s current application areas and to identify its possible application areas in a South African Banking Institution. The best possible use of a new technology depends on how quickly people can develop and apply new knowledge on how to leverage off the technology’s most useful features and know how to avoid its pitfalls.

Knowledge-mapping is the practice of information and knowledge management principles associated with knowledge categorisation, knowledge audits, knowledge maturity levels, knowledge gap analyses, processes of translating and transforming tacit knowledge to explicit knowledge, organisational learning, knowledge mentoring, and knowledge-sharing. Knowledge-mapping is one of many techniques of embarking upon a new technology in a structured manner. This study developed a blockchain knowledge-mapping theory to serve as a first level of future blockchain knowledge-mapping models of the SABI. This theory might also serve other financial institutions on the African continent.

Financial institutions in Africa must take advantage of blockchain – it is a foundational technology and knowledge of blockchain technology is key to its application in financial institutions. This conclusion is based on a literature review and an empirical study. Literature describes blockchain technology as a “disruptive technology” and a “foundational technology” that will affect the world of money and financial transactions. It is based on the principles of decentralised data and privacy protection on a distributed ledger, peer-to-peer transactions, transparency linked to pseudonymity, irreversibility of records, and the computational logic to assist possible future implementations for blockchain technology in the FSI.
In conclusion, the study conceptualised a blockchain knowledge-mapping theory which will be useful for developing use cases that are vital to the researched case institution’s future blockchain applications and to the FSI at large. Developing knowledge maps gives people and organisations a competitive advantage. This study concludes by emphasising the importance of “everyone on the network can see” in the words of Frøystad and Holm (2015), that blockchain technology provides a “decentralised database or ledger of transactions that everyone on the network can see. This network is essentially a chain of computers that must all approve an exchange before it can be verified and recorded.” If the blockchain knowledge maps of financial institutions integrate knowledge across Core Banking Application pillars, then the financial services industry will create an Internet of Value-Exchange advantage for everyone on the network. This theory must be thoroughly investigated because it will shape the future business of banking institutions.
Reference list


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**ANNEXURE A**
**Research ethics clearance**

**FACULTY OF MANAGEMENT**
**FACULTY ETHICS COMMITTEE (FEC)**
**RESEARCH ETHICS CLEARANCE FORM**

<table>
<thead>
<tr>
<th>RESEARCH COMPLIES WITH</th>
<th>COMPLIANCE</th>
<th>NON-COMPLIANCE (flagged issues that need closer scrutiny)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants’ right to privacy, confidentiality and anonymity</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>Participants’ right to equality, justice, human dignity/life and protection against harm</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>Participants’ right to freedom of choice, expression and access to information</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>Participants’ right to be informed, consent/letters of request</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>Rights of the community and the scientific community</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>The responsibility of presenting data that is accurate, truthful and not falsified</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>The responsibility of acknowledging ownership of ideas, theories, contributions or concepts</td>
<td>YES</td>
<td></td>
</tr>
</tbody>
</table>

**OVERALL RATING**

<table>
<thead>
<tr>
<th>CODE 01 - Approved</th>
<th>CODE 02 - Approved with suggestions without re-submission</th>
<th>CODE 04 - Not approved, re-application required</th>
</tr>
</thead>
<tbody>
<tr>
<td>CODE 03 - Suggestions with re-submission</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FACULTY ETHICS CODE:** FOM2016-IKMNov2016_1

**STUDENT NAME:** Natisha Sewpersadh

**SIGNATURE:** N. Sewpersadh

**SUPERVISOR NAME:** Prof T du Plessis

**SIGNATURE:** __________________________

**CO-SUPERVISOR NAME:** n/a

**SIGNATURE:** __________________________

**PF CHAIR SIGNATURE:** __________________________

**DATE:** 11 November 2016

**HOD SIGNATURE:** __________________________

**DATE:** 14 November 2016

**FHDC CHAIR:** __________________________

**DATE:** __________________________

*Original signed form on file with CBE HDC (celoff@uj.ac.za).*
Access: The financial institution agreed to assist the researcher; the researched institution allowed access and research participants agreed to participate in the knowledge mapping of blockchain technology applications (cf anonymised email communication).

Informed consent: Chief Information Officer, Head of Workflow application, Core Banking applications
Informed consent: Examples of System/Business Analysts; Bitcoin Miners and attendees International Blockchain Africa Conference (2017)

Informed consent: Example of Technical Developer
Informed consent: Example of Solution Architect – Processing Models

Hi Natasha,

It would be my honour to partake in this survey.

Eagerly awaiting more info.

---

Dear [Name],

Thank you for your email. I am writing to confirm that you and your colleagues from [Company] are willing to assist and support the interview scheduled as part of the research study to increase our understanding of how the use of blockchain technology can change existing operational models and fill knowledge gaps that exist within the financial institution's [Department].

With prior knowledge of this foundational technology and its uprising within banks, you are in an ideal position to give valuable first-hand information from your own perspective and experience. The interview will take around 30 minutes of your time; I am simply trying to capture individual thoughts and perspectives based on the foundational technology and future use cases to implement. Your participation is greatly appreciated.

Best regards,

[Your Name]
1. Is it important to define the difference between Bitcoin and Blockchain in relation to each other?

**Follow-up:** Please explain when was your first encounter dealing with these technologies for one of the pillars in core banking segments.

______________________________________________________________________________

________________________________________

______________________________________________________________________________

________________________________________
2. Do you think that financial institutions will adopt issuing a cryptocurrency known to be a third form of money?

Follow up:

a) Yes – please give a reason specific to which core banking segment will be affected initially?

b) No – please give a reason specific to which core banking segment will be affected initially?

3. What is the most meaningful debate for financial institutions between Bitcoin/Blockchain?

__________________________________________________________________________

__________________________________________________________________________

4. What properties of blockchain can be useful right now for financial institutions?

______________________________________

______________________________________

Follow up:

a) If the properties of blockchain are not useful, what alternative substitute technology could serve blockchain adoption?

5. Which core banking department will adopt blockchain application quicker than other departments?

______________________________________

6. How would blockchain affect the Internet of Value-Exchange for core banking applications?

_______________________________________________________________________________

_______________________________________________________________________________

7. What would be a potential business case for implementing a blockchain in financial institutions?

Follow up: Please discuss one business use case that is most likely to be adopted within core banking.

_______________________________________________________________________________

_______________________________________________________________________________

8. What are the main challenges faced to the most affected core banking segment utilising blockchain as technology implemented?

_______________________________________________________________________________

_______________________________________________________________________________
Knowledge Mapping Blockchain Technology

Blockchain technology applications for Financial Institutions

New technologies have radically altered front-office functions for investment banks, bringing unprecedented efficiency gains and new business opportunities. The latest technology, blockchain, has grabbed attention in the tech world. While still relatively new to the financial space there is an intense interest for the implementation and practice within the financial sector.

The focus of this study is to map knowledge by gathering information on how will blockchain technology change existing operations models and fill knowledge gaps that exist within the Financial Institution.

1. Please specify your gender
   - Male
   - Female
   - Other

2. Please specify the age group
   - 20 years or younger
   - 21 years - 34 years
   - 35 years - 54 years
   - 55 years and above

*3. Do you own any cryptocurrency?

Yes, please specify which cryptocurrency ________________________________

No, please explain why _________________________________________

4. How likely did you know that the technology platform (blockchain) supports Bitcoin (cryptocurrency), which can be used for any type of digital transaction not just Bitcoin?
   - Extremely likely – Understand the full logic of how blockchain works
   - Very likely – Yes, but need to do more research on the know how's of digital transacting on blockchain
   - Somewhat likely – Just heard of it not much knowledge on the application
   - Not so likely - Just know about it because of the hype recently
   - Not at all likely

*5. Which of the following blockchain start-ups / platforms do you recognise?
6. Do you understand the blockchain technology concept that supports the phases such as inception, verification, and security of blockchain transactions?

- I understand the conception phases
- I only understand certain phases
- Not at all
- Please specify which phase you are more familiar with

7. What would be banks' reasons for internal resistance adopting blockchain technology?

- Regulatory and Compliance
- Support
- Privacy and Security
- Lack of Internal Buy in
- Lack of Network
- High Additional Costs
- Lack of Knowledge and Technical Know How’s on blockchain application
- Use of blockchain is known for assisting illegal transactions
- New cultural and change adoption
- Distrust blockchain application
- Other (please specify)

8. What are the major anticipated blockchain drivers that will impact a financial institution in the near future?

- Reduce total cost of ownership
Easy management of record sharing systems
Faster transaction clearing and settlement
Easy to create electronic transactions on your own
Lower Administrative costs
New Revenue opportunities
Reduce Duplication record keeping
Uniting employees and agreeing on the communication and data standards

9. When do you think blockchain technology will be adopted into the financial services industry?
- In the next 1 - 3 years
- 3 - 5 years
- More than 5 years
- Not too sure, cannot predict
- Never
Please explain your answer:

10. Do you think that blockchain should be regulated to assist financial institutions?
- Yes
- No
- Don't know, not too sure how it will assist

https://www.surveymonkey.com/analyze/lF_2B6OFofTH4vxlE8LCP8vbguddbkKVxrlzKzaW9mHCc_3D
Summary

- Respondent A - Chief Information Officer (1)
- Respondent B1 and Respondent B2 – System Analyst and Business Analyst (2)
- Respondent C1 and Respondent C2 – Technical Developers (2)
- Respondent D1 and Respondent D2 – Solution Architects (2)

Respondent A - Chief Information Officer

Respondent B1 and Respondent B2 - System Analyst and Business Analyst

Respondent C1 and Respondent C2 - Technical Developers

Respondent D1 and Respondent D2 - Solution Architects

–END–