DISRUPTIVE TECHNOLOGIES IN THE LOGISTICS AND SUPPLY CHAIN INDUSTRY:
A STUDY ON BLOCKCHAIN

BY

CHRISTABEL A. OMOLLO

UNITED STATES INTERNATIONAL UNIVERSITY-
AFRICA

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CHRISTABEL A. OMOLLO

A Project Report Submitted to the Chandaria School of Business in Partial Fulfillment of the Requirement for the Degree of Masters in Business Management (MBA)

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STUDENT’S DECLARATION

I, the undersigned, declare that this is my original work and has not been submitted to any other institution, or university other than the United States International University-Africa in Nairobi for academic credit.

Signed: ______________________  Date: ______________________

Christabel Omollo (ID 657558)

This dissertation has been presented for examination with our approval as the appointed supervisors.

Signed: ______________________  Date: ______________________

Prof. Francis W. Wambalaba

Signed: ______________________  Date: ______________________

Dean, Chandaria School of Business
ABSTRACT

The purpose of this research was to examine the capabilities of blockchain technology in logistics and supply chain management. The research was aimed at investigating the unique feature of blockchain technology that made it useful in logistics by answering the following research questions; how can Blockchain technology improve the flow of goods or information in the logistics sector, how can the capabilities of Blockchain technology meet the needs of privacy, transparency and trust in logistics and the challenges in implementation of blockchain in logistics.

The research was carried out in the form of a descriptive qualitative research design. The study was done at Logistics Ltd, a pseudonym for a firm that operates in the logistics and supply chain industry. The sampling frame was drawn from the 531 employees of Logistics Ltd as at May of 2019. Purposive sampling was used to select 70 employees working in senior management, information technology, and operations departments of Logistics Ltd. The qualitative data was collected by conducting interviews and was thereafter summarized, coded and analyzed by use of thematic content analysis.

With respect to blockchain technology improving the flow of goods and information in the logistics sector, the study established that blockchain improved the flow of goods and information in the logistics and supply chain industry by enabling the ease of paperwork processing, facilitating tracking of the origin of goods and services and delivery of an end to end system that governs and secures business networks. The findings reflect that blockchain, with its decentralized solutions and simplified access rights provided a solution to IT systems that were outdated and too complex to use.

In terms of capabilities to meet the need of privacy, transparency and trust, the study established that blockchain had the capabilities to meet the requirements of information systems in logistics due to its ability to create trust and facilitate the development of an overarching platform that enabled the exchange of information. In addition, the study established that transparency for customers and tractability throughout the entire supply chain was significantly improved.

Lastly, on the challenges in implementation of blockchain in logistics, the study identified the challenges of blockchain and found that adoption of blockchain systems would require a change of mindset within companies with regards to how data was managed and
owned. The ownership of future platforms would also need to be clarified and regulations put in place to govern the information exchange. Other challenges included difficulties in global roll-out, differences in regulations and laws applied per region, a lack of qualified personnel, technical challenges, security concerns, and negative environmental impacts.

Therefore, with respect to Blockchain technology improving the flow of goods or information in the logistics sector, the study concluded that blockchain technology has a huge potential for application and development in the logistics and supply chain industry despite still being in its infancy. As to capabilities to meet the needs of privacy, transparency and trust in logistics, it was concluded that blockchain improved the flow of goods and information by facilitating the development of a platform that enabled seamless information exchange. Lastly, on the challenges in implementation of blockchain in logistics, it was concluded that challenges such as regulation, future platform ownership and technical challenges would need to be overcome in order to be able to successfully implement blockchain in the logistics industry.

Consequently, with respect to blockchain improving the flow of goods and information the study recommends increased collaboration between organizations in order to adequately test the concept. In terms of capabilities to meet the needs of privacy, transparency and trust in logistics, this study recommends further exploration of use cases to understand the potential areas of application. Finally, about the challenges in implementation of blockchain in logistics, this study recommends deployment and testing of open-source strategies to be able to overcome these hurdles.

In addition, this research paper recommends further research in the broader topic of blockchain technology usage in logistics and supply chain management and to further investigate on how small startups or companies can be successfully be included in blockchain system.
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I would like to acknowledge both my supervisors, Prof. Peter Lewa who started this process with me and Prof. Francis Wambalaba who took up the process thereafter for the guidance and wise counsel during the development of this thesis. I would also like to thank my friends and family for their support.
DEDICATION

I dedicate this project to all my loved ones that supported me throughout this process.
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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

This work was on Blockchain and looked into the technology’s potential application in Logistics and Supply Chain. Blockchain has been described by Accenture (2017) as a technology that is especially disruptive to the Logistics industry. Christensen (1997) popularized the idea of disruptive technologies. According to Christensen (2013), there are two main types of innovations namely sustaining and disruptive. Sustaining technologies are those that innovate progressively from time to time while disruptive technologies are those that create greater value than the existing technology and substantially alter the way people live, work, and do business.

The term disruptive technology was first coined by Christensen (1997) as an extension of Schumpeter’s hypothesis of creative destruction. Disruptive technology refers to changes that result from technologies in an existing business model (White, 2017). Disruption is thought to occur when technological innovations make existing systems obsolete by bringing about decreases in price, simplification of processes, and convenience (Christensen, 2017). Disruptive technology applies to hardware, software, networks and combined technologies. Because disruptive technology is new, it has certain advantages, enhancements and functionalities over competitors. As an unused, unapplied and untested alternative, it takes time for disruptive technology to be dominantly deployed, ultimately degenerating existing technology (Elgazzar & Hemayed, 2016).

Disruptive technologies typically take longer to develop and are usually associated with a high level of risk (Christensen, Raynor , & McDonald, 2015). However, it has been established that these technologies have fast penetration and easily replace existing technologies. Often times, these technologies force companies to alter the way they approach their business, or risk losing market share or becoming irrelevant (Chen, 2018). According to Daneels (2004) and Markides (2006), disruptive technologies manifest in different manners with the main identification being that these technologies alter the competition framework by changing the performance parameters along which firms compete.

Schwab (2017) maintains that the world is currently in the fourth industrial revolution. Previous industrial revolutions liberated humankind from animal power, made mass
production possible and brought digital capabilities to billions of people. This Fourth Industrial Revolution is, however, fundamentally different. It is characterized by a range of new technologies that are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human (World Economic Forum, 2017). This period is associated with ten disruptive technologies as illustrated in Fig 1 below:

**Figure 1.1: Disruptive Technologies**
Source: Korn Ferry Institute (2017)

Each of these technologies changes industries in their own way. All the technologies offer incumbent players struggling to adjust to digital disruption the keys to a variety of new, customer-centric business models, each of which could offer significant value generation opportunities (Graser, Krimpmann, & Denhardt, 2017). This research study is limited to blockchain as a technology with disruptive capabilities.

Blockchain technology was created for the digital cryptocurrency bitcoin in 2008. However, its applications are much wider than alternative currency and it is poised to be “the next big thing” in applied sciences. Andreessen (2016) referred to blockchain as one of the most important technologies since the advent of the Internet. Simply put,
blockchain is a distributed database that provides an unalterable public record of digital transactions. It can be viewed as a distributed digital ledger containing a chain of information blocks, where each block is identified by a cryptographic signature. These blocks are all back-linked; that is, they refer to the signature of the previous block in the chain, and that chain can be traced all the way back to the very first block created (Zheng, Xie, Dai, Chen, & Wang, 2018). As such, the Blockchain contains an un-editable record of all the transactions made. The transparent and decentralized nature of the Blockchain network enables the development of a non-refutable and unbreakable record of data, which is the fundamental feature to many applications, such as insurance, finance, fraud detection, copyright protection, smart contracts, identity management, ecommerce and healthcare. Even in higher education, Blockchain technology can help track student credentials and achievements in a cheap, secure, reliable and public way (Wang, 2016).

The blockchain is an undeniably ingenious invention – the brainchild of a person or group of people known by the pseudonym, Satoshi Nakamoto (Bagley, 2016). Early research describes it as a technology that will prove disruptive to the logistics industry. But is it really? Can blockchain technology prove more foundational to the core concepts of logistics and supply chain management? Can building in blockchain concepts into the logistics process solve recurring issues in the industry? Since its conception and development in 2008, blockchain technology has been largely known for being a key foundational component for the cryptocurrency Bitcoin. However, in recent years, the technology has sparked a huge debate on its potential applications in other areas and industries. The technology enables a broad range of possibilities: any sort of asset registry, inventory, and exchange, including every area of finance, economics, and money; hard assets (physical property); and intangible assets (votes, ideas, reputation, intention, health data, information) (Seppälä, 2016).

Blockchain and distributed ledger technology in supply chain and trade flows emerged as a top area of exploration – and a topic of much debate – in recent World Economic Forum events, including the 2018 and 2019 Annual Meetings in Davos-Klosters. Building on vital insights from these and other Forum meetings and research, the World Economic Forum’s Centre for the Fourth Industrial Revolution formally launched a project focused on blockchain governance within supply chains in 2018 (Smith, 2019). In the last two decades the dependency of businesses on efficient logistics and supply chain processes
has significantly increased. Supply chains have become a vital business process that can encourage the competitiveness of a business in the market (Clancy, 2017). It has been recently emphasized that the success of a company is based on the interaction between flows of information, materials, workers and capital equipment. Logistics have been playing a major role in achieving an effective value proposition to the customers as defined by (Kshetri, 2018).

What is emerging at this point is that blockchain applications may have one of the most profound impacts on the logistics industry, especially the supply chain (Huetger & Kueckelhaus, 2018). According to Goyal (2018) a lot of companies are interested in blockchain for creating more efficient workflows, however supply chain management will be one of the big killer applications. Enthusiasts of the decentralized application are therefore promoting an early adoption of the technology for companies to stay competitive in the market (Kshetri, 2018).

Multiple companies such as Maersk (Jackson, 2017) and Walmart in cooperation with IBM (Popper and Lohr, 2017) have started to plan the implementation of the technology by creating pilot projects to achieve the benefits of the technology already at an early stage. In the field of logistics, researchers see many possibilities for the blockchain technology to improve for instance track and trace and quality measurement solutions (Kshetri, 2018).

In developed and developing economies, blockchain technology has found application in various areas. In Europe for example, healthcare companies such as MedicalChain, Encrypgen and Blockpharma are using the technology extensively to authenticate medications, process patient’s insurance claims, provide real-time information on medical tests; locate medical records and x-rays; used for clinical services; used for clinical trials (Health Europa, 2019). In addition, blockchain is being used in this sector to fight drug counterfeiting by improving drugs traceability and to allow participants in the supply chain to interact easily and alerts the labs if fake drugs are detected (The Medical Futurist, 2018).

In addition, European governments have been using blockchain technology to provide public services and to govern. For example, in Estonia, the government uses the technology as asset registers for items like title deeds, patient’s healthcare records,
education certificates, and for e-voting systems (Lyons, Courcelas, & Timsit, 2018). In Switzerland, local authorities use blockchain technology to verify the identities of their residents which is subsequently used for e-voting and renting of items from the local authorities (Huillet, 2018). In Germany, regulatory authorities use blockchain technology to reduce fraud and increase public safety. They rely on real-time data from financial markets to detect trouble in financial institutions much more quickly than in the past which also allows the government to take proactive measures (Global Legal Group, 2018).

Furthermore, in the United States, blockchain technology has found application in the management of homeless people. According to Levy (2018) blockchain technology provides municipalities and non-governmental organizations with a cost-effective method of managing people with no fixed address, few physical possessions, and zero digital assets. These entities use the decentralized system to provide healthcare and social services and a wide database that can manage details of persons who often lose their identification, move from place to place, and require services from a wide variety of locations (Blythe, 2015).

Latin America is positioned to take full advantage of blockchain technology in the private sector with several entrepreneurs and startups developing world-class solutions that will change the way the technology is used. In the private sector, banking is taking a huge interest in the technology (Carter, 2018). The Latin America region still has a large unbanked population setting the stage for valuable companies such as MercadoLibre and Globant to leverage blockchain in order to be able to tackle this issue. Traditional banking still holds a strong monopoly, but, besides a few exceptions, is not always the most innovative industry. There is also a general skepticism over banks due to economic measures taken, such as by the Argentinean or Venezuelan government to formally adopt crypto currency (Palladino, 2018).

According to Pollock (2018), the use of blockchain technology in Africa is a panacea to the problems that the continent faces. In Africa a range of blockchain applications are being implemented across the continent from enabling micropayment systems to digital identity management to smart contracts, there is no doubt that blockchain-based solutions can leapfrog traditional or non-existent technology infrastructures in African countries (Kimani, 2018). In Nigeria for example, blockchain technology is been adapted
as a tool for tracking crime and criminals. The database is a shared platform with Interpol that allows Nigerian police agencies to access and share information on crime and criminals (Voguepay, 2018). In the private sector, South Africa’s De Beers in 2018 announced a pilot program using blockchain to ensure that its diamonds were authentically, conflict-free and naturally sourced. A pilot scheme in quarter three of 2018 also saw the Democratic Republic of Congo launch a project using blockchain to ensure that cobalt used in lithium-ion batteries were not mined by children (Trend Watching, 2018).

In East Africa WiseKey partnered with Microsoft and the Rwandese government as part of an initiative to turn Rwanda into a blockchain and IoT centre of excellence. The first phase focused on digitizing the land registry to aid authenticity of land and property which has been a well-documented problem (Trend Watching, 2018). Uganda’s Yoweri Museveni has also expressed interest in use of the technology to help deal with challenges in land registration, service delivery tracking in health and other critical areas (Kiprop, 2018).

Kenya has also not been left behind in the exploration of blockchain implementation. This has however been mostly has limited to sectors such as finance, security, healthcare and insurance (Kiprop, 2018). The Ministry of Health in Kenya has rolled out a smart database in ninety-eight hospitals across the country which creates a shared hub were vital information about the patient’s history, the management of the hospital, and the use of resources can be monitored (Ngila, 2019). In the security sector, the government has used blockchain technology to link the National Registration of Persons Bureau database to the Kenya police manned close circuit television cameras to enable immediate face recognition (Kariuki & Ochieng, 2017). Most recently, Twiga Foods, a Kenyan delivery service that runs a cashless platform through which vendors order and pay for fresh food and vegetables, adopted blockchain as a means of eliminating layers of middlemen. In this way Twiga creates more efficient supply chain, benefiting both farmers and vendors (International Finance Corporation, 2018).

According to Kimani (2018), there is still unexplored significant potential for blockchain applications in other industries in Kenya. Blockchain technology represents the potential to enhance transparency and reduce long-standing inefficiencies and costs within multiple sectors of any economy and is therefore of particular relevance to the economy. Despite
the incredible characteristics of the technology that include decentralization, security, provenance, transparency and improved management of data and information, the Gartner 2018 survey of Chief Information Officers (CIOs) across the globe found that only 5% of the CIOs used blockchain in their firms (Levy, 2018). The researchers found that the firms’ surveyed preferred alternate technology such as artificial intelligence, cloud computing, and analytics.

In general, the development and implementation of blockchain solutions in supply chains are still at an early stage. Thus, there are many opportunities for companies in the future when the technology is further developed (Nowiński & Kozma, 2017). Particularly for the improvement of collaboration between supply chain partners, the blockchain technology could offer different solutions. Therefore, this research analyzed the technology under a critical perspective, providing an objective description of the blockchain feature, the potential use cases and the relative industry impact.

1.2 Problem Statement

Movement of goods across the globe is a constant, this process involves multiple parties using different channels for information and communication flows. Each company uses its own operational data and there is little interest in sharing information with partners to protect privacy. This leads to a process that lacks transparency and the participants are provided with asynchronous information (Nakamoto, 2008). It is for this reason that past research has identified potential for blockchain technology in logistics.

Another problem is the reliance on a trusted third party when transactions are carried out between two parties (Swan, 2015). These problems relate to the concepts of privacy, transparency and trust. The role of these concepts in a blockchain in logistics setting is not yet explored from a Kenyan context (Kimani, 2018). The Blockchain technology has aspects that can solve the existing problems but there are also obstacles. The existing information systems infrastructure in the logistics sector is not designed for a new technology like Blockchain, this results in the need for organisational and technical adjustments. This also leaves room for new approaches to solve these problems. For example, Korpela et al. (2017) identified the Blockchain technology as an enabler for digital supply chain integration. Logistics processes are an integral part of supply chain management and processes usually involve several participating parties. Establishing
communication and information exchange between all involved parties is complex and problematic, especially if new technology is used.

Much of the research on Blockchain technology in general has been conducted in the financial sector (Beck & Müller-Bloch, 2017, Yli-Huumo et al., 2016). Korpela et al. (2017) identified the lack of fundamental functionalities in the services current operating intermediates in the logistics sector. Some of the missing functionalities like the record and storage of transactions are already embedded in the Blockchain technology, but they have yet to be exposed in a logistics setting.

1.3 Purpose of the Study

The purpose of this research was to examine the potentials of disruptive technologies in the logistics and supply chain industry with focus on blockchain.

1.4 Research Questions

1.4.1 How can Blockchain technology improve the flow of goods or information in the logistics sector?

1.4.2 How can the capabilities of Blockchain technology meet the needs of privacy, transparency and trust in logistics?

1.4.3 What are the challenges in implementation of blockchain in logistics?

1.5 Importance of the Study

The findings of this study would of importance to several individuals and institutions including: The logistics industry and companies within this area of business and their key stakeholders (customers), Governments or Policy makers, and future scholars and academicians.

1.5.1 Logistics Industry

Through the findings of this study there is hope to uncover the benefits of this technology to this sector. Blockchain technology is still a very new and complex phenomenon to most people and organizations. In recent years it has begun to gain attention from various industries and academics from different disciplines. While most experts, consultancy companies and research point towards the technology being disruptive with a potential to
change the logistics and supply chain landscape, much is yet to be uncovered about the benefits brought by the technology to the logistics sector. So far there is several use cases described with no further evaluation on their feasibility or critical evaluation on the potential challenges or barriers. Therefore, this project contributes in expanding the current literature on blockchain technology in application to logistics and defining the expected impact of blockchain use or cases in the field. The information gathered also helps inform future strategy formulation and implementation to ensure the identified challenges are well planned for and dealt with. This improves the ability of the industry to achieve its strategic goals in a seamless and sustainable manner.

1.5.2 Governments and Policy Makers

Through the findings of this study, the Governments and policy makers would be informed on the potential application of blockchain technology in areas such as election transparency and land registry thus informing its policy formulation, implementation and regulation to ensure smooth operations of its organizations related to these areas. The research also hopes to jumpstart discussions on new and disruptive technologies globally that could potentially impact operations of companies locally thus give policy makers a head start on potential implications of such change.

1.5.3 Future Scholars and Researchers

It is further hoped that the findings of this study would be beneficial to future scholars and researchers as it provides empirical evidence upon which they can base their studies. In addition, this study suggests areas for further research where future scholars and research can extend the existing knowledge on strategic management in general.

1.6 Scope of the Study

This research explored and the concept of disruptive technologies with specific focus on blockchain in the logistics sector. The technology was studied from an information systems perspective. The study was conducted in the form of a case study at Logistics Ltd, a multinational logistics firm operating out of Kenya. The study was limited to Logistics Ltd as it is known to use blockchain technology in its business process.

The firm has 531 employees in its Nairobi office. The study data was collected from a sample of 70 employees working in the corporate, information technology, and operations
departments. Data was collected in 2019 through interviews, meetings, documents and limited to the fields of logistics and information technology with a focus on Blockchain technology outside the use of crypto currencies.

The scope did not cover creation of a specific implementation plan for any company and will only propose solutions specific to the logistics industry and not all areas of potential application.

1.7 Definition of Terms

1.7.1 Blockchain Technology

Blockchain can be defined as a distributed ledger technology that can record transactions between parties in a secure and permanent way (Tapscott & Tapscott, 2016).

1.7.2 Bitcoin

Bitcoin is a virtual currency based on the blockchain technology, which enables bitcoin to function as a medium of exchange without involving a trusted intermediary, such as a bank (Frankenfield, 2019).

1.7.3 Cryptocurrency

Cryptocurrency is a digital or virtual currency designed to work as a medium of exchange (Frankenfield, 2019).

1.7.4 Disruptive Technology

Disruptive technologies are those that significantly alter the way businesses or entire industries operate (Smith, 2019).

1.7.5 Software as a Service

Software as a service (SaaS) is a software distribution model in which a third-party provider hosts application and makes them available to customers over the Internet (Rouse, 2019).
1.7.6 Supply Chain Management

Supply chain management (SCM) is the active management of supply chain activities to maximize customer value and achieve a sustainable competitive advantage (Kenton, 2019).

1.7.7 Supply Chain Collaboration

SCC means that two or more independent companies work closely together to plan and realize different supply chain operations with the result of increasing their profits and gaining competitive advantages (Simatupang & Sridharan, 2005).

1.8 Chapter Summary

Chapter one presents an overview of the concept of disruptive technologies with specific focus on Blockchain and its role as a potential solution to the problems still experienced in the logistics industry specifically pertaining to Supply Chain Management and collaboration within supply chains. The chapter highlights a lack of information and research on the potential applicability of Blockchain in areas other than finance and its common use as a foundational technology for the cryptocurrency bitcoin. The research covered the following research questions- How Blockchain technology can improve the flow of goods or information in the logistics sector; how the capabilities of Blockchain technology meet the needs of privacy, transparency and trust in logistics; The challenges in implementation of blockchain in logistics. Within logistics the focus of the study lied on information systems in logistics. The aspects of Blockchain that are concerned with financial topics are not covered in this study.

Chapter two provides and extensive literature review. It discusses the existing research literature on recurring issues in the logistics industry and characteristics of Blockchain technology that can be applied to resolve them. The chapter reviews the literature related to the study based on Blockchain and the intersection between the flow of goods and information, the characteristics of the technology that make it well suited to solving the problems of privacy, transparency and trust in the logistics sector and the challenges that implementation presents to the industry. Chapter three describes the case study conducted within the Operations department at XY Logistics in Nairobi, the research domain for the project. A non-probability sampling approach was used to select respondents who were
familiar with the technology. A sample of 70 was drawn from the population and data collected through semi-structured interviews for primary data and project data, presentations and company reports for secondary data. Data was then analyzed through content analysis. Chapter four presents the results and findings of the empirical data collection. The first sections present the results concerning logistics and the results regarding the concepts of privacy, transparency and trust. Subsequent sections cover the maturity of Blockchain technology and technical implications. Chapter five presents the discussion, conclusion, and recommendations for action and further research.
CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter provides an overview of existing literature in the areas of information systems in logistics, state of the art of the Blockchain technology and available research on Blockchain technology in the research field of logistics. The basic concepts of information systems in logistics are identified as well as the core concepts of the Blockchain technology. The last section of this chapter relates concepts of the logistics and Blockchain research.

The chapter reviews the different literature that is related to the study. It reviewed literature based on the specific research questions; how blockchain technology can improve the flow of goods and information in the logistics sector; how the capabilities of blockchain technology can meet the needs of privacy, transparency and trust in logistics and the challenges in implementation of blockchain in logistics. In addition, the chapter presents a summary which clearly illustrates the research gap to be filled by this study.

2.2 Blockchain and the Flow of Goods and Information

Like most other industries, the logistics industry is currently confronting immense change; and like all change, this brings both risk and opportunity. New technology, new market entrants, new customer expectations, and new business models. There are many ways the sector could develop to meet these challenges, some evolutionary, others more revolutionary (Tipping & Kauschke, 2016). The idea behind digital transformation is using technology to radically improve the performance and the reach of enterprises. The technologies themselves are varied: cloud computing, mobile applications, the Internet of Things, social networks, Big Data and analytics, machine learning and artificial intelligence, 3D printing, robotic process automation, augmented reality and virtual reality, and the block chain (Raschke, Waterman, & Lambert, 2017).

Fig 2.2 illustrates the intersection between digital disruptive technologies and supply chain management.
Historically, the supply chain and manufacturing industry has been relatively slow to embrace the opportunities presented by the digital revolution. Technology is advancing quickly, and it’s time to buck this trend (Riley, 2017). Across all industries—from consumer goods to health care, manufacturing to financial services—more companies are “going digital.” Digitization is very much at the forefront of any CEO’s mind. Predictions are that every company and virtually every job will be touched and most likely transformed or eliminated by digital innovation. For supply chains to fulfill their full digital potential companies need to connect disparate systems, provide end to end visibility, capture and analyze massive amounts of data. The availability of advanced analytics and affordable cloud-based technologies allows companies to go beyond the improvement of service levels and cost reduction (Raschke, Waterman, & Lambert, 2017).

Fig 2.1: Digital Supply Chain Landscape  
Source: Korn Ferry Institute (2017)
As innovative technological solutions continue to shake up logistics, managing the supply chain is no longer business as usual (Gresham, 2016). Historically over the last 30 years, the supply chain has undergone a tremendous change. What was once a purely operational logistics function that reported to sales or manufacturing and focused on ensuring supply of production lines and delivery to customers has become an independent supply chain management function (Beck & Müller-Bloch, 2017). The focus of the supply chain management function has shifted to advanced planning processes, such as analytical demand planning or integrated sales and operations planning, which have become established business processes in many companies, while operational logistics has often been outsourced to third-party logistics providers. The supply chain function ensures that operations are well-integrated, from suppliers through to customers, with decisions on cost, inventory, and customer service made from an end-to-end perspective rather than by each function in isolation (Raschke, Waterman, & Lambert, 2017).

Recent surveys reflect "an incredible increase" in the number of supply chain business leaders who identify technology as crucial to strategy, according to Pierfrancesco Manenti, vice president of research at London-based SCM World. These leaders no longer view technology as a tool, but as a critical driver, affecting every level of business decision-making (Gresham, 2016). Digitization creates a disruption and requires companies to rethink the way they design their supply chain. At the same time, customer expectations are growing. The online-enabled transparency and easy access to a multitude of options regarding where to shop and what to buy drive the competition of supply chains. This does not only apply to B2C but also B2B companies (Raschke, Waterman, & Lambert, 2017).

The management of information is crucial for many companies and is considered as one of the most important factors for success in a competitive market (Loebbecke & Powell, 1998). The logistics sector also profits from the use of IS and research on IS in logistics has been conducted since the 1990s. Initial research focused on exploring the potential of IS in management and the impact on organisational structures (Lewis & Talalayevsky, 1997; Bowersox & Daugherty, 1995). The research on organisational structures describes that information technology influences the strategy and the competencies concerning the competitive advantages of logistics companies (Bowersox & Daugherty, 1995). Lewis and Talalayevsky (1997) explain that the use of IS in logistics goes beyond providing
status information of the flow of goods (Rayport & Svioka, 1995). The flow of information should therefore be handled separately from the flow of goods (Lewis & Talalayevsky, 1997).

In this research project, logistics is viewed as a part of supply chain management according to the Council of Supply Chain Management Professionals (CSCMP). Supply chain management involves the flow of three key resources, which are the flows of information, goods and finances (Chen, Drezner, Ryan, & Simchi-Levi, 2000); (Kulp, Lee, & Ofek, 2004); (Mentzer, et al., 2001). The flows of goods and information are especially important for the logistics process (Klein & Rai, 2009). The financial flow could be a worthwhile research topic in combination with the Blockchain technology as well, however this thesis is not concerned with the cryptocurrency aspect of the Blockchain technology. Therefore, the following sections describe these two concepts.

2.2.1 The Flow of Goods

The very basic activity of the logistics process is the re-allocation of physical goods (Glöckner, Ludwig, & Franczyk, 2017). To further specify, logistics provides goods to customers at the right time and in the right quantity (Prajogo & Olhager, 2012). The number of shipping and receiving locations determines the complexity of this process (Simchi-Levi, Kamisnsky, Simchi-Levi, 2008). With increasing complexity, the management of the flow of goods gets more difficult (Prajogo & Olhager, 2012). Information systems help to manage the flow of goods (Lewis and Talalayevsky, 1997) Lewis and Talalayevsky (1997) explain that logistics is driven by an increased product proliferation, increasingly demanding customers, just-in-time manufacturing and a globalized marketplace. This is reflected for example by custom-made products, with next day delivery (Lewis & Talalayevsky, 1997). The successful flow of physical goods depends on the flow of information, which means that shipping information should be transmitted before the goods arrive (Sheombar, 1992; Hou, Chaudhry, Chen & Hu, 2017). This example illustrates the synergy between the information flow and the flow of physical goods.

2.2.2 The Flow of Information

The management of the flow of information is equally important to the management of the flow of physical goods to add value to the logistics process (Rai, Pavlou, Im & Du,
The role of information systems in logistics is to convert data into information to support managers in their decision-making process (Introna, 1991; Gomez, Grand, & GatziuGrivas, 2015). The competitive advantage that the use of information systems brings is recognized by Closs, Goldsby and Clinton (1997). A disruption in the flow of information leads to a disruption of the process and ultimately to a disruption in the flow of goods (Heilig, Schwarze & Voss, 2017). The logistics process involves multiple parties, and therefore information is exchanged not only within a single organization but also across multiple organizations. Seidmann and Sundararajan (1997) suggest sharing strategic information with partners to improve forecasts about demand and planned production. However, sharing strategic information is not without risk and the partner might increase prices based on this information. Klein and Rai (2009) found out that buyers and suppliers benefit financially and non-financially from the sharing of strategic information flows. They further state that there is a risk of exploiting involved parties, which leads to losses (Klein & Rai, 2009).

### 2.3 Capabilities of Blockchain Technology

Blockchain is a form of a distributed database, where records of transactions are stored and shared among independent parties and updated upon agreement of all participants based on a consensus protocol (Crosby et al., 2016). Some of the characteristics that attract researchers and industry in blockchain are decentralization, security and data integrity (Yli-Huumo, Ko, Choi, Park, & Smolander, 2016).

In general, "logistics and transportation tend to lag behind other sectors in technological innovation," Waggoner says. Today, however, that sector is chasing the possibilities of predictive analytics en masse (Gresham, 2016). By 2020, ninety percent of supply chain execution systems expenditure will be for cloud-based applications, while supply chain planning applications will remain on premise, according to Gartner. The IoT will give companies the ability to digitally connect physical assets and create a flow of data across the value chain, linking every piece of the product lifecycle. In addition, advanced (predictive) analytics will allow for condition analysis and real-time visibility. Early adopters will start deploying burgeoning technologies such as blockchain to assist shippers with gross weight verification. Digital transformation will be key to capitalize on the available value of these technologies in the supply chain (Riley, 2017).
For centuries, businesses and in some cases entire industries have been built on the simple principle of trust between multiple parties. However, this business of trust is about to be disrupted and transformed with the advent of blockchain technology (Huetger & Kückelhaus, 2018). The main advantage and impact of the Blockchain is the trust of transactions and the ability to share assets. Every transaction is trusted and secured due to the presence of ledgers. A ledger is a consensus of replicated, shared, and synchronized digital data geographically spread across multiple sites, countries, or institutions. There is no central administrator or centralized data storage. Accordingly, Blockchain users are provided with the ability to share assets without concerns regarding how to protect them (Eljazzar & Kassem, 2018).

All the previous work is based on the idea of using a data centralized system. Which was, until recently, the main conceivable approach to achieve information transparency along supply chains? With the rise of Blockchain, a whole new approach has drawn attention from researchers in many different domains in public services, Internet of Things (IoT), smart cities, reputation systems and security services (Elgazzar & Hemayed, 2016). Supply chain is not far away from Blockchain. While discussing the benefit of merging blockchain technology in manufacturing supply chain. They listed the main characteristics of the blockchain software architecture to enhance trust through transparency and traceability in the supply chain network. In addition to the transparency within any transaction of data, goods, and financial resources, blockchain could offer an innovative network for new decentralized and transparent transaction mechanism in industries and business (Zyskind, Oz, & Pentland, 2015).

**2.3.1 Blockchain Basics**

The blockchain is a feature of a distributed ledger, which means that it is not controlled by any single actor but maintained by several participants (The Economist, 2016a). This allows people who do not know or even have trust in each other to form a trustworthy ledger, where information is recorded (The Economist, 2015). It records the transactions between parties in a secure and permanent way. By ‘sharing’ databases between multiple parties, blockchain essentially removes the need for intermediaries who were previously required to act as trusted third parties to verify, record and coordinate transactions. By facilitating the move from a centralized to a decentralized and distributed system (see
Blockchain effectively liberates data that was previously kept in safeguarded silos (Huetger & Kueckelhaus, 2018).

**Fig 2.2: Blockchain Principles**
Source: DHL (2016)

Blockchain was mentioned for the first time in the Bitcoin research paper (Nakamoto, 2008). The definition in 2008: was basic and straightforward, i.e. Blockchain is a technology which runs Bitcoin. However, this definition lacks important details. The Blockchain is a chain of connected blocks that consist of data about transactions (Khudnev, 2017). Arguably, bitcoin was the world’s first decentralized public ledger and it has today gained global status around the world (Pilkington, 2015). However, the success of bitcoin comes from the cryptographic technology underlying it, namely the blockchain technology (Pilkington, 2015). This technology has also recently become a hot topic for researchers and been argued to be an even more revolutionizing phenomenon than bitcoin.

What kind of impact could this have on everyday life? The blockchain technology’s most known application is bitcoin. There is a need to emphasize that the blockchain technology has more significant uses than bitcoin and it has also been claimed that bitcoin is in fact a poor application of the blockchain technology (The Economist, 2016b). Imagine in healthcare, sensitive data from all stakeholders – ranging from patients to medical companies – could be shared using the highest levels of encryption and data protection to greatly improve service efficiency and quality. Or in finance, companies and customers could potentially adopt a common digital currency as an alternative to traditional money, reducing the cost of transfers and enabling micro transactions. And in logistics, data
sharing across the supply chain could enable higher levels of transparency, empowering consumers to make better choices about the products they buy. These are just some of the many opportunities that blockchain presents (Huetger & Kueckelhaus, 2018).

2.3.1.1 Blockchain and the Supply Chain Process

Several applications of the technology have been theorized by now. They include smart contracts, blockchain-based securities trading and blockchain-based land registries, electioneering fraud prevention to mention but a few. This project will however only focus on its potentials applications in the logistics industry and further explain how to utilize the blockchain technology in this specific area. The application of blockchain technology in the transport and logistics industry is expected to have far-reaching implications (Friedlmaier, Tumasjan and Welpe, 2018), with some logistics experts considering blockchain to offer ‘enormous potential’ (O’Marah, 2017), to “transform the supply chain and disrupt the way we produce, market, purchase and consume our goods” (Dickson, 2016) and to be a “much-needed platform for economic renewal” (Casey & Wong, 2017).

Figure 2.4 illustrates the principles of Blockchain technology that make it ideal to solve the issues of transparency and access among relevant stakeholders in the supply chain thus creating a single source of ‘truth’. As a consequence, blockchain can potentially help to overcome these frictions in logistics and enhance efficiency in supply chain processes (Ellis, 2017).
Many parts of the logistics value chain are also bound to manual processes mandated by regulatory authorities. For example, companies must oftentimes rely on manual data entry and paper-based documentation to adhere to customs processes. All this makes it difficult to track the provenance of goods and the status of shipments as they move along the supply chain, causing friction in global trade (Hovarth, 2001). Blockchain can potentially help to overcome these frictions in logistics and realize substantial gains in logistics process efficiency. This technology can also enable data transparency and access among relevant supply chain stakeholders, creating a single source of truth. In addition, the trust that is required between stakeholders to share information is enhanced by the intrinsic security mechanisms of blockchain technology (Huetger & Kueckelhaus, 2018).

Furthermore, blockchain can achieve cost savings by powering leaner, more automated, and error-free processes. As well as adding visibility and predictability to logistics operations, it can accelerate the physical flow of goods. Provenance tracking of goods can enable responsible and sustainable supply chains at scale and help to tackle product counterfeiting. Additionally, blockchain-based solutions offer potential for new logistics services and more innovative business models (Huetger & Kueckelhaus, 2018).

### 2.3.2 Consensus Finding

One of the basic concepts of Blockchain technology is the consensus mechanism, which verifies the correctness of transactions based on cryptography, rather than based on a
trusted third party (Yli-Huumo et al., 2016; Pilkington, 2016). The term consensus mechanism is used because the key challenge is to reach a consensus about the correctness of a transaction amongst all participant, which is crucial in a distributed system (Milutinovic, He, Wu & Kanwal, 2016; Crosby et al., 2016). If several blocks are created at the same time, which is not an unusual case in a distributed system, it is also necessary to determine which block is next to be added to the chain (Crosby et al., 2016). Further, the consensus mechanism prevents the double-spend problem. The problem there is that digital assets can be copied infinitely, which means that transactions also could be copied and in case of digital cash, it could be spent multiple times without a central authority monitoring all transactions. The consensus mechanism eliminates the need for a trusted third party (Swan, 2015). The consensus mechanism used in the Bitcoin network to solve these problems is called “proof-of-work” (Nakamoto, 2008). Proof-of-work requires a huge amount of computational power, which costs approximately $15million/day in the Bitcoin network (Yli-Huumo et al., 2016). These are essentially wasted resources and therefore alternative consensus mechanisms are being explored.

2.4 Challenges in Implementation of Blockchain Technology

Blockchain has the potential to deliver vast savings by improving operational efficiency and generating value through new business models. However, as with many emerging technologies, considerable challenges must be overcome before blockchain can achieve mainstream adoption in all industries (Huetger & Kueckelhaus, 2018). Before blockchain technology can reach its full potential, it has a number of challenges to overcome (Casey & Wong, 2017).

The failure of adoption of the technology has been attributed to the fit for purpose nature of the technology (Yli-Huumo, Ko, Choi, Park, & Smolander, 2016). Mackey, Tsung-Ting Kuo, and Gummandi (2019) further questioned the task-technology-fit of blockchain technology. Yli-Hummo et al. (2016) indicate that the applications viability across various sectors of the economy are determined by the adoption of features and design to cater for real-world situations and determine its adaptability. This led Furlonger and Kandeswamy (2018) to conclude that blockchain technology was just a hype and was being adopted due to the bandwagon effect.
2.4.1 Industry Readiness

The blockchain creates most value for organizations when they work together on areas of shared pain or shared opportunity – especially problems particular to each industry sector (Crosby, Pattanayak, Verma, & Kalyanaraman, 2016). The problem with many current approaches to the adoptions of the technology, though, is that they remain stove-piped: organizations are developing their own blockchains and applications to run on top of them. In any one industry sector, many different chains are therefore being developed by many different organizations to many different standards. This defeats the purpose of distributed ledgers, fails to harness network effects and can be less efficient than current approaches (Swanson, u.d.).

The most benefit is derived from blockchain technology if the community contains many relevant members (Francisco & Swanson, 2018). A powerful network effect is only triggered when stakeholder adoption reaches a critical mass, turning blockchain into an accepted industry practice. According to Heutger and Kückelhaus (2018), gaining industry adoption is of utmost importance and will determine the success of blockchain in an industry that is characterized by a supply chain environment with multiple stakeholders. Clancy (2017) further postulates that there is a complexity in bringing all parties in the supply chain together with the goal of transferring it to a blockchain solution in the current industry environment.

Stakeholder commitment presents further challenges. It will be difficult at first to obtain stakeholder commitment because of differing levels of digital readiness and the initial requirement to recognize the mutual benefits of blockchain-based collaboration (Shermin, 2017). In addition the lead time to negotiate agreements and contracts is thus that mutually benefit all parties represented has been nearly next to impossible in some instances (Qinghua & Xiwei, 2017).

In terms of the practical use of the technology, Zheng, Xie, Dai, Chen, and Wang (2018) identified technical challenges in the scalability of blockchain technology. There are a limited number of transactions that can be dealt within a short amount of time in order to maintain the high degree of security. Therefore, the tradeoff between block size and security has become a challenge (Zheng et al., 2017). Furthermore, problems of hacked IP addresses from users in the network are discussed (Biryukov, Khovratovich, &
Pustogarov, 2014). In addition, the geographical spread of companies and their resources means that there are differences in levels of digitalization. Suppliers and partners in developing countries might therefore not have the ability to participate in blockchain solutions (Kshetri, 2018).

According to Yli-Huumo, Ko, Choi, Park and Smolander (2016) previous research on blockchain has been restricted to crypto currencies and the financial sector as such a serious lack of awareness and understanding of how the technology works is hampering its adoption in logistics and other industries. It might therefore take a couple of years before the technology is ready to be implemented in actual business processes, but researchers view opportunities for implementation in supply chains (Nowiński & Kozma, 2017). It is also necessary to make progress with blockchain technology itself in order to overcome current technical limitations. This is especially required for companies moving from a pilot implementation to full-scale deployment. For example, some blockchain implementations have been known to scale poorly and suffer from high latency although new innovations are being developed to address these scalability and performance issues. In some specific applications (such as large-scale, public cryptocurrency networks) there are issues with energy consumption and computing power requirements. These obstacles will need to be addressed for blockchain to reach maturity (Huetger & Kückelhaus, 2018).

2.4.2 Governance

Another challenge is the development of standards and governance of blockchain in each industry. It seems more likely that there will not just be a single blockchain-based system in the logistics industry; instead, there will likely be multiple private permissioned blockchains due to the competitive nature of business. And of course, in future there will be multiple public blockchains (Clancy, 2017). Organizational bodies will be required to determine standards and agreements, especially in the context of interoperability between blockchains. To tackle this challenge, the first blockchain consortia are now beginning to emerge; for example, the Blockchain in Transport Alliance (BiTA) in the logistics industry (Huetger and Kückelhaus, 2018). In addition, the development of standards and governance models for blockchain in the logistics industry as well as the associated cost to migrate from legacy systems to new technological environments are additional challenges.
Regulations and laws are defined as a challenge for blockchain-based solutions considering the global environment in supply chains. Businesses operating in international markets are today struggling to adapt to old jurisdictions, customs, and institutions (Casey & Wong, 2017). In contrast, Mitsuaki (2017) highlights the fact that regulations and policies could be programmed directly into the technology itself. In practice this means that blockchains can act as a legal indication in sharing and storing sensitive data. Being that the logistics domain will not be characterized by just a single blockchain-based system due to the competitive nature of business. This underpins the requirement for standards and mutual agreements, particularly addressing the interoperability between blockchains (Huetger and Kückelhaus, 2018).

2.4.3 Trust

A blockchain represents a total shift away from the traditional ways of doing things – even for industries that have already seen significant transformation from digital technologies. It places trust and authority in a decentralized network rather than in a powerful central institution. And for most, this loss of control can be deeply unsettling (Gresham, 2016). It has been estimated that a blockchain is about 80 per cent business process change and 20 per cent technology implementation. This means that a more imaginative approach is needed to understand opportunities and also how things will change (Swanson, u.d.)

Streamlining the logistics and supply chain process is underpinned by a high level of trust among all key stakeholders involved. Many researchers underline the importance of collaboration in supply chains and explain how companies put effort into reaching successful collaboration. Most of the companies have the aim of improving their overall performance through collaboration (Baur & Pettersson, 2018). However, collaboration requires a high level of trust and information sharing between the different parties. Simatupang and Sridharan (2005) present in their model which main aspects need to be addressed to achieve successful collaboration.

The Blockchain paves the way for a “trust-free” economy, where no trusted third party is needed, due to the transparent and highly secure design (Becker et al., 2013; Beck et al., 2016). As Blockchain technology does not have a single instance as a trusted “third party”, and trust must be created differently. This is reached in a way that all participants
are mutually untrusted, and the trust is generated through the consensus mechanism of the Blockchain (Milutinovic et al., 2016; Zyskind& Nathan, 2015).

Furthermore, an organization’s culture plays a significant role in the success of digital transformation in any industry. Particularly with blockchain technology, this cannot be overlooked as its adoption will require a collaborative mindset to engage with a large number of stakeholders. Therefore, within organizations, a culture of embracing new opportunities from blockchain technology should be fostered. The capabilities of Blockchain technology to create trust between partners in logistics have not been investigated in previous studies (Korpella, Hallikas, & Dahlberg, 2017).

2.4.4 Cost

The speed and effectiveness with which blockchain networks can execute peer-to-peer transactions comes at a high aggregate cost, which is greater for some types of blockchain than others. This inefficiency arises because each node performs the same tasks as every other node on its own copy of the data in an attempt to be the first to find a solution (Iansiti & Lakhani, 2017). For the Bitcoin network, for example, which uses a proof-of-work approach in lieu of trusting participants in the network, the total running costs associated with validating and sharing transactions on the public ledger are estimated to be as much as $600 million a year and rising. This total does not include the capital costs associated with acquiring specialist mining hardware (Crosby, Pattanayak, Verma, & Kalyanaraman, 2016). Blockchains are something of a productivity paradox, therefore. At the scale of the entire network the process is significantly productivity enhancing but requires a certain ‘critical mass’ of nodes. Yet, even so, individual nodes can work extremely hard and may not contribute very much to the network overall. Therefore, decisions about implementing blockchain applications need to be carefully thought through (Fawcett, Fawcett, Watson, & Magnan, 2012). The returns to individual processing nodes – either individuals in a public blockchain or organizations in a sector-wide blockchain – may diminish as the network grows in size. This means that blockchain applications must harness network effects to deliver value to consumers or to sectors at large (Swanson, u.d.).

There are clearly more than a few hurdles to overcome, however, these challenges with blockchain are not insurmountable. Already this technology, despite its relative infancy,
is showing promise across a wide range of industries including citizen services, retail, life sciences and healthcare, automotive, manufacturing, energy, and logistics (Huetger & Kückelhaus, 2018).

2.4.5 Privacy

Privacy, or information privacy in information systems has a range of definitions and Bélanger and Crossler (2011) provide a review of multiple definitions. A definition from an information systems perspective is provided by Do Prado Leite and Cappelli (2010) as a concept that deals with information disclosure and has mostly been discussed regarding the empowering of citizens through their rights. The terms privacy and transparency seem to be contradictory at first.

Blockchain is designed as an open technology, where anonymous transactions are visible to anyone. On a high level, a distinction can be made between a public and a private Blockchain. The terms ‘open’ or ‘permissionless’ for a public Blockchain and ‘permissioned’ for a private Blockchain are used as well in the literature (Lewis, 2016; Pilkington, 2016). In a public Blockchain everybody has access to the Blockchain and therefore everybody can participate unconditionally in the decision-making and validation process. The concept of a private Blockchain is to monitor write-permissions by a central decision-making entity and restrict or allow read permissions of individual users (Pilkington, 2016). The level of decentralization and anonymity also differentiates public and private Blockchains. A private Blockchain can never reach the same level of decentralization as a public Blockchain. This also has implications on the degree of transparency. A public Blockchain is completely transparent, whereas the degree of transparency of a private Blockchain can be controlled. Transparency in the Blockchain means that transactions are visible, but the involved parties remain anonymous (Qinghua & Xiwei, 2017).

Léauté and Faltings (2011) describe the dilemma of logistics providers to coordinate their operations to keep costs low and the degree of information that they are willing to share and what to keep private. While the Blockchain technology has potential to solve the problem of overarching communication between organizations (Christidis & Devetsikiotis, 2016), it is stated that the technology lacks transactional privacy (Kosba at al., 2016; Zhang, Cecchetti, Croman, Juelsand Shi, 2016). Kosba et al. (2016) approach
the issue with a framework for privacy-preserving smart contracts. There is a lack in the literature about the balance between privacy and transparency regarding the application of the Blockchain technology in logistics.

2.5 Chapter Summary

This literature review looked into the concept of disruptive technologies and their potential applications in other industries besides the financial sector. It specifically focused on blockchain technology and the principles of blockchain that make it an ideal foundational technology for the logistics industry. Perspectives of different scholars and researchers have been brought forward to help understand what has already been done in this area. The chapter has also looked into some challenges into the application of the technology despite its showing promise in a wide range of industries.
CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

The research methods that were used to conduct this study are described in this chapter. First, the choice and motivation for the research method is outlined, followed by an explanation of the empirical setting and the data collection method. The last section of this chapter outlines the data analysis strategy.

3.2 Research Design

A descriptive qualitative research design was employed to examine disruptive technologies in the logistics and supply chain industry. When scheming through the numerous studies on the subject matter of this research, the researcher established that a descriptive qualitative design was the most effective. Kim, Sefcik, and Bradway (2017), advocate for the use of descriptive qualitative research design as this approach is rich in data.

The research elected to use qualitative data rather than quantitative data as the aim of the study was to explore a phenomenon. DeFranzo (2011) indicated that qualitative research should be used where the researcher seeks to understand a given occurrence by seeking opinions and reasons from the parties involved. Qualitative research aids in the uncovering of trends in thoughts and opinion and getting a deeper understanding of the area under study. The research design allows the researcher to extract a large amount of information as possible regarding the phenomenon being researched. This allows the research to present a clear picture and fulfill the research objective.

Polit and Beck (2009; 2014), identified the descriptive qualitative research design as being appropriate where the research questions are aimed at discovering who, what, where, how, and experience with a given phenomenon. This research design allows the research to gain information regarding a phenomenon that is not well understood. The study aimed at understanding the use of blockchain technology in supply chain and logistics. The information for the study was obtained from a firm operating in the logistics and supply chain industry. The use of this technology in logistics is not well understood (White, 2017).
Due to the nature of the research questions, the researcher felt that the case study was the most appropriate approach. The empirical data of this research was based on a case study of a project that explores the implementation of blockchain technology in logistics. In the information systems field, case studies are a common research method (Walsham, 1995; Orlikowski & Baroudi, 1991). The ability to investigate a phenomenon in a real context and generate, test and develop theory is the reason why a case study as research methodology is chosen. Yin (2013) describes three characteristics for case studies as preferred research method: First, for research questions based on “how” or “why” questions, Second, there being little control over events by the investigator, and lastly, a focus on a contemporary phenomenon in a real-life context. Further, the researcher should be an observer or investigator rather than a participant and data is collected by multiple means (Benbasat, Goldstein & Mead, 1987).

By considering the purpose of this research was to find out how the logistics sector can benefit from Blockchain technology and to explore the technical and organisational challenges, the case study of a real use-case in logistics is an appropriate research method. Case study research design has evolved as a useful tool for investigating trends and specific situations in many disciplines. Case study research design is useful for testing whether specific theories and models can actually work in the real world (Shuttleworth, 2008).

3.3 Population and Sampling Design
3.3.1 Target Population

Mugenda(2008) describe a population as a complete set of individuals, cases or objects with some common observable characteristics. The study’s focal is Logistics Ltd which is a pseudonym for a firm that was established in the 1800’s to provide freight forwarding services. Logistics Ltd is a multinational, which operates in 150 countries and employs some 390,000 people. They are one of a few companies in the industry that have taken an active interest in incorporating blockchain technology into their processes and have an active ongoing project on the same. The case study was conducted within the logistics department of the firm. In this context, Blockchain technology is of high interest within the department and research on the technology is supported by the upper management. The logistics sector is a promising area for the application of Blockchain technology and therefore a project was initiated to implement it in cooperation with a logistics operator.
The requirements proposed by Yin (2013) and Benbasat et al. (1987) are met by studying this case because Blockchain technology is a contemporary phenomenon and the project happens in a real-life context. There was no involvement of the author in the planning and execution of the project, however the progress of the project was observed. In addition, there have been few researches on Blockchain in a logistics context and data was collected from multiple sources.

3.3.2 Sampling Design

The sampling design of a study specifies the possibility of a particular sample from being drawn from a whole population. Any statements made about the sample should also be true of the population (Mugenda & Mugenda, 2003). In this research a sample was drawn from the population of employees in Logistics Ltd.

3.3.2.1 Sampling Frame

In its operations in Kenya, Logistics Ltd operates more than 90 branches countrywide. The firm’s services in Kenya include collection and delivery of parcels; global freight through the use of air, road, and rail; and a comprehensive array of services based on its global capacity and local capabilities to deliver logistics and supply chain services. The firm has a total of 531 employees.

3.3.2.2 Sampling Technique

Creswell and Creswell (2017) indicate that there are different types of sampling techniques including simple random sampling, stratified sampling, purposive sampling amongst others. The study sample was determined using multi-stage sampling approach. This approach is advantageous as it reduces within-stratum variances (Atikiya, 2015).

The sample refers to the units of observations derived from the population using a defined framework (Atikiya, 2015). The sample is important as it is from these units that data is collected. The sample was derived from the 531 employees of Logistics Limited. The data collected from the sample is used to make inferences and extrapolations about the population.

The researcher divided the employees into four categories with each category forming a stratum. Stratified sampling was thought to be appropriate to categorize the employees as
all areas of the firm were represented. Table 3.1 summarizes the sampling frame of the study;

Table 3.1: Sampling Frame

<table>
<thead>
<tr>
<th>Department</th>
<th>No. of Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Management</td>
<td>57</td>
</tr>
<tr>
<td>Operations</td>
<td>344</td>
</tr>
<tr>
<td>Marketing</td>
<td>100</td>
</tr>
<tr>
<td>Information Technology</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>531</strong></td>
</tr>
</tbody>
</table>

Source: Logistics Ltd. (2019)

### 3.3.2.3 Sample Size

A sample is a subset of population about which the findings are to be generalized. A sample size of respondents was selected from the total population at Logistics Ltd. Because this is a study case, the researcher chose a purposive sampling technique in order to determine the sample size.

Purposeful sampling is a technique widely used in qualitative research for the identification and selection of information-rich cases for the most effective use of limited resources (Patton, 2002). This involves identifying and selecting individuals or groups of individuals that are especially knowledgeable about or experienced with a phenomenon of interest (Creswell & Plano, 2011). In addition to knowledge and experience, Bernard (2002) and Spradley (1979) note the importance of availability and willingness to participate, and the ability to communicate experiences and opinions in an articulate, expressive, and reflective manner.

The researcher considered the entire population of employees within the Nairobi office of Logistics Ltd that had initially been categorized per department. The researcher then specifically selected the number of employees from each department who were working on the blockchain project. The sample size was therefore limited to the individuals working on the project and was established as follows;
Table 3.2: Sample Size

<table>
<thead>
<tr>
<th>Department</th>
<th>No. of Employees</th>
<th>No. Sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Management</td>
<td>57</td>
<td>10</td>
</tr>
<tr>
<td>Operations</td>
<td>344</td>
<td>40</td>
</tr>
<tr>
<td>Marketing</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>Information Technology</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>531</strong></td>
<td><strong>70</strong></td>
</tr>
</tbody>
</table>

3.4 Data Collection Methods

Creswell (2009) defines data collection as a means by which information is obtained from the selected subjects of an investigation. According to Ngechu (2004), there are many methods of data collection. The choice of a tool and instrument depends mainly on the attributes of the research topic, research questions, objectives, design and expected data and results. Empirical data for this study was collected through the use semi-structured interviews and observation as a means to collect primary data and consulting company reports and research findings for secondary data. An overview of the data collection activities is showcased in Table 3.4in Appendix B.

3.5 Research Procedure

The researcher sought and obtained permission from the university to collect data from Logistics Ltd. The researcher obtained an introduction letter to inform the respondent that the purpose of the research was purely academic. The interview questions were developed from questions used in previous studies and validated sources such as peer-reviewed journals. The aim of conducting validation of the study questions was to ensure that they were relevant, useful, and accurately provided information that would fulfill the objectives of the study. Using the approach by Al Mofarreh (2016), the interview questions were given to three employees working in the three departments that participated in the study. They were requested to review the questions and indicate if they were relevant, could be understood, and were applicable. The three respondents’ comments were taken into consideration during the development of the final interview questions. The respondents who participated in the pilot study were excluded from the
final study. According to Yin (2014), it is necessary to exclude the participants of the pilot study from the final study to ensure they do not introduce biases in the study.

The interviews were conducted at the main office of Logistics Ltd located in Nairobi County, Kenya. The interviews were conducted in three stages. The first stage was a one on one interview with the senior management team involved with the project. The second stage involved focus group interviews with the employees working in the IT department that were involved in the project. The third stage combined both interviews and conference calls with employees in the operations department who were part of the project teams and also those who would have their processes impacted by the project. The respondents allowed the researcher to record the interviews on the condition that it was done using a tape recorder. The respondents firm requested that the recordings be treated with utmost confidentiality and only be handled and played by the researcher. They requested that the recording not be shared with third parties and be erased when the final report was written. The researcher adhered to the firm’s request. The anonymity of the firm was maintained by using the pseudonyms Logistics Ltd as prescribed by (Mertens, 2005). The researcher visited the premises of Logistics Limited a total of 10 times during the course of the research.

3.6 Data Analysis Methods

In the final stage of the research, the data collected using interviews was analyzed using content analysis. In the content analysis approach, the researcher evaluates the patterns in the interviewees’ responses (Bryman, 2011). The process of content analysis entails the systematic reading of text or listening to recordings after assigning labels/codes to indicate the presence of meaningful and relevant content (Tipaldo, 2014). The themes of the study were the research questions. This means that data relating to a given research question was recorded under that section. Thereafter, the themes were sub-divided into categories and evaluated using the interviewees’ responses, theories, and empirical literature. The researcher drew inferences based on the coding and themes used illustrated in Table 3.3 below;
Table 3.3: Phases of Analysis

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description of the phases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Familiarizing yourself with your data</td>
<td>Data transcription, reading and re-reading of data, notation of initial ideas</td>
</tr>
<tr>
<td>2. Generating initial codes</td>
<td>Systematic coding of interesting features of the data across the data set, collection and combination of data relevant to each code</td>
</tr>
<tr>
<td>3. Searching for patterns</td>
<td>Translate codes into potential themes and gather all data relevant to the potential themes</td>
</tr>
<tr>
<td>4. Reviewing themes</td>
<td>Involves two levels: level 1 reviewing regarding the assigned codes, level 2 reviewing regarding the entire data set.</td>
</tr>
<tr>
<td>5. Defining and naming themes</td>
<td>Refining aspects of each theme define clear definitions and names for each of the themes. Use of a thematic map.</td>
</tr>
<tr>
<td>6. Producing the report</td>
<td>Finalization of the analysis that includes final selection and analysis of extracted examples, relating back to the research questions and literature review, producing of a scholarly report</td>
</tr>
</tbody>
</table>

3.7 Chapter Summary

The chapter looked at the research design used for the study. The research project looked into disruptive technologies with a specific focus on blockchain technology and its application in the logistics supply chain industry. A research design was established to be the most appropriate approach to fulfilling the purpose of the research.

A case study of Logistics Ltd, a global firm in the logistics and supply chain sector which operates in 150 countries across the globe. In Kenya, the firm operates 90 branches and has 531 employees. The study sample of 70 individuals was computed using purposive sampling technique. Data was collected from senior management, information technology professionals, and operations department employees who were part of the blockchain project. Data was collected through semi-structured interviews, conference calls and focus groups.
CHAPTER FOUR

4.0 RESULTS AND FINDINGS

4.1 Introduction

The purpose of this study was to find out how the logistics sector can leverage and benefit from disruptive technologies such as Blockchain and to explore the technical and organisational challenges at Logistics Ltd. This chapter represents the results of the findings. Data was collected through multiple sources for this thesis. The sources were semi-structured interviews, documentation from the project and meetings. Interviews are the main source of data and evidence for this project. Interviews were conducted with both logistics experts and blockchain experts.

4.2 Case Study

The focal for this research is Logistics Ltd, which is a pseudonym for logistics multinational, which operates in 150 countries and employs some 390,000 people. The case study is conducted within a project team created for the purposes of the case study at Logistics Ltd. This department aims to explore new business ideas, innovations and create a niche product for the company that will create a competitive edge for Logistics Ltd in the industry. In this context, Blockchain technology is of high interest within the department and research on the technology is supported by the upper management. The logistics sector is a promising area for the application of Blockchain technology and therefore a project was initiated to implement it within the company.

The empirical research of this thesis was based on a qualitative study of an ongoing project – BlockShard. The project is carried out between the IT and Operations department at Logistics Ltd. The BlockShard project aims to develop a use case to apply blockchain technology within the firm.

The project is a pilot test with the goal to explore the capabilities of the combination of IoT devices and Blockchain technology in the logistics sector. The firm was looking to improve their operational efficiencies, make cost savings and improve transparency between the firm, its internal and external customers and suppliers through this project. The BlockShard platform and necessary infrastructure was provided by an external service provider and customized in-house by the IT project teams to fit with the current
business processes and operations of the firm. The platform was built in an open-source hyperledger and used as a backend for the IoT devices and the information flow between the participants. The platform was also used to implement smart contracts to automate transactions between the participants. Logistics Ltd is pursuing this project to gain expertise in blockchain technology and explore a platform for their IoT devices, while at the same time hoping to create a competitive advantage and increase market share should the project prove to be a success.

4.3 Blockchain and the Flow of Goods and Information

The requirements for information systems in the logistics industry were one of the key questions posed to the interviewees and there were several points brought forth worth mentioning. There was general agreement that there was no system that allowed for full end to end visibility of the logistics process from start to end. It was mentioned that there was too much effort put into handling information from customers and acting as a go between two then route this documentation and information to subcontractors. There was also a general agreement that blockchain’s flexible architecture was fast enough to adopt new processes which is crucial for a modern IT system. The respondents indicated that the blockchain used by their firm had a central listed distributed ledger that generated a single electronic storage area where the myriads of documents needed for the transportation of products was stored.

The findings of the interviews described a myriad of problems with information systems in logistics thereby negatively impacting the flow of goods and information. Most interviewees agreed that the systems were old legacy systems that were not up to date. This brought about problems such as compatibility issues and severely affected integration of new technology. There was also the issue of use of multiple systems to accomplish different tasks, some which were not compatible with each other thereby also negatively impacting the smooth flow of goods and information.

In addition, all interviewees agreed that the cost-driven nature of the logistics sector was a key reason for the lack of investment in working, compatible software. This was stated as a reason for the existence of age-old, legacy systems still being in use. Based on the findings from the analysis of the responses from the data collected during the interviews, it was found that the concepts of privacy, transparency and trust were linked with both the requirements and capabilities of blockchain in logistics. A thematic map in illustrated in
Fig 4.0 is found in Appendix D. This was created to provide an illustration of the same. The subsequent sections will explain the requirements in relation to Blockchain Technology and the connection between the elements.

4.3.1 The Flow of Goods

The provenance of goods covers the concept of trust. Provenance being a broad concept can be split into the desire of customers to know the origin of a product and from the organizations perspective, the tracing of goods through the whole supply chain including customs and other authorities. It was found during the interview process that the general feeling was that while provenance creates trust, blockchain technology validates that trust and acts as an enabler. The consensus mechanism of a blockchain puts the matter of trust in an algorithm and therefore the technology facilitates trust. To sum up the interviewee’s sentiments, the first way to create trust is through transparency and the second way is through technology. The term technology enabled compliance based on the interview responses refers to the adherence of laws and regulations. This was ensured through the use of smart contracts.

The IT department felt that a key feature of the blockchain technology was the security feature. They explained that a key challenge of using traditional IT platforms was the challenge of pickups that could not be verified. Using the blockchain, the IT department had been able to give clearance for personnel such as truck drivers to pick up consignments. The respondents indicated that the blockchain technology solved the problem of double-spend. They indicated that the technology had public-key cryptography which allowed the IT department to allocate a private key and a public key which was shared by other users. The respondents indicated that data in the system is protected using three safeguards namely ownership of data; data transparency and audit ability; and fine-grained access control.

The ability to trace goods following through the process was also thought to be a significant advantage of the blockchain technology. The respondents indicated that both internal and external entities such as different vendors and customers could be provided special access to the system. The respondents indicated that the systems used by their firm had traceable identifiers that were encrypted to protect the personal information of the users. The system was designed to allow the vendors and customers to monitor the
access of the system using their credentials. The respondents indicated that the use of blockchain improved the ability of the firm to track and manage quality.

The respondents also indicated that the use of blockchain allowed for the integration of the supply chain process. The respondents indicated that the integration allowed for the efficient transfer of products. The blockchain technology allowed for the integration of the firm’s internal processes with that of external parties. The respondents indicated this was necessary particularly in a business environment that was driven by the need to respond quickly, efficiently, and cost-effectively to the demand of the consumers.

All of the respondents agreed that blockchain technology allowed for storage of information on certified systems, gave clear indication of the origins, provided certificates of ownership, and records of the handling of the product. This information was able to be stored on one platform which made it easy to access and makes the supply chain transparent. The use of this technology was credited by the respondents of reducing the amount of fraud and theft of cargo.

The respondents estimated that the firm would be able to save at least Ksh. 10 million a year from the use of blockchain technology per their current calculations. The efficiency, transparency, reduction of processes, reduction in the paperwork associated with each good processed through the system all resulted in the reduction in the costs.

### 4.3.2 The Flow of Information

According to the interviewees the variety and age of systems coupled with a lack of standardization are the reasons that exchange of information takes a lot of effort for the multiple parties involved in the logistics process. This makes transparency a pressing issue concerning information systems in logistics. Transparency was identified as a second core requirement to facilitate the exchange of information over boundaries of organizations. The processes in logistics are quite opaque and from the interviews we gathered that even though logistics service providers would prefer their processes not to be as transparent to their customers in order to be able to maintain competitive advantages, they would like their internal processes to be transparent for ease of working.
By considering the privacy requirements and capabilities of Blockchain technology described in the subsequent sections, a correlation between the concepts of trust and transparency were identified. All respondents agreed that blockchain technology with its ability to provide a platform that facilitates the exchange information and its capability to store unalterable information can be a solution to the transparency issue in logistics. This therefore ensures a smooth flow of information from one party to another.

The respondents indicated that the blockchain technology had revolutionized the logistics and supply chain systems used by the firm. The contracts between the customers and the firm were able to be tokenized. The aim of this was to do away with vulnerabilities of the booking process and ensuring that the customers complied to the terms and conditions of the contract. When booking for freight and courier services, the customers were not required to pay in advance; this meant that there were no consequences if the customer did not deliver their products for transportation on time.

The blockchain system allowed for testing of a token deposit system in which the parties to the shipping contract used the smart contracts available on blockchain to make booking. The interviewees agreed that while the tokenized system allowed for a faster more transparent way of managing exception transactions, further testing was still needed to establish usefulness of the approach.

A majority of the respondents also indicated that the system allowed for the updating of transactions in real-time. The respondents felt that this removed the need to duplicate the transactions and helped in the workflow. Further, the respondents indicated that the use of blockchain had reduced the need to reconcile internal and external records. Information sharing and updates in the system allowed for all parties in the transaction be informed of progress. This had the overall effect of improving the firm’s performance.

4.4 Capabilities of Blockchain Technology

4.4.1 Blockchain Basics

Among the interviewees, there was a general agreement that blockchain technology is in a mature state in other sectors especially finance and cryptocurrencies such as Bitcoin. The matureness of blockchain technology in its applications outside of cryptocurrency was rated as not yet completely mature and still moving from alpha to beta stage. In logistics
especially, the interviewees all agreed that the technology was still in its infancy. The consensus was that the maturity level would be reached in another few years and any organization wanting to experiment with blockchain would have to proceed with extra caution and engage in extra planning. It was emphasized during the interviews that the technology used was dependent upon the specific use-cases within which it was supposed to be implemented.

The respondents from the corporate department indicated that in their research before the adoption of blockchain technology, they had established that they were multiple cases in which blockchain were not adding value. Thus, in order to determine the usefulness of blockchain technology, the firm decided to examine a few factors. The first consideration for the firm was to evaluate a need for a consistent, shared database. This was addressed by the use of the blockchain system which provided historical data that was consistent and immutable through cryptography. The respondents indicated that this was a key consideration given that the data used should not be altered.

The second consideration was to determine if more than one entity required accessing and writing data into the database. The respondents indicated that their operations require entities in different parts of the logistics and supply chain to access the database. The solution to this problem is to use blockchain systems that offer peer-to-peer features that allow for multiple users to add data into the distributed ledger. Where there is only one entity to write into the system blockchain technology was not required.

The third consideration was blockchain’s immutable characteristic. The respondents indicated that there was a major challenge of fraud and theft in the company and also in the industry as a whole. Because the blockchain system tested did not allow for alteration of historical data, it was found to be useful to the firm.

The fourth consideration for the firm was the sensitivity of the data input and held by the system. The participants indicated that the recoverability of the data easy was a major factor. The corporate respondents indicated that the blockchain system in some cases allowed full transparency thus they felt that sensitive data should not be stored on blockchain. This was despite the fact that blockchain was encrypted. The respondents indicated that the use of private keys reduced the chances of sensitive data being compromised.
The fifth and last consideration was whether the customers and other entities would agree that the firm should handle their data. The respondents indicated that the users, their customers, had to be given assurances about the safety of their data. The respondents indicated that blockchain was designed to address the trustless environment of the managed database. The respondents indicated that the answers to the questions were positive, thus the conclusion was that blockchain technology was relevant to the firm. The respondents indicated that the use of blockchain had also reduced searching costs related to obtaining information such as the identity of customers, verifying assets, obtaining know your customer information (KYC), and due credit assessment.

4.4.2 Consensus Finding

The matter of finding consensus was brought up by all interviewees. The IT experts all agreed that there were about 30 different possible consensus technologies and that the technological challenge was to figure out which consensus technology could be applied for which particular use-case. A point was brought up that the consensus mechanisms or algorithms of blockchain are in place to ensure that there is one version of the truth and everyone believes in the same thing, which is not necessarily possible in the current environment.

The respondents from the corporate department indicated that data was extremely valuable and that correct data was maintained lacked some necessary details. The respondents indicated that they required a detailed and substantial amount of data to conduct their job functions effectively and efficiently. Additionally, they felt that the data provided was sometimes not understandable as it came from multiple sources and was difficult to verify.

It was said that the degree of audit-proof was directly related to the consensus mechanism. The IT department believed a consensus like the proof-of-work, which is what is used in cryptocurrency, was not suitable for use-cases in business environments. Therefore, blockchain presented a challenge in this respect which was to make consensus finding more efficient. A proposed solution to this was to use game-theoretical approaches in finding consensus.

The respondents also indicated that the use of blockchain technology by the firm locally and internationally had improved the efficiency of handling products in the logistics and
supply chains. They indicated that the amount of paperwork that the firm needed to process had reduced significantly. Additionally, the automation of the process means that there can be a direct relationship between all parties to the transactions which made it easier to transfer ownership between the entities and to process payments.

Furthermore, a majority of the respondents indicated that the system allowed for the updating of transactions in real-time. The respondents felt that this removed the need to duplicate the transactions and helped in the workflow. In addition, the respondents indicated that the use of blockchain had reduced the need to reconcile internal and external records. Information sharing and updates in the system allowed for all parties in the transaction be informed of progress. This had an overall effect of improving the firm’s performance.

The respondents in the corporate department indicated that prior to the introduction of blockchain technology; the company created, saved, and shared its data using traditional methods such as flash disks, hardcopy documents and cloud databases. The previous approaches of handling data often required intermediaries. The respondents indicated that the use of the blockchain system had made it easy for the firm to save and share data without the need of third parties and provided a higher level of protection for the data.

The respondents also indicated that the blockchain technology created new business possibilities. This is because the technology had improved exchange of information and trade both locally and internationally. The technology provided a good linkage between all parties to the transaction thus allowing for greater volumes and types of transactions which in turn resulted in increased and new business for the firm.

4.5 Challenges in Implementation of Blockchain Technology

4.5.1 Industry Readiness

The interviewees agreed that there were major organisational implications described for companies when working with Blockchain technology. The general feeling was that blockchain implementation was bound to be a big paradigm shift for companies within the industry because the system is not completely owned by themselves but built on another ecosystem. This raised serious concerns on safeguarding of intellectual properties and maintenance of technological competitive advantages. Another key concern that was
raised was of access to multiple parties would create a situation where not every participant is known within the network.

The senior management was also concerned about the implication to some of the core business of the company itself and the other companies it works with such as SAP and ERP systems providers. It was noted that all the collaborating companies within the network would have to make changes to and upgrade their systems significantly but there was no indication of whether the industry was ready for such a shift.

Besides the implications within organizations, there is also the matter regarding the current use of different systems between different organizations in the industry. The general concern would be how to get all industry players to agree to one new-normal for the industry and work on development and roll-out at the same time to avoid inconveniences to any given party. How would the development of the different systems, which are mostly organized as collaborative open-source projects are handled? The senior management related this issue to earlier examples of digitalization pushes, where systems were developed by a single organization but later governed by multiple entities citing examples such as port systems and revenue collection technologies.

### 4.5.2 Governance

Governance relies on a set of policies and regulations and all interviewees agreed that blockchain in its current form did not have standard rules and regulations. The regulations vary from organizations to organizations and country to country. For a global company like Logistics Ltd the general feeling among the interviewees was that it would be difficult at first to scale the system to its other areas and regions of operations due to the lack of standard rules and regulations. The consensus was that a significant amount of time and effort would have to be spent on sorting this out before the application could be rolled out.

A situation was brought forth where if the current blockchain solution that Logistics Ltd was testing actually worked and was ready to be rolled out, only the company would be in a position to decide who joins the network. On a small scale those decisions would be easy, but on a larger scale there would be need for some guidelines around this issue.
4.5.3 Trust

It was further described that most of the Blockchain projects are open-source, and companies that are working with intellectual properties need to adapt their strategy to work with open-source software. This would create an issue where companies used to having their information systems private would be hesitant to use an open source system in the fear of having their intellectual properties compromised. However, it was clear from the interviews that opening up a company’s data to multiple sources would need to happen in order to have a successful blockchain system within the logistics sector. A solution for this was tabled through the use of permissions and specific use roles in private blockchains between the collaborating entities.

4.5.4 Cost

According to the senior management and IT department interviewees responses, setting up of initial blockchain infrastructure could cost upwards of USD 10-13 million for one project. This would make the whole exercise quite costly and the significant investments would have to be a priority for the entire company as a whole to make the large-scale investment possible.

Scalability, high maintenance costs and changes to legacy systems are part of the factors that were highlighted as contributing to the high costs. In addition, the time and efforts of the project teams taken out of their day to day also have to be considered as a human resource cost element as well.

4.5.5 Privacy

It was a general consensus that protection of intellectual property is a key requirement for a logistics operator. A key factor for competitiveness, especially in larger companies is the ability to manage information. This goes beyond pure protection but also includes the control over information. During the interviews, concerns that the application of blockchain was not designed to meet the requirements of privacy came up.

It was however revealed by the IT interviewees that there are ways to meet this requirement through private blockchain concepts with user and permission management. A possible scenario would be for the logistics sector to build public and private
blockchains that are interconnected. Sensitive information would be saved in a private blockchain with restricted access and at certain points, information can be published to a public Blockchain. This would ensure privacy but also allows processes to be transparent.

Figure 4.1 below provides a more detailed summary of the requirements, capabilities and challenges that each requirement entails as per the findings of the study. An illustration of how the requirements of IS in logistics are met with the capabilities of Blockchain technology, the challenges that must be addressed if the technology is to be seamlessly incorporated is made. The table provides a complete overview of the analysis and can be used as guideline for practical application as well as for further research efforts.

Table 4.1 Requirements Summary Table

<table>
<thead>
<tr>
<th>Requirements of IS in Logistics</th>
<th>Capabilities of Blockchain technology</th>
<th>Challenges</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection of intellectual property</td>
<td>User roles and permissions in private blockchains</td>
<td>Private Blockchains are less decentralized</td>
<td>Organisational</td>
</tr>
<tr>
<td>Organization overarching system to access information</td>
<td>Allows sharing and distribution of authentic information across multiple organizations</td>
<td>Companies need to change their mind-set in terms of data management and ownership</td>
<td>Organisational</td>
</tr>
<tr>
<td>Digital document transfer between organizations</td>
<td>Hash value of data is stored in a Blockchain</td>
<td>Data storage concept needs to be developed</td>
<td>Technical</td>
</tr>
<tr>
<td>Integration of customs systems</td>
<td>Smart contracts to follow regulations and call APIs of third party systems</td>
<td>Authorities need to be involved in the process</td>
<td>Organisational</td>
</tr>
<tr>
<td>Control over data</td>
<td>Stack like approach of private and public Blockchains</td>
<td>Clarification of ownership of future platforms</td>
<td>Organisational</td>
</tr>
<tr>
<td>Ensure data security</td>
<td>Data is distributed to all nodes, which means once the data is out it can’t be reverted</td>
<td>Hacking and data breach</td>
<td>Technical</td>
</tr>
<tr>
<td>Transparency towards customers to provide proof of provenance</td>
<td>Publication in a public Blockchain as proof to the public</td>
<td>Establishing of connections between different Blockchains</td>
<td>Technical</td>
</tr>
<tr>
<td>Ability to trace goods through the whole supply chain</td>
<td>Allows sharing and distributing of authentic information across multiple organizations</td>
<td>Storage for transactions that can be altered, which ensures correctness</td>
<td>Organisational</td>
</tr>
</tbody>
</table>

4.6 Chapter Summary

This chapter presented the results and findings of the analyzed data. The chapter relates the findings to the research questions of the project. It was a general agreement that
blockchain technology has the capability to improve the flow of goods and information by providing an organization overarching information exchange system that addresses the requirements regarding privacy, transparency and trust. Due to fewer disruptions in the flow of information, the flow of goods is improved as well.

It was also found that blockchain has the capabilities regarding privacy, transparency and trust to meet the requirements of information systems in logistics. This can be achieved through implementation of user management and access control mechanisms and a mixed approach of private and public Blockchains.

With regards to the challenges in blockchain implementation. It was a general consensus from the interviewees that industry readiness, governance, trust, privacy and cost were major hurdles that would need to be addressed to facilitate the successful implementation and roll-out of a blockchain system within the industry. The next chapter will present the discussions, conclusions and recommendation of the study based on results and findings.
CHAPTER FIVE

5.0 DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter contains the discussion based on the outcomes of the previous chapters. This section of the study provides the summary of the findings, conclusion, and recommendations of the study based on the research questions.

5.2 Summary

The purpose of the study was to evaluate disruptive technologies by studying the application of blockchain technologies in logistics and supply chain industry. To achieve the objectives of the study, the researcher undertook a case study of Logistics Ltd which is a global logistics firm with a presence in Kenya and sought to answer the following research questions; how can Blockchain technology improve the flow of goods or information in the logistics sector, how can the capabilities of Blockchain technology meet the needs of privacy, transparency and trust in logistics and the challenges in implementation of blockchain in logistics.

The research design adopted for the study was the descriptive qualitative research design due to the how and why nature of the research questions. The study data was collected using interviews from a sampling frame drawn from the 531 employees of Logistics Ltd. The participants were selected using stratified sampling and purposive sampling techniques.

The study found that Blockchain technology has the potential to improve the flow of goods and information in logistics by improving the information flow between organizations and especially by including small businesses and sole proprietors. Blockchain technology was found to facilitate better flow of information by providing organizations with an overarching information exchange system that addresses the requirements regarding privacy, transparency and trust.

The study also found that blockchain and its capabilities regarding privacy, transparency and trust are able to meet the requirements of information systems in logistics. It was found that this could be done with the implementation of user management and access
control mechanisms through a mix of private and public blockchains. Certain data could be saved in public blockchains in order to be able to provide proof to the public.

Lastly the study established that there were several key challenges in the development and implementation of blockchain in logistics. The challenges could be categorized into technological and organisational challenges and the major ones were found to be industry readiness, governance, trust, privacy and cost. The study found that all these would need to be overcome in order to successfully implement and roll out blockchain in the industry as they limited the adoption of blockchain in the logistics and supply chain industry.

Since research on this topic is still in its infancy and this research paper contributes to the discussion to develop theory about the use of blockchain technology in logistics.

5.3 Discussion

5.3.1 Blockchain and the Flow of Goods and Information

Logistics and supply chain management are regarded as domains where blockchains are good fits for a series of reasons. In the literature presented in this study logistics is viewed as a part of supply chain management Supply chain management involves the flow of three key resources, which are the flows of information, goods and finances (Chen, Drezner, Ryan, & Simchi-Levi, 2000); (Kulp, Lee, & Ofek, 2004); (Mentzer, et al., 2001). The flows of goods and information are especially important for the logistics process (Klein & Rai, 2009). The study identified that blockchain has the technological capability to provide an exchange platform for all parties involved in the information exchange process.

5.3.1.1 The Flow of Goods

The study found that fewer disruptions in the flow of information in turn made an impact on the improvement of the flow of goods as well. The results of the study confirmed the notion that the successful flow of physical goods depends on the flow of information as presented by Sheombar (1992); Hou, Chaudhry, Chen and Hu, (2017). This example illustrates the synergy between the information flow and the flow of physical goods which was also confirmed by the findings of the study.
During the testing phase of the blockchain application at Logistics Ltd. it was found that an improved flow of goods in the supply chain elicited positive reactions from customers which led to increased bookings for the company. Research on organizations structures has described use of innovative systems in logistics influences strategy and provides increased competencies concerning the competitive advantages of logistics companies (Bowersox & Daugherty, 1995). Lewis and Talalayevsky (1997) also explain that the use of information systems in logistics goes beyond simply providing the status information of the flow of goods. This statement adequately represents the findings of the study.

5.3.1.2 The Flow of Information

The study identified that transactions could be verified, recorded and coordinated autonomously without need for intermediaries within the process. During the lifecycle of the product, as it flows down the value chain (from production to consumption) the data generated in every step can be documented as a transaction, thus creating a permanent history of the product. The study identified that blockchain technology with its ability to provide an exchange platform for all parties involved in the logistics process has the potential to improve the whole logistics workflow. Advice for practice is that there is a possible scenario for the blockchain if information is shared across borders of organizations and if the information must be authentic and real.

This was in line with the initial literature that stated blockchain paves the way for a “trust-free” economy, where no trusted third party is needed, due to the transparent and highly secure design (Becker et al., 2013; Beck et al., 2016). As Blockchain technology does not have a single source to verify the authenticity of information exchanged in the system, all participants are mutually untrusted, and the trust is generated through the consensus mechanism of the Blockchain (Milutinovic et al., 2016; Zyskind& Nathan, 2015).

5.3.2 Capabilities of Blockchain Technology

In the literature, a research gap between the relationship of privacy and transparency concerning blockchain technology in logistics was identified. The results of this study indicate that privacy and transparency are not contradictory concepts. All the previous literature is based on the idea of using a data centralized system. Which was, until recently, the main conceivable approach to achieve information transparency along supply chains? With the rise of Blockchain, a whole new approach has drawn attention
from researchers in many different domains in public services, Internet of Things (IoT), smart cities, reputation systems and security services (Elgazzar & Hemayed, 2016).

While discussing the benefit of merging blockchain technology in manufacturing supply chain. They listed the main characteristics of the blockchain software architecture to enhance trust through transparency and traceability in the supply chain network. In addition to the transparency within any transaction of data, goods, and financial resources, blockchain could offer an innovative network for new decentralized and transparent transaction mechanism in industries and business (Zyskind, Oz, & Pentland, 2015). Based on the results of the research project, it was established that at this stage it is important to explore use-cases and develop an understanding of which form of blockchain would need to be implemented to ensure sustained privacy and transparency within the same account control mechanisms.

The study further established that blockchain characteristics through the basics of its in-built infrastructure and its consensus mechanisms further enhanced its capability to meet the needs of privacy, transparency and trust in logistics.

5.3.2.1 Blockchain Basics

The study found that blockchain features of distributed ledger technology allowed of records of supply chain transactions to be shared between multiple parties in a secure and permanent way. This removed the need for intermediaries who were previously required to act as third parties to verify, record and coordinate transactions. This finding is in line with that of Huetger and Kueckelhaus (2018) that by blockchain facilitating the move from a centralized to a decentralized distribution system, it effectively liberates data that was previously kept in safeguarded silos.

The study further found that use of this blockchain application made it possible for Logistics Ltd to fulfill the requirements for privacy and transparency within the logistics information system.

Privacy can still be achieved whilst maintaining a certain degree of transparency. The study showed that challenge for organizations would be to determine which information was made publicly available and which information must be protected. Kosba et al. (2016) identified a lack of transactional privacy in blockchains and the results of the study
confirmed that transactional privacy raised important questions in logistics as well, especially regarding information about partner networks. A solution to that problem was identified with the use of private and permissioned approaches recording of data in the form of hash values. Private Blockchains introduce user account control mechanisms, which allow restricting the access to a Blockchain to a specific user group.

The blockchain technology allows more secure tracking of all types of transactions (money transactions, data transactions, information transactions, etc.). In the logistics sector, blockchain technology could dramatically reduce time delays, added costs and human errors. Blockchain technology can be the solution for overall improvement of logistics, it can help reduce or eliminate fraud and errors, minimize costs, reduce waste and delays, improve inventory management and it can help to identify issues faster. The study indicated that the technology can facilitate logistics tasks: it can be used to track purchase orders, order changes and freight documents, and it can help in information sharing about manufacturing process and delivery.

The study findings suggest that the next point for practitioners is to start developing prototypes, because the programming logic of smart contracts is different from common, object-oriented programming languages. The fact that a Blockchain is not owned and controlled by a single entity requires a change of attitudes within organizations. There is indeed a big difference between data management in a central database and data management in a Blockchain in the way in which entries are stored and are distributed over the whole network. Steps must be taken to ensure that no sensitive data is published to the public network to prevent legal consequences as well as harm for the own business.

**5.3.2.2 Consensus Finding**

The study also established that the blockchain application was able to make use of the cryptography to verify the correctness of transactions. This was previously a key challenge for Logistics Ltd due to the complex nature of its business. This backed up the notion by Yli-Huumo et al. (2016) who stated that one of the basic concepts of blockchain was its consensus mechanism which in effect eliminates the need for a trusted third party.
The study further found that the applications ability to be able to eliminate the need for third party verification made it possible for Logistics Ltd to fulfill the trust requirement within the logistics information system.

The potential of Blockchain technology to create trust between two parties was identified in earlier studies (e.g. Milutinovic et al., 2016; Zyskind& Nathan, 2015; Lemieux, 2016). This research shows that a trusted third party is still required in logistics to operate. The potential of the Blockchain to eliminate the need of a third party to created trust is valuable for logistics providers. Trust can be created by improving the transparency of logistics processes and by enabling compliance through technology in the form of smart contracts. Trust in the sense of information sharing was examined as well by Klein and Rai (2009), and the results of this study show that businesses in logistics demand control over their private data, which confirms the earlier study.

5.3.3 Challenges in Implementation of Blockchain in Logistics

5.3.3.1 Industry Readiness

The study found that there was limited awareness of the technology especially in the logistics industry and this hampered industry readiness which would need to be addressed before full scale deployment of blockchain technology could be achieved. This concurred with Yli-Huumo, Ko, Choi, Park and Smolander (2016) who claim that previous research has been restricted to crypto currencies of blockchain technologies but that the technology’s characteristics make it adaptable to other areas than the financial one (Anjum, Sporny, & Sill, 2017). Moreover, White (2017) confirms the argument that little research has been made solely on blockchain technologies, and that the conducted research is mostly developed from the computing field. The principal challenge associated with blockchain is a lack of awareness of the technology, especially in sectors other than banking, and a widespread lack of understanding of how it works. This is hampering investment and the exploration of ideas (Swanson, u.d.).

In addition, another challenge was found in the of leadership in logistics companies. Based on the results, there is a lack of IT affinity in management and therefore information systems are often not seen as means to add value but merely as means to an end. Management needs to see their value in order to successfully implement new technology.
5.3.3.2 Governance

The study found that blockchain in its current shape and form did not have a standard set of rules and regulations. This presents a challenge in that each company or region was developing its own set of rules and regulations to fit its blockchain solution. This agreed with the notion brought forth by Anjum, Sporny and Sill (2017) that there will probably be not just a single blockchain-based system in the logistics industry; instead, there will likely be multiple private permissioned blockchains due to the competitive nature of business. The future will also present multiple public blockchains.

5.3.3.3 Trust

The potential of Blockchain technology to create trust between two parties was identified in earlier studies (e.g. Milutinovic et al., 2016; Zyskind & Nathan, 2015; Lemieux, 2016). This research shows that a trusted third party is still required in logistics to operate. The potential of the Blockchain to eliminate the need of a third party to created trust is valuable for logistics providers. Trust can be created by improving the transparency of logistics processes and by enabling compliance through technology in the form of smart contracts. Trust in the sense of information sharing was examined as well by Klein and Rai (2009), and the results of this study show that businesses in logistics demand control over their private data, which confirms the earlier study.

5.3.3.4 Cost

The research found that setting up blockchain infrastructure could cost anything upwards of USD 10-13 million per project but also dependent upon the type of blockchain solution being implemented. That makes the whole exercise quite costly and the significant investments would have to be a priority for the entire company as a whole to make the investment worth it. This is in line with the literature that stated the speed and effectiveness with which blockchain networks can execute peer-to-peer transactions comes at a high aggregate cost, which is greater for some types of blockchain than others (Glöckner, Ludwig, & Franczyk, 2017).
5.3.3.5 Privacy

The study revealed that the protection of intellectual property is a key requirement for a logistics operator. A key factor for competitiveness, especially in larger companies was found to be information management. This goes beyond pure protection but also includes the control over information. The study highlighted concerns that the application of blockchain was not designed to meet the requirements of privacy.

This finding is in agreement with Léauté and Faltings (2011) who describe the dilemma of logistics providers to coordinate their operations to keep costs low and the degree of information that they are willing to share and what to keep private. While the Blockchain technology has potential to solve the problem of overarching communication between organizations (Christidis & Devetsikiotis, 2016), it is stated that the technology lacks transactional privacy (Kosba at al., 2016; Zhang, Cecchetti, Croman, Juels and Shi, 2016) which in turn threatens a firm’s competitiveness.

Rethinking is also required in terms of intellectual property and the use of open-source software. All major Blockchain platforms are open-source software and if companies are used to develop proprietary software, they need to employ open-source strategies to handle this change.

5.4 Conclusions

5.4.1 Blockchain Technology and the Flow of Goods and Information

The study concludes that blockchain technology offers an innovative platform for a new decentralized and transparent transaction mechanism in industry and business. Blockchain technology can improve the flow of information by providing an organization overarching information exchange system that addresses the requirements regarding privacy, transparency and trust. Due to fewer disruptions in the flow of information, the flow of goods is improved as well.

5.4.2 Capabilities of Blockchain Technology

The study concludes that Blockchain technology offers an innovative platform for a new decentralized and transparent transaction mechanism in industry and business. Features of this technology increase confidence through transparency within any transaction of data,
goods, and financial resources. Blockchain technology can easily provide secure business operations in logistics. The technology platform is based on a decentralized system, and it creates a permanent record that can be shared and publicly accessible thus fulfilling the requirements of privacy, transparency and trust within the logistics information system.

5.4.3 Challenges of Implementing Blockchain Technology in Logistics

The study concludes that blockchain applications within logistics industry are still in its infancy. This presents several challenges that will need to be resolved before industry-wide adoption becomes a possibility. The main challenges that will need to be overcome are a lack of industry readiness, lack of governance, a lack of trust between collaborating parties in the industry, high cost of implementation and privacy requirements.

5.5 Recommendations

5.5.1 Recommendation for Improvement

5.5.1.1 Blockchain and the Flow of Goods and Information

The study established that blockchain technology can be an enabler for a much-needed push for digitalization in the logistics industry that will significantly improve the flow of goods and information. Therefore, the study recommends that companies begin to look for ways to collaborate on blockchain projects in order to be able to adequately test the concept.

5.5.1.2 Capabilities of Blockchain Technology

The study established that blockchain technology besides the application in cryptocurrencies is still in its infancy. Therefore, the study recommends exploration of use-cases in order to develop an understanding in which application scenarios blockchain technology can add value.

5.5.1.3 Challenges of Implementing Blockchain Technology in Logistics

The study established that challenges of industry adoption, governance, trust, privacy and high implementation costs will need to be addressed before blockchain can be fully adopted. Therefore, the study recommends deployment and testing of open-source strategies to be able to overcome these hurdles.
5.5.2 Recommendation for Further Research

This research can be used as a basis to conduct further research regarding blockchain technology in logistics but based on the experience throughout the process of the thesis and the case study, it is suggested to place further research in the broader topic of supply chain management. In addition, the issue of an efficient way to find consensus is a pressing research topic, as this is a crucial part of the technology and has yet to be solved. A final suggestion for further research is to investigate how small companies and sole proprietors can be successfully included in a Blockchain based system because the supply chain integration plays a crucial role.
REFERENCES


Rouse, M. (2019, February). *Software as a Service (SaaS).* Retrieved from TechTarget: https://searchcloudcomputing.techtarget.com/definition/Software-as-a-Service


APPENDICES

Appendix A: Interview Guides

Before the start of an interview, I will propose to record the interview. The recorded material will only be available for the researcher during the analysis process and deleted afterwards and this will be explained to the respondents. However, interview participants names will not be mentioned in the recording, only designations will be used in cases where the respondent will not be comfortable with their identity being revealed.

First, a short introduction about myself and the project is explained to the interview participants. Moreover, the research purpose as well as the research questions is presented. In the second step, the interviewees are informed why they are suitable candidates for our research. It is explained that we conduct interviews with companies that are having experiences with the blockchain technology through being a provider for blockchain solutions or being interested in an implementation of the technology or having used the technology before.

After the introduction to the interview, the main questions are asked. A general draft of the asked questions is prepared in advance. Nevertheless, the interviewer will be flexible, and questions can be changed depending on the situation and responses. In general, the questions for the interview participants are organized in these main topics: Disruptive technologies, blockchain in general, blockchain solutions in logistics and supply chains, and reasons why to implement the technology. The questions are designed as follows:

Section A: Blockchain and the Flow of Goods and Information

1. How would you describe your experience with IT systems in the logistics?

2. How would you describe the role of the following concepts in regard to information systems in logistics?
   a. Privacy (control over one’s information)
   b. Transparency (visibility of the logistics process)
   c. Trust (willingness to share information with partners)
**Section B: Capabilities of Blockchain Technology**

1. Can you tell me about your experiences with the Blockchain technology?

2. How mature is the Blockchain technology at this point?

3. In your opinion, what are important requirements for an information system in logistics?

4. Based on your experience, where do you see the biggest potential for the Blockchain?

5. How would you describe the role of the following concepts in regard to the blockchain technology?
   
a. Privacy (control over one’s information)
   
b. Transparency (visibility of the logistics process)
   
c. Trust (willingness to share information with partners)

**Section C: Challenges in the Implementation of Blockchain Technology**

1. How would you describe the general understanding of the Blockchain technology?

2. Public vs. private Blockchain: What advantages and disadvantages does either of the approaches have?

3. What role does scalability play in terms of transactions per second and number of nodes?

4. How can compatibility to existing IS infrastructure be established?

5. Can you give an outlook on the success or failure of the project?

6. Is there anything else you would like to add?
Appendix B: Data Collection Overview

Table 5 below illustrates the data collection methods, instruments and sources used in the research project. The projects primary source of data was through semi-structured interviews; one-on-one, focus groups and conference calls were the methods used to conduct the interviews due to the large number of respondents involved in the project.

Table 4.2: Data Collection Overview

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Data Source</th>
<th>Number of Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-structured interviews</td>
<td>One on One Interviews</td>
<td>Senior Management</td>
<td>10</td>
</tr>
<tr>
<td>Focus Groups</td>
<td>IT Department in two batches of 10 each</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>External Con Calls</td>
<td>Operations Department in batches of 10 each</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Documents</td>
<td>Meeting notes</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technical documentation</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Project presentation slides</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Meetings</td>
<td>Regular internal project meetings</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meetings with project partners</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
Appendix C: Content Analysis

Table 6 below illustrates the analysis of the collected data and the general themes that were drawn from the data. The analysis was tabulated according to the research questions:

Section A: Blockchain and the Flow of Goods and Information

Section B: Capabilities of Blockchain Technology

Section C: Challenges in the Implementation of Blockchain Technology

Themes were then drawn for the responses and thereafter given a rating based on the number that were in agreement with the general statements and given a score in order to be able to draw conclusions and create the thematic map;

Table 4.3 Content Analysis
Appendix D: Thematic Map

The final thematic map is depicted in Fig 5 below. The map was drawn to give an illustration of the outcome of the analysis from the data collected during the interviews, documents and notes. The map reflects the core requirements of information systems in logistics in relation to the core capabilities of the BlockShard application that was tested throughout the project that sought to showcase the capabilities of blockchain technology in Logistics Ltd. The map illustrates the connect of the information system, blockchain technology and the concepts of privacy, transparency and trust.

Figure 4.1: Final Thematic Map