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Tambudze, Pelagia. (2024). Factors Affecting Blockchain Technology Adoption by Organizations in the Livestock Supply Chain Industry in Zimbabwe [Masters dissertation, University of the Witwatersrand, Johannesburg]. WIReDSpace. https://hdl.handle.net/10539/45071

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RESEARCH REPORT

Factors Affecting Blockchain Technology Adoption by Organizations in the Livestock Supply Chain Industry in Zimbabwe



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Date: 30 March 2024

Declaration

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Master of Commerce in Information Systems to Wits University, Johannesburg. It has not been submitted before for any other degree or examination at this or any other University.

_____

Pelagia Tambudze

30 March, 2024

Acknowledgements

All thanks to the Almighty God, who makes all things possible, for the grace and blessings during this research study.

I am sincerely grateful for the support, counsel, and motivation of my supervisor, Dr Naomi Isabirye who was always available to assist and provide valuable feedback throughout the research.

I also truly appreciate all the participants who agreed to take part in this research and shared their knowledge despite their busy schedules.

Dedication

I dedicate this research to my family for their steadfast support and motivation throughout the study. Your unconditional love and zeal to succeed inspired me to complete this research.

A special thanks to all participants who contributed immensely to this research.

Finally, all praise to HIM, who gives strength. Thank you, Lord, for this and many other blessings!

Abstract

Blockchain is a distributed ledger technology that provides the building block for many innovations. The distributed nature of blockchain, its immutability, and anonymity enable trust, transparency, and security among transacting or trading partners. The accelerated unfolding of 4IR due to the COVID-19 pandemic recently unveiled several critical gaps within global supply chains, including livestock supply chains. The main challenges faced by organizations in the livestock supply industry in the developing world include difficulties for farmers in accessing new markets, no flexibility in production times, and no traceability for the consumer market to trace food component authenticity. In Zimbabwe, livestock is an important sector contributing about 22% of the total GDP. From several studies done by other researchers in different industries, such as health care, banking, mining, education, and agriculture, it is evident that blockchain technology solves most of these issues by decreasing data asymmetries and the cost of transactions to benefit all stakeholders. Blockchain-based solutions have recently been introduced to the livestock sector, and Zimbabwe is one of the early adopters among its African counterparts. However, the adoption rate by organizations within the livestock supply chain has been minimal. Using the lens of the TOE framework, this study investigated the factors that affect the decision by organizations in Zimbabwe's livestock supply chains to adopt blockchain technology. A qualitative approach was applied, interviewing fifteen informants from various levels of the livestock supply chain. Responses were analysed using thematic analysis. The study found that adopting blockchain benefits organizations and the overall livestock supply chain. The study found that technological, organizational, and environmental factors influenced organizations' decision to adopt blockchain technologies within livestock supply chains. These factors included availability of the technology, cost of the technology, skills availability, regulation and policies, competitive pressures, presence of blockchain providers, political and socio-economic factors and market trends.

Keywords: adoption, anonymous, blockchain, decentralized, developing country, distributed, innovation, immutable, livestock, supply chain, technology-organization-environment framework, service provider

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List of Abbreviations

4IR	Fourth Industrial Revolution
AI	Artificial Intelligence
BCT	Blockchain Technology
CAPEX	Capital Expenditure
DLT	Distributed Ledger Technology
DOI	Diffusion of Innovation
ERP	Enterprise Resource Planning
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
IoT	Internet of Things
IS	Information Systems
IT	Information Technology
OPEX	Operational Expenditure
RFID	Radio Frequency Identification
ROI	Return of Investment
TAM	Technology Acceptance Model
TOE	Technology, Organisation, and Environment
TPB	Theory of Planned Behaviour
UTAUT	Unified Theory of Acceptance and Use of Technology
VUCA	Volatility, Uncertainty, Complexity, and Ambiguity

Chapter 1: Introduction

1.1 Introduction

The Fourth Industrial Revolution (4IR) has brought about a paradigm shift in how organizations and individuals across all organizations operate. The indicated re-imagination of industries has seen new and untapped opportunities being created. 4IR is defined as the coming together of several new innovative technologies, these technologies include artificial intelligence (AI), big data, cloud computing, Internet of Things (IoT), and blockchain among others (Xu et al., 2018; Huawei 2018). This revolution, which is mainly characterized by digital transformation has suddenly become a necessity and there has been a profound impact on all industries including the agricultural sector. Herrmann (2019) explains that the fourth industrial revolution (4IR) is disrupting daily operations for all agricultural players, from typical peasant farmers to commercial farmers (Hughes et al., 2019a). In the agricultural sector, this 4IR concept has been named by Zambon et al. (2019) as Agriculture 4.0.

According to Pogorelskaia & Várallyai (2020), Agriculture 4.0 can be referred to by different terms which include smart agriculture, intelligent agriculture, digital farming, and digital agriculture. The concept aims to transform the agriculture industry by increasing competitiveness using modern technologies such as the Internet of Things, Artificial Intelligence, Robotics, Drones, Cloud Computing, and Blockchain. The end goal of applying technology in agriculture is to improve the profitability and economic-environmental-social sustainability of agriculture. This is because technology warrants the elimination of inflexible processes in operations that hamper the agricultural supply chains, (Nyagadza et al., 2022).

The major challenge that the agriculture industry faces is the need to determine and verify the origin of food and its authenticity. Thus from the moment stock is kept at a farm, until harvest, slaughter, or other livestock produce is distributed and consumed by the end customer, (Sylvester, 2019). A lot of mistrust and unreliability have been a factor in agriculture, especially in the livestock sector. Technology and most importantly blockchain have allowed massive ideas and initiatives to be devised to eliminate challenges within the supply chain, (Sylvester, 2019). Blockchain technology as highlighted by Bublitz et al. (2019) and a report by Accenture (2017) is emerging into a robust tool for introducing radical changes that bring efficiencies in processes, and the ultimate realization of potential value that is not being realized currently due to existing extensive processes.

The World Bank (2021) posits that in agriculture, blockchain technology can decrease data asymmetries and the cost of transactions to benefit both the farmers and end-consumers. Hughes et al. (2019) summarise the properties of blockchain, and it can be deduced from their study that blockchain enables trust in the transfer of value, assets, or data between two or more parties without the need for a trusted middleman. All the exchanges (transactions) are recorded in a shared list (commonly referred to as a distributed ledger) between all users of the blockchain.

1.2 Background

Based on a report by the Food and Agriculture Organisation, FAO (2018), livestock production constitutes a very significant and important economic output for both developing and developed countries, a contribution that goes beyond direct food production. For developing countries, animal products not only represent a source of high-quality food, but, equally important, they are a source of income for many smallholder farmers. This is supported by Rota (2016) who indicates that livestock accounts for at least 30 percent of the agricultural GDP of developing countries and more than 33 percent of household income

During the peak of the COVID-19 pandemic, the World Economic Forum Report (2021) highlighted the critical gaps and weaknesses in global supply chains. These gaps and weaknesses include sustainability, integration, and visibility. Thus, how stakeholders in the chain are interlinked by processes - integration, but due to the complexity of the processes they remain invisible to each other - visibility, leading to compromise of the chain - sustainability, (Khan et al. 2022). Blockchain technology due to its properties, can offer trust, and transparency and build resilience in the supply chains. Leveraging these properties, many proofs of concept to extract the value of blockchain in supply chains have been undertaken (Rocha et al., 2021).

An example is the Walmart supply chain management use case. In this instance, due to the distributed ledger technology of blockchain, discrepancies in invoices and payments were eliminated (Vitasek et al., 2022). In the mining sector, according to Ambler (2017), issues to do with unethical dealers and trust, mainly emanating from back-door dealings, especially in the diamond mining sector have also been addressed by some organizations using blockchain technology. This is because authenticity can easily be attained due to the immutability property of blockchain. Table 1 summarises these examples to give a viewpoint of how different industries have applied blockchain technology to solve challenges they were facing in their supply chains.

#	Industry	Challenge Faced	Blockchain Application	Source
1	Water Transportation industry, Hyundai Merchant Marine	• Vast data discrepancies at every end of the supply chain Payment processing delays to freight carriers • Invoices delayed at vendors' end • Slow update of inventory in the warehouses • Systemic disruption because of the macro environment.	• Blockchain network technology to overcome the incompatible management information systems across various players in the supply chain management to establish a shared truth. • Accessible by each player in the supply chain.	(EMBA, 2022)
2	Supply Chain Management, Walmart Canada	• Vast data discrepancies in the invoice and payment process for freight carriers, which required costly reconciliation efforts and caused long payment delays	• Walmart Canada contracted DLT Labs, a leader in developing and deploying innovative enterprise solutions using distributed ledger technology. • Before DLT Labs had over 70% of invoices were disputed. • Today less than 1% of invoices have discrepancies, and these disputes are easily flagged and quickly resolved	(Vitasek et al., 2022)
3	Mining, Diamond Sector	• Unethical dealers • Legitimate diamonds have a reputation for being sold through back-room dealings with cash and a handshake. • Fraudulent claims for lost jewellery have resulted in billions in losses each year.	• Verify the authenticity, provenance, and custody of diamonds using a single source across the supply chain	(Ambler, 2017)
4	Health; Distribution and delivery of the Coronavirus 2019 (COVID-19) vaccine	• Absence of temperature monitoring systems for thermo-sensitive vaccines. • Absence of equipment that is capable of storing vaccines • Insufficient number of trained staff that can handle and transport the vaccines.	• Ensures that COVID-19 vaccines will be administered to beneficiaries in good condition by monitoring them in real-time while they are being delivered to vaccination centres. • Allows users to verify the origin of the vaccine.	(Musamih et al., 2021)

Table 1.1 Blockchain Use Cases

1.3 Problem Statement

The livestock sector and its supply chain in developing countries especially in Africa is hampered by numerous challenges. These challenges arise throughout the chain from calving or birth of livestock, the feed, immunization, and other medicines required by the animal, abattoirs, processing, and distribution of the livestock produce, up till the consumer at the end of the cycle. It is very difficult to identify the brands or specific persons who were involved in each of the stages. The lack of visibility of the players makes it difficult to comply with global regulations which require information on the source level geo-coordinates and composition of any produce to be readily accessible. This therefore makes it difficult for new market penetration to sell produce, (Rota, 2016; Soosay & Kannusamy, 2018).

Looking at Zimbabwe, being a developing country in Southern Africa, with a unique environment, these challenges have been very prevalent. 66% of Zimbabwe's population relies on agriculture for their livelihood, while 40% of these are in livestock management. Zimbabwe's economy largely relies on livestock, according to the Government of Zimbabwe (2022)publication livestock encompasses 22% of its total GDP. The fact is that of the 5.5 million total herds, only 800,000 cattle belong to commercial farmers with the rest being owned by the smallholder communal farmers. This makes the Zimbabwean situation very unique. Due to shortages of resources such as funding, it is difficult for communal farmers to acquire the necessary equipment and technologies to improve processes in their day-to-day operations. Micro and Small to medium enterprises, MSMEs also make up about 90% of organizations making up the livestock supply chain thus the distributors, processors, and retailers. The MSMEs are mainly undocumented thus they are not compliant with regulations concerning company registrations, (African DevelopmentBank, 2019). This means that it is very difficult for policies to be applied and fully adhered to compromising the whole livestock supply chain and exposing it to unethical dealings and difficulties in controlling the movement of livestock widening the risks of disease outbreak spread, lack of trust between trading partners in the chain and animal theft, (Aich et al., 2019; MasterCard, 2021).

As explained by Rukasha et al. (2021), these challenges have adversely affected Zimbabwe's economy as it becomes difficult to generate foreign currency through exporting livestock produce especially to lucrative markets in Europe and the Middle East. As evidenced by MasterCard (2021) blockchain-based technology solutions can be an answer to these issues. Blockchain presents an opportunity to ensure that all data from each stage of the cycle is accurately available ensuring there is transparency among all transacting parties. This is made

possible by the characteristics of blockchain which are built on a decentralized database solution making information available to all concerned parties, while the data cannot be easily modified and accessed by unauthorized parties, Aich et al. (2019).

These blockchain-based solutions in the Livestock sector are still a fairly new concept and are regarded as an innovation. Zimbabwe is among the first adopters of such solutions, however, acceptance and use by all organizations within the livestock sector supply chain remain very limited (MasterCard, 2021). This is one of the motivations for the focus on the livestock supply chain in Zimbabwe in this study. While blockchain is a solution to the challenges indicated above, adoption of the technology is still very limited by these organizations. This study examines the factors affecting blockchain adoption to provide recommendations that promote technology adoption decisions.

1.4 Purpose of Study

For organizations in the livestock farming supply chain to capitalize on the benefits of blockchain technologies, there is a critical need to understand the barriers to blockchain adoption. This study seeks to examine the factors that affect the decision by organizations in the livestock supply chain to fully adopt and or not adopt blockchain-based technology as an innovation in their supply chain. Henceforth, the specific objective of this study is to evaluate and answer the following research question: **What are the factors affecting the adoption of blockchain technology by Zimbabwean livestock farming organizations to support the livestock supply chain?** To address the research question, the study will examine the technological, organizational, and environmental characteristics surrounding an organization. In addition, the study will establish how the properties of blockchain as a technology as well as the perceived benefits of adoption will influence the decision to adopt it.

1.5 Intended Contribution of Study

Looking at developing countries such as Zimbabwe, the adoption of blockchain by organizations in livestock management can be classified in the evaluation Stages of the technological innovation lifecycle. This means that this technology is at a phase where it is becoming more defined, with clarity on product offerings and organizations contemplating decisions to adopt. Pichlak (2016) explains this as a phase in which managers of organizations look at the practical, strategic, financial, and/or technological perspectives of adopting the technology, and also do the resource allocation for its acquisition. According to MasterCard (2021) although the MasterCard Provenance Solution, which is blockchain-based, is usage-ready, looking at Africa at large, it has been adopted so far by a few organizations in Zimbabwe only and the rest of Africa still exploring its feasibility.

Several studies have been done focusing on barriers and factors that impede blockchain technology adoption in supply chains in the agricultural sector as highlighted by Zhang et al.(2023) and Sylvester (2019). These studies have not, however, touched on the adoption of this technology in the livestock sector specifically for developing countries such as Zimbabwe, which face unique conditions that impede blockchain adoption. Past studies tend to focus more on the properties of blockchain technology and how these provide benefits to those who would have adopted it, examples include the studies by Bikoro (2022) and Wang et al. (2019). This study intends to leverage this gap and investigate the factors that cause organizations to decide to adopt blockchain technology to support livestock supply chains.

This study also seeks to contribute to the blockchain and livestock management body of knowledge, by being a source that is of practical use and importance to institutions wanting to adopt blockchain-based systems. Future considerations for this study are to apply the proposed model in other industry sectors as well as other countries to gain a clear perspective on this technology adoption in different set-ups.

1.6 Research Questions

The following section highlights the key research questions to be answered by this paper.

1.6.1 Main Research Question

a) **What are the factors affecting blockchain adoption decisions by livestock supply chain organizations in Zimbabwe?**

1.6.2 Specific Research Questions

a) **What are the challenges faced by organizations in a livestock supply chain?**
b) **What are the characteristics of blockchain that can benefit livestock supply chains?**
c) **What factors affect the adoption of blockchain technologies in developing countries?**

1.7 Delimitation of Study

This study will only focus on both private and public organizations within the livestock agribusiness supply chain. As supported by Aich et al. (2019) and Chandra et al. (2019) the livestock supply chain consists of regulatory bodies, raw material suppliers, producers and farmers, distributors, wholesalers, retailers, and the end customer. The study will not limit organisations based on province or district in Zimbabwe. It will exclude other farming groups such as poultry farming, grain farming, and plantation farming.

Chapter 2: Literature Review

2.1 Introduction

This chapter reviews the literature on blockchain technology and its adoption by organizations in the Livestock supply chain. The main aim is to determine the factors that can lead to the adoption of blockchain technology by establishing the existing body of knowledge in this area. It initially discusses blockchain technology, livestock supply chain, as well as policy regulation in this area, particularly looking at Zimbabwe as the environment. It then discusses contributions by other researchers for blockchain-based solution applications in several other industries. It then concludes with a summary of the literature review and the identified gaps informing the research questions.

2.2 Blockchain Technology

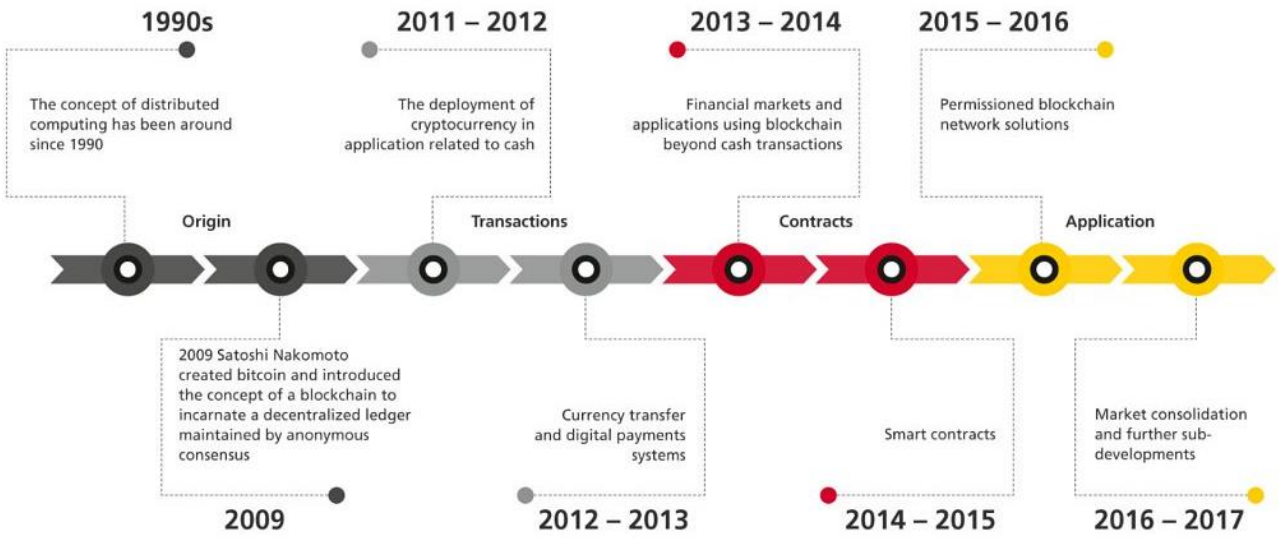
This section will introduce blockchain as a technology. It will discuss the origins of blockchain, how the technology works as well as the concepts and properties of blockchain technology.

2.2.1 History of Blockchain

Blockchain Technology is built around the concept of distributed computers, a notion that has been in existence since the 1990s. According to Popovski et al.(2018), there are three notable breakthroughs in blockchain technology, starting with the introduction of distributed computing architecture in the 1990s. This concept was later developed into distributed ledgers, thus the creation of Bitcoin in 2009, which has now evolved to include many other cryptocurrencies since the year 2012. The year 2013 saw the rise of blockchain and it's positioning as a future technology. While China and Thailand banned Bitcoins, over 11 million Bitcoins were traded within the year to a value of 1 billion dollars. In 2014 Ethereum Foundation was established. Ethereum, a blockchain-powered distributed computing platform became more than a cryptocurrency and a decentralized platform as self-executing contracts that fulfil pre-set conditions were introduced, thus smart contracts (TradeFinance Global, 2018).

According to Jin (2023) and Aggarwal & Kumar (2023)Use cases of blockchain continued to grow, in 2016 people started to appreciate blockchain more outside of cryptocurrencies. Additional permissioned distributed platforms such as Corda were launched to cater to financial services as part of the blockchain as service offerings. From 2019 up to date blockchain has been globally accepted as a potential technology with some countries such as El Salvador accepting Bitcoins as a legal currency, and the Bank of China issuing bonds that are based on blockchain technology. Blockchain technology applications continue to be applied in several sectors. Worldwide expenditure on blockchain solutions

is expected to grow from $4.5 billion in 2020 to $19 billion by the end of 2024, figure 2.1 summarises these developments:



Source: Crypto Unveil, 2018

Figure 2.1: History of Blockchain

2.2.2 Blockchain Technology Explained

Whenever the term blockchain is raised, Bitcoin is most likely to be what comes to mind, leading to some mistakenly defining blockchain as Bitcoin. Blockchain is rather the underlying technology for Bitcoin (Sultan et al., 2018). The first white paper on the blockchain model was instigated by Satoshi Nakamoto in 2008. The model extended an innovative system for aggregating and storing pivotal data across several nodes thus creating a distributed and immutable (unchangeable) ledger of transactions and records with extensive computing power, (Hawkes et al, 2018). Euromoney (2020) defines blockchain as a system of recording information in a way that makes it difficult or impossible to change, hack, or cheat the system. While IBM (2020), a leading technology service provider also defines blockchain as a synergic, unchangeable ledger for recording records, tracking assets, and building trust.

Sultan et al. (2018) describe blockchain as an innovative technology that combines some disciplines such as software engineering, cryptographic science, distributive computing, and economic game theory. They also describe applications using blockchain technology as crypto-economics, thus involving trade between partners using computer networks and cryptography to enhance digital markets.

Blockchain, a revolutionary model, proposes a "peer-to-peer distributed time-stamped server" that ensures trust between transacting nodes. This is done by generating computational proof for all transactions from communicating nodes. Nakamoto (2008) describes the flow of transactions in this model as the transfer of a chain of digital signatures (coins) by an owner to the receiver. This is done by digitally signing with a hash, and a public key and appending these to the digital signature (coin) forming a block- unanimous and anonymous property. The receiver can verify the signatures in the block by certifying the ownership of the chain and establishing trust for the transaction originator. It also ensures that each hash in the chain is time-stamped and widely published to all nodes (Nakamoto, 2008). This works as proof that data was present at a particular time. Each block contains information with the previous transaction timestamp in the hash, a hash from the previous transaction, and a public key or the next owner forming a chain. Figure 2.2 below gives a visual representation of this proposed model:

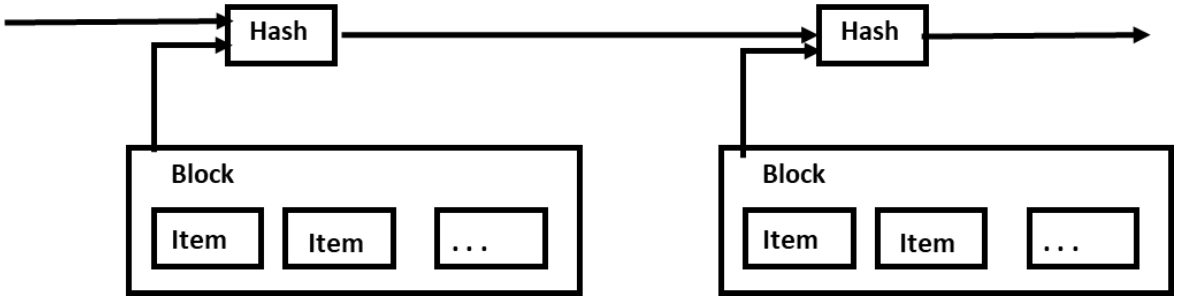


Figure 2.2: Nakamoto Proposed Blockchain Model

Source: (Nakamoto, 2008b)

All the transactions between nodes or transacting parties are published to all nodes. Each of these nodes formats these into a block consisting of the hash, timestamp, and public keys which are used as "proof-of-work", thus enhancing security. Nodes only accept a block if all the transactions can be validated (Nakamoto, 2008a). This then forms the basis of blockchain properties, which include its decentralized/distributed nature. Unlike in traditional systems which rely on a central authority or database, in the blockchain model copies of the records in the chain are published to all nodes and they can all access it (transparency). Each block in the chain is verifiable by all participating nodes, thus the unanimous characteristic. Also, the fact that each block or record carries a hash and timestamp enables blockchain to be very secure, programmable, and immutable (Sultan et al., 2018). Figure 2.3 below shows these properties of blockchain explained above as summarized by Euromoney (2021):

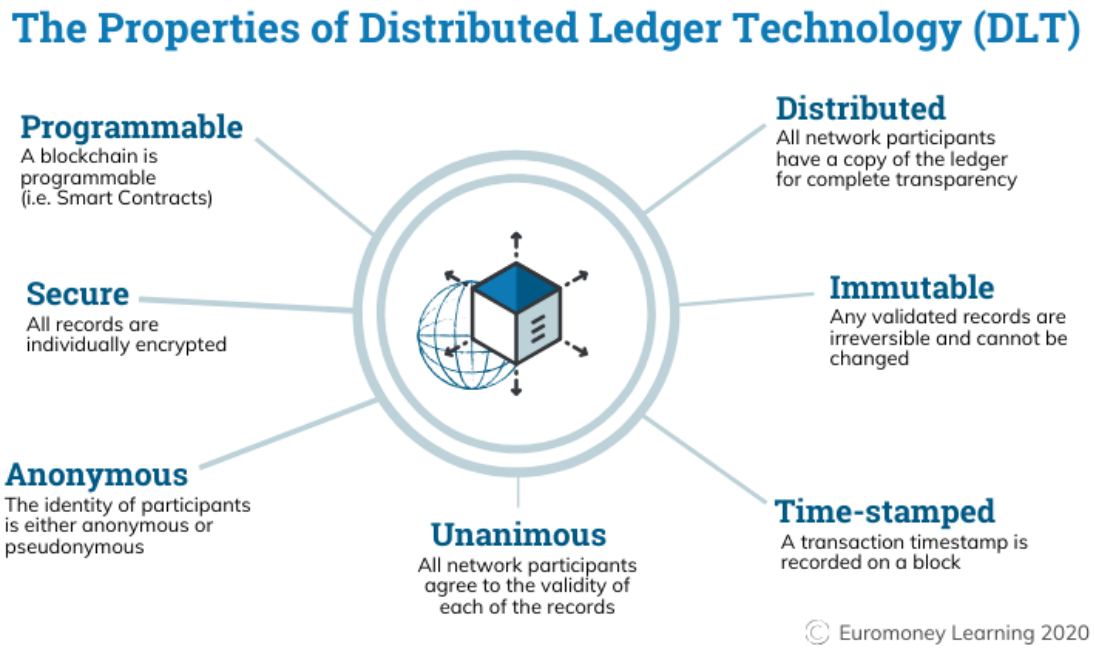
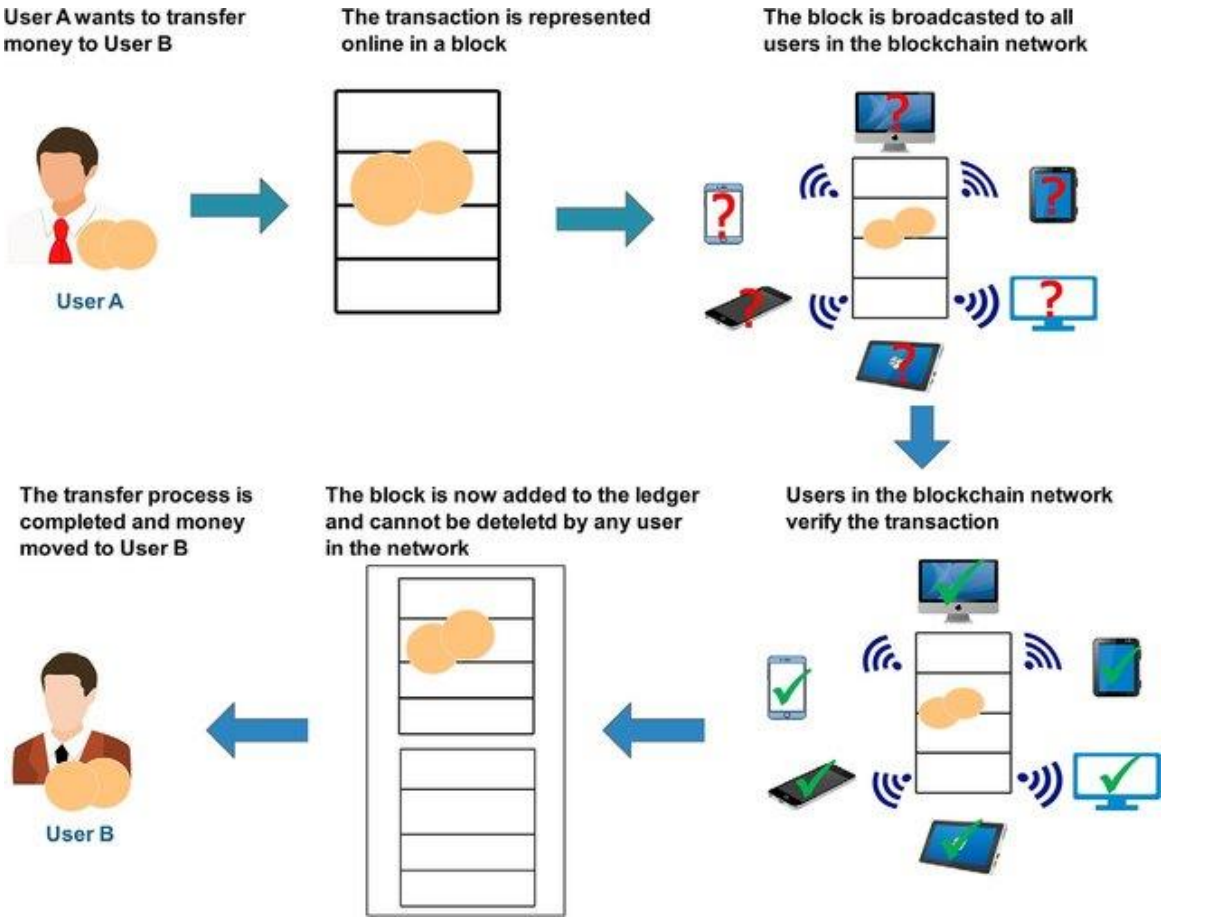


Figure 2.3: Blockchain Underlying Technology

2.1.2.1 Blockchain Architecture

As described by Nakamoto (2008), the Blockchain system is composed of nodes, transactions, blocks, chains, miners, and a consensus. A node is a user or computer within the blockchain architecture (each having a replica version of the blockchain ledger). A block describes a data structure that is used for storing sets of transactions that are allocated to all the nodes within the system. These blocks are arranged in a distinct order which forms a sequence called a chain. Before anything is appended to the blockchain structure, miners which are distinct nodes verify the block process. The verification process fulfils the blockchain operations, based on a set of rules/algorithms which is referred to as a consensus protocol. Sultan et al. (2018) explain that each block in the chain consists of total transactions. In each instance, a new transaction is triggered within the blockchain, and a record of that transaction is added to every participant's ledger. The transactions are recorded with an immutable cryptographic signature called a hash. This is summarized in Figure 2.4 showing a step-by-step process flow of how a transaction is processed from the source to the destination in a blockchain:



Source: Atlam et al, 2018

Figure 2.4: Block Chain Transaction Process

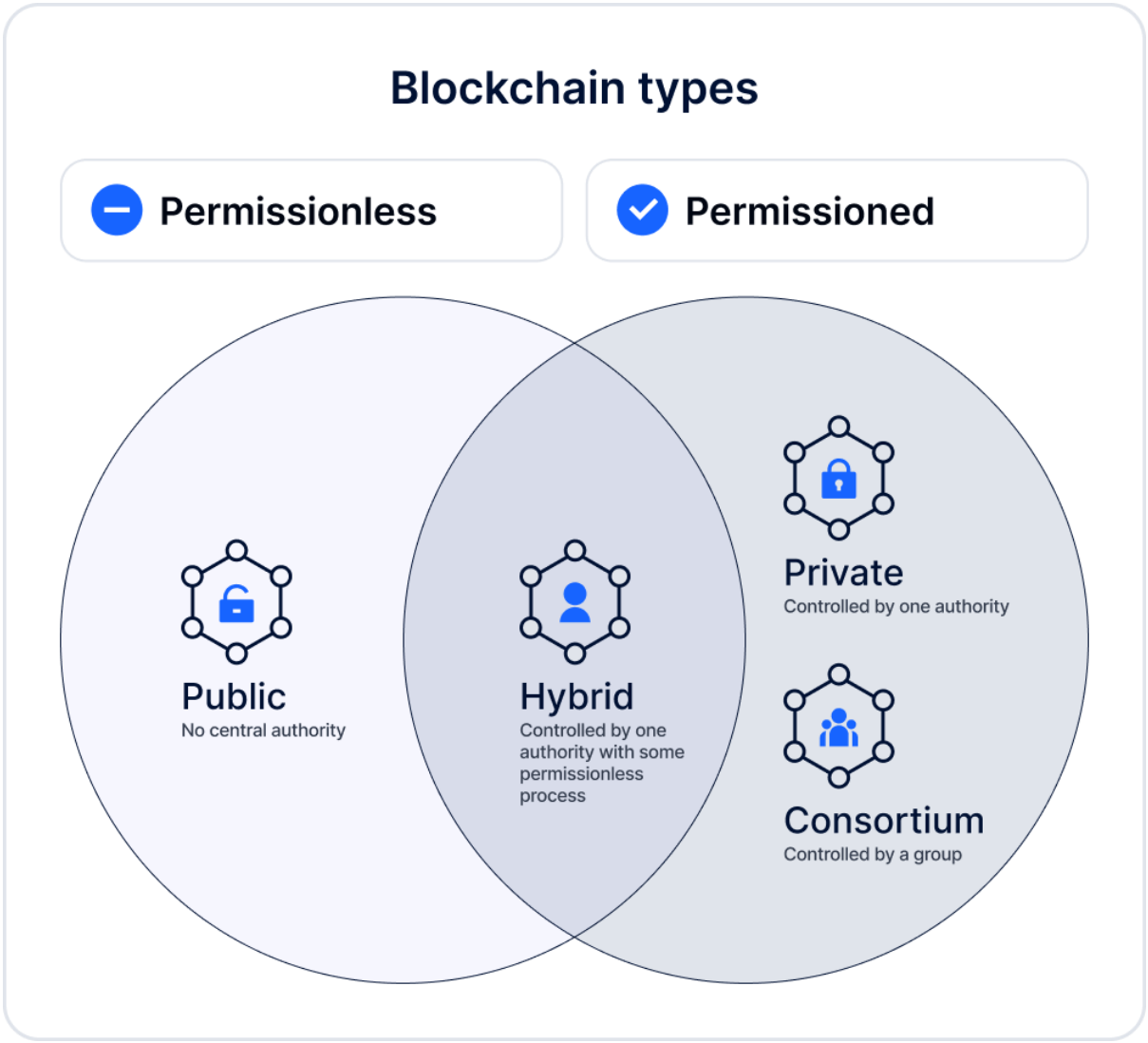
Each block in the chain consists of a total of all preceding transactions. Thus, when a new transaction is triggered within the blockchain, a record of that transaction is added to every participant's ledger, making sure there is trust between all participants in the chain. This explains the transparency property of blockchain, as all parties have information on all transactions. The transactions are recorded with a cryptographic signature that is unchangeable or immutable called a hash. This denotes the traceability of transactions, and their source of origin inclusive of all interfaces of the transaction within the chain. All these capabilities of blockchain are enabled by the fact that blockchain is fabricated by the distributed ledger technology which possesses all these qualities. As supported by Hughes et al. (2019) this distributed ledger technology enables all participants to have the same data records as the master making blockchain very accurate, efficient, and consistent at all levels. Table 2.1 below matches these characteristics to benefits blockchain can provide:

Blockchain Property/Benefit	Explanation	Advantage
Programmable	According to Weber & Staples (2022), blockchain allows small programs that carry records of transactions these are mostly referred to as smart contracts. This enables blockchain to be used for different use cases	Disintermediation (no third-party mediation required); streamlined processes, (Hughes et al., 2019).
Distributed	Hughes et al., (2019b) describe the blockchain structure as decentralized with all entities of the chain having visibility to the entire distributed database. This includes visibility to the consensus algorithm which allows for control of the network, making it different from a central-based system	Trust; processing speed; and cost reduction. (Hughes et al., 2019)
Secure	Garrard & Fielke (2020) instigate the fact that there is a trail of the origin of every transaction that is within the blockchain ledger	Non-repudiation; trust; stream-lined processes, (Hughes et al., 2019)
Immutable	Records made within a blockchain cannot be altered, and they are time-stamped which makes the records easily traceable, (Gupta, 2017)	Non-repudiation; trust; stream-lined processes; and automation, (Hughes et al., 2019).
Anonymous	All blockchain participants have a unique generated address with no user identity. This keeps users' anonymity, mainly in public blockchain architecture, (Park & Sung, 2020)	Non-repudiation; trust; stream-lined processes, (Hughes et al., 2019)
Unanimous	According to Euromoney (2021), blockchain technology enables transparency for all players within the chain. This is because the blockchain system cannot be altered. It is very rare for it to be changed, as it requires extreme computing power to truncate the blockchain network utterly.	Non-repudiation; trust; stream-lined processes; automation, (Hughes et al., 2019)

Table 2.1 Benefits of Blockchain

2.2.3 Types of Blockchain

As indicated in Figure 2.5 below, there are 4 distinct types of Blockchain. These are the public and hybrid blockchains' that are regarded as permission-less because they are accessible to anyone. Then, there are private and consortium blockchains which are permissioned chains, they can only be accessed by users granted required access permissions, (Gartner, 2020)



Source: SAP

Figure 2.5: Types of Blockchain

2.2.3.1 Permissioned Blockchains

This is a blockchain that only allows authorized users to access the blockchain and transact. The blockchain network owner is responsible for granting access depending on permission levels for each individual. This type of blockchain is highly secure and uses identity verification methods to allow users access. An application example of permissioned blockchain is in organizations that have information shareable only to a small group of users (Michael Crosby, et al., 2015).

2.2.3.2 Permissionless Blockchains

According to Michael Crosby, et al. (2015), this is an open network blockchain that allows anyone to participate in the chain, gain consensus, and transact. In a permissionless blockchain, there is no central authority, any user with an internet connection can join the chain and start transacting.

2.3 Livestock Supply Chain

The term 'supply chain' refers to activities required by an organization to deliver goods or services to its end customers (Taylor & Hinrichs, 2012). From the existing literature gathered through a thematic approach of searching content related to this study, it can be concluded that an effective supply chain is crucial for the success and expansion of any industry, the livestock sector is included. As explained by Rana et al.(2021) the worldwide economy is vastly constituted by supply chains, which make up about 76% of global trade based on a report by the International Trade Administration. One of the major challenges that have been in existence in the livestock supply chain is inventory management inefficiencies, (Aich et al., 2019). This is mainly a result of different players in the chain having unique interactions that do not have a point of reference for effective communication and recording of pertinent data.

The livestock supply chain is uniquely composed of different groups of participants governed by regulations as set by authorities in the environment they are operating. Technology is a critical enabler of supply chain process efficiencies, (Khan et al., 2022). Farmers are important stakeholders of the chain and this includes farmers in the rearing of animals such as dairy, beef, sheep, pigs, and grass. They require technology to automate farm processes, such as capturing components of livestock feed, tracking livestock movement, and checking livestock health status. The capturing of this data is done by RFIDs/tags and sensors around the neckline of the animal to detect possible health problems when an animal is on heat for insemination to be done at the optimum time, and to determine acidic components for predicting digestive problems.

Other examples are sensors that trace tail movements to detect labour contractions and send alerts to the farmer. Using blockchain this information is captured into a distributed ledger system, (Akhigbe et al., 2021). Information about the health status of an animal is relevant to the processors, distributors, and retailers, while they capture information into the chain related to their process flows they also gather information on the origins of the product- availing opportunities for new markets for all the supply chain components, and related history for the safety of the consumer.(Hanley et al., 2020). Below is an illustration of the livestock supply chain components:

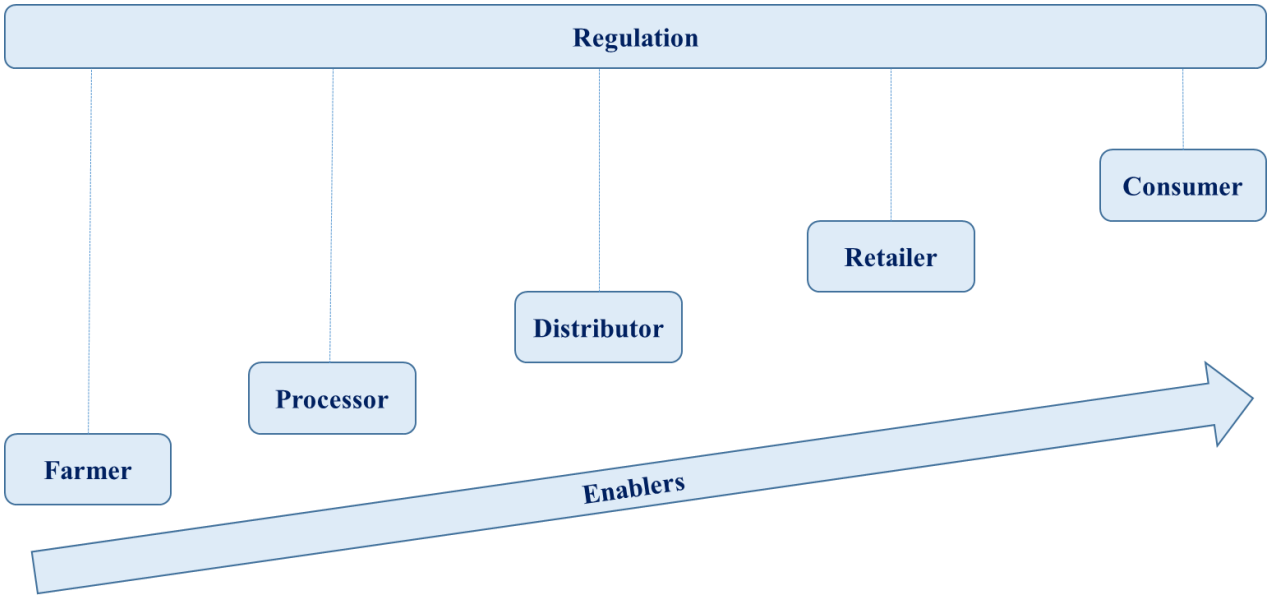


Figure 2.6: Livestock Supply Chain

2.3.1 Challenges in the Livestock Supply Chain

As demonstrated by several authors in other pieces of literature, stakeholder groups in the livestock supply face unique challenges. The major challenges are the inability of players, especially the farming organizations to reach new markets, the lack of trust between players, and the lack of traceability of the products. For the regulators, the main challenge is the lack of evidence for compliance with set regulations (Aich et al., 2019; Etemadi et al., 2021). Table 2.2, summarises some of these challenges per component listed in the Supply chain structure above:

#	Supply Chain Component	Challenges	Source
1	Farmer	• Lucrative markets for Livestock farmers are out of reach, as a result of the lack of traceability of their produce.	(MasterCard, 2021)
2	Processor	• Production systems less flexible in terms of production timing • Lack of traceability	(Aich et al., 2019; Etemadi et al., 2021)
3	Distributor	• Production systems less flexible in terms of production timing • Lack of traceability	(Aich et al., 2019; Etemadi et al., 2021)

4	Retailer	• Production systems less flexible in terms of production timing • Lack of traceability	(Aich et al., 2019; Etemadi et al., 2021)
5	Consumer	• Risks to buyers due to lack of health records for the livestock	(Chandra et al., 2019)
6	Regulator	• Lack of evidence to implore measures for effective scrutiny and standards for food safety • In addition, regulatory compliance can also be an issue in the sector as there is a need to demonstrate continued compliance with both domestic and international food regulation standards which are essential for seeking to penetrate the global market.	(USDA ERS, 2018)

Table 2.3 Challenges in Livestock Supply Chain

2.3.2 Regulations in the Livestock Supply Chain in Zimbabwe

The Livestock sector is a critical area for Zimbabwe and its people. Based on a report by Euromoney (2021), 40% of Zimbabwe's population derives their livelihoods from this sector, with a commendable contribution to the country's agriculture GDP. In developed countries, according to USAID (2016), livestock contributes an average of about 44% of their overall GDPs. Even though Zimbabwe has a favourable climate for livestock farming there is a severe value gap realised between Zimbabwe and developed countries. One way of averting this gap to some extent is by the use of technology to improve process efficiency. The Livestock sector in Zimbabwe falls under the Ministry of Agriculture, Mechanisation and Irrigation Development which devises policies and regulations around this sector. Such policies include but are not limited to the 2015, Livestock Policy.

According to the **SI 35 of 2002 Animal Health (Livestock Identification) (Cattle) Regulation**, many regulations are available that govern livestock movement, types and sizes of tags/ sensors that can be put onto an animal as well as taxes for abattoirs. Guidelines for abattoir operations are specified in the Public Health - Abattoir, Animal and Bird Slaughter and Meat Hygiene Regulations of 1995. However, with all the legislation for this sector well defined, the sector is still suffering from a wide range of challenges. As described in the MasterCard (2021) report some of these challenges include the struggle to control outbreaks such as the Foot and Mouth Disease (FMD) and other animal diseases due to uncontrolled movement of livestock as a result of animal theft. There is difficulty in building trust between meat suppliers and consumers as there is no source of truth on the origins of the meat product, whether it was affected by any kind of disease, or whether the supplier is the

legitimate owner of the livestock. This has become a great concern in Zimbabwe, especially in the period between 2000 and 2001 as there has been an influx of uninspected beef in the market, as reported by local newspaper The Herald of February 2021.

2.4 Blockchain Applications in Livestock Supply Chain

Across the livestock value chain from regulatory bodies to the end customer, supply chain activities are classified as complex. This is a result of the need for specialized integral control, tracking, tracing, and time-based systems along the chain. As explained by Soosay & Kannusamy (2018) temperature control requirements, quality metrics, and product perishability are some of the concerns that make livestock supply chain activities challenging. It can also be noted that the attributes surrounding these challenges are mainly trust. Trust issues emanating from the underlying causes of production inefficiencies include poor nutrition and animal health, infertility, unsuitable genetics, inefficient marketing, inadequate infrastructure, equipment, and funding, low levels of entrepreneurial and technical skills, and weak institutional support. All-inclusive, this results in a lack of trust around the quality of goods and organic composition of the end product, which can only be affirmed based on the honesty of the producer/farmer (Feng et al., 2020).

Blockchain-based solutions improve traceability in the supply chain through the use of RFID tags, DNA barcoding, and QR barcodes (Leduc et al., 2021). This allows for the data to be captured and availed to the end customers, regulators, and all other players in the supply chain directly thereby maintaining trust between the parties. Blockchain technology allows it to provide a platform that enables secure traceability. As posited by Garrard & Fielke (2020), each user within the blockchain network will have a copy of the ledger which they can change willingly through defined protocols that allow authorized stakeholders within the chain to agree on the same ledger. The protocols require that each transaction be submitted into a database in a form that is permit-table and agreed on by all the stakeholders (Sanka et al., 2021). This allows transactions to be monitored and to have a unique identifier that can be noticed throughout the cycle of the supply chain. The livestock industry is highly regulated, and the regulatory authorities can also utilize this data to ensure that policies are being adhered to from the chemical composition of input feeds to distribution and retailing processes as explained by Chandra et al. (2019). This implies that by using blockchain-based systems regulators can issue smart contracts for tax payments, and veterinary compliance certificates including the ability to track livestock movements within regions.

2.5 Contributions by Other Researchers

Several researchers have explained how the properties of blockchain as a technology can be leveraged, to solve the existing challenges within the Livestock supply chain. These include Wang et al. (2019); Rocha et al. (2021); Aich et al.(2019); Demestichas et al (2020) among others. However, they differ in their approaches to defining the benefits of blockchain technology. For example, Rocha et al.(2021), explain perceived benefits based on processes across supply chains such as finance, logistics, environmental management, and the farm in general. Wang et al. (2019), on the other hand, explains the correlation between these blockchain properties which guarantees blockchain as the ideal solution. The concept matrix below gives a view of connections between research articles by other authors and blockchain properties that make it a solution to the mentioned challenges.

Context	Traceability	Transparency	Authenticity	Trust	Security	Cost Reduction	Efficiency	Source
Supply chain management	**X**	**X**	**X**	**X**		**X**		Aich et al.(2019)
Supply chain transformation using blockchain	**X**	**X**	**X**	**X**	**X**	**X**	**X**	Wang et al. (2019)
Blockchain application in agribusiness	**X**		**X**			**X**	**X**	Rocha et al. (2021)
Blockchain application in agro-foods	**X**							Demestichas et al (2020)
Haalal Food Sector	**X**	**X**	**X**	**X**	**X**			(Chandra et al., 2019)
Bitcoin and Smart contracts	**X**		**X**			**X**	**X**	(Gupta, 2017)
Risk Avoidance in Supply chains	**X**		**X**	**X**	**X**			(Liu et al., 2019)

Table 2.4 Blockchain Concept Matrix

As evidenced by literature in the above, Blockchain avails several benefits to supply chain management. It enables supply chain process improvement through automation, increases trust and transparency among partners, as well as enhances security allowing the provision of authentic products to the markets.

2.6 Other Blockchain Applications in Supply Chain Literature

Based on a study by the Harvard Business Review written by Gaur & Gaiha (2020), supply chain management is one the most crucial implementations of Blockchain technology. This is because of its ability to build an impenetrable, transparent, and complete history of transactions, averting challenges faced by partners in a supply chain.

One of the recent successful global applications of blockchain technology is in the distribution of COVID-19 vaccines (Park & Sung, 2020). After the world was struck by the Covid-19 pandemic, hope for the future depended upon the urgent availability of the vaccine. This meant several challenges such as exposure to corruption, theft, and falsification of vaccines and vaccination certificates. The need to employ the use of blockchain technology to safeguard vaccine distribution was a priority (U4 Anti-Corruption Resource Centre (2022). Application of Blockchain technology builds digital trust, (Garrard & Fielke, 2020). The immutability property and the fact that a blockchain is not owned by anyone, allows it to provide a generic standard protocol. This means that all vaccines monitored in the chain could be supervised by all interested parties. Thus, manufacturers and distributors that track shipments delivery have access to efficient and effective tracing systems. In addition, hospitals and clinics can manage their stocks better and cater for storage requirements. Individuals also have some guarantee regarding the specifications of the vaccine. According to WeForum (2020), these efforts have helped in creating efficiencies in the distribution of the much needed vaccine, saving lives and reducing hesitancy by individuals to get vaccinated.

Based on a study by the U4 Anti-Corruption Resource Centre (2022) effectiveness of a blockchain use case is affected by environmental factors such as the risk of corruption in the supply chain. The study also shows that adoption by international organizations is grounded on an evaluation of costs against benefits, as well as a detailed understanding of blockchain solutions.

2.7 Blockchain Adoption Literature

To analyze the existing academic research on Blockchain adoption, a search of some databases/journals was done, including Science Direct, Pro Quest, EBSCOhost, and JStor. To select relevant articles only, the search keywords used included “Blockchain Adoption” OR “Blockchain Adoption Agriculture” OR “Blockchain Adoption Livestock”) AND (Supply chain). The inclusion criteria were that the studies needed to be empirical studies and carried out at the organizational level.

Date filters were also applied to supplement the above-mentioned search strategy and limit the search to recent articles. Reviewing of reference lists for articles was also used as well as ad-hoc search from Google Scholar. The articles that were found to be relevant to this study are analyzed in Table 2.4, which is a summary of key findings in these studies, theories used as well as the purpose of the study:

Purpose of Study	Industry	Context	Theory	Findings	Source/Study
Understanding the barriers that impede blockchain adoption for sustainable supply chain management and evaluating their interrelationships	Sustainable supply chains	Organizational	TOE and Force Field Theory	Technological barriers and external barriers need to be initially addressed to harness supply chain obstacles for adopting blockchain Technological barriers require initial attention to address organizational obstacles to adopting blockchain	(Zhang et al., 2023)
Analyze the application of BCT in a supply chain model to enable the effective and efficient implementation of trade credit (called ‘‘smart credit’’) and demand information transparency.	Chinese Fashion Industry	Organizational		Blockchain's value to the supplier and its spill over effect on the workforce are both dependent on the type of customer demand correlation Blockchain enables information transparency and efficient smart contracts between the two players	(Yu et al., 2022)
Investigates two-way impacts of grey markets and blockchain adoption in a global supply chain	Grey Markets	Organizational		Blockchain adoption cannot alter the impacts of the grey market on the manufacturer’s pricing decisions. The manufacturer’s blockchain adoption can either promote or prevent the grey marketer’s entry, depending on the manufacturer’s extra cost in the foreign market and the real product quality. When the manufacturer is	(Sylvester, 2019)

				the first mover in the game, it will adopt blockchain if the real product quality is high in equilibrium	
Investigates blockchain technology for agricultural supply chains during the COVID-19 pandemic	Agriculture			* This study identified the benefits of using blockchain technology for agricultural supply chains. * Successful agricultural business enterprises can carry out their duties effectively and efficiently through blockchain technology.	(Kouhizadeh et al., 2021)
Show how the blockchain can improve the practice of intelligent agriculture in Africa	Agriculture			* Determining the benefits of blockchain technology in Agriculture 4.0	(Andeme Bikoro, 2022)

Table 2.5 Contributions by other Researchers - Blockchain Adoption

The analyzed papers among others indicated that vast contributions have been made to this field, however, many limitations can also be noted. This includes that expertise in a technology being researched is necessary to make meaningful contributions as highlighted in the paper by Kalaitzi et al., (2019). Another gap identified is that most researchers concentrated on one element of a supply chain mostly on processes done by the farmer and agriculture as a whole. However, it is important to note that adoption is dependent on a variety of use cases and also the intensity of its usage. Therefore

this paper will capitalize on these findings by studying the adoption of blockchain technology across the whole livestock supply chain inclusive of regulatory bodies, distributors, and wholesalers.

2.8 Conclusion

This chapter reviewed the literature on blockchain technology, its properties, and benefits. It also discussed the livestock supply chain and policies related to this area in the Zimbabwean context. It analyzed contributions that have been made so far by other researchers in the blockchain body of knowledge. This chapter also highlighted other studies that have been conducted so far for the adoption of blockchain adoption in the agricultural sector. It gives a view to the fact that there are very few studies that have been done specifically focusing on the Livestock supply chain and the adoption of new technologies. From the literature analyzed it can be concluded that blockchain technology indeed provides benefits to those who adopt it, while developed countries are at an advanced stage of adoption, it is a different story altogether for African communities. The next chapter will discuss the theoretical framework for this study including the theoretical underpinnings of the research model.

Chapter 3: Theoretical Background and Research Framework

3.1 Introduction

As deduced from the literature review, blockchain technology poses many benefits based on its characteristics, as evidenced by its applications across all industries. However, its applications in the livestock supply chain are a recent development, it is a disruptive innovation and can be classified as a technological Innovation. Several research frameworks were considered to guide the study. This chapter aims to provide insights into the theoretical background of this study and the Blockchain Adoption- TOE model that was proposed before the analysis stage. This chapter also discusses theories that were considered to guide this study in addition to the TOE Framework.

3.2 Theoretical Underpinnings

The theories considered for this study were the Institutional Theory, Diffusion of Innovation (DOI), and the Technology Organisation and Environment Framework. These are the top three theories that focus on the organizational loci when studying the adoption and use phenomena of interest. As incited by Oliveira & Martins (2011, p. 2) "DOI, especially the TOE framework are the only ones that are at the firm level. The Technology Acceptance Model (TAM), Theory of Planned Behaviour (TPB), and Unified Theory of Acceptance and Use of Technology (UTAUT) are at the individual level".

The TOE framework was selected as the model of choice to provide a lens for this study on the adoption of blockchain technology by organizations in the livestock supply chain. This decision was arrived at, mainly because other theories that are at the organizational level such as the Institutional theory, to a larger extent, provide a framework for understanding organizations and decision-makers' practices as a result of social and not economic pressures. It can actualize the impact of organizational behaviours on the impact of innovation adoption. As explained by Liang et al. (2007), in their study of ERP assimilation in organizations they concluded that institutional forces strongly influence the adoption of the technology. This implies that the adoption of technology by an organization is largely dependent on social pressures and not on other factors which include organizational effectiveness and efficiency improvement, (Greve & Argote, 2015). However, the context of this study is to have a 360-degree view of what impacts the decision to adopt a technology, thus the socio-economic issues, regulatory, and economic issues, as well as technological properties and not only on organisational behaviours. Therefore, the decision not to use the Institutional theory as a reference model or this study.

Similarly, the DOI theory as developed by E.M. Rogers in 1962, explains how, over time, an idea peeks and spreads through a specific population, (Dearing & Cox, 2018). This theory also did not suffice the framework requirement for this study. As explained by Oliveira & Martins (2011) DOI explains the innovativeness of a firm as being "related to such independent variables as individual (leader) characteristics, internal organizational structural characteristics, and external characteristics of the organization." Thus, it details how, why, and at what rate new ideas and technology spread through societies, from an organisational and individual loci. For this study it is critical to have an understanding of the actual factors that affect adoption and not limited to the rate of spread of the innovation or technology, hence the reason why the TOE Framework was selected. The next section will discuss the TOE framework in detail.

3.2.1 Technology Organisation and Environment Framework

The Technology, Organisation, and Environment Framework, TOE was developed by Tornatzky & Fleischer in 1990. The model describes technological innovation as the involvement of a combination of several events, activities, decision-making points, and behavioural/cultural changes for an organization. The adoption of blockchain by organizations in livestock management can be classified to be in the **Persuasion Stages** of the technological innovation life cycle, (Sahin, 2006). This means that this technology is at a phase where it is becoming more defined, with clarity on product offerings and organizations contemplating decisions to adopt. An example is the MasterCard Provenance Solution, according to Newsroom (2019) although this solution is usage-ready, looking at Africa at large, it has been adopted so far by a limited number of livestock organizations in Zimbabwe only and the rest of Africa still envisaging its feasibility assessments.

The TOE framework, as developed by Tornatzky & Fleischer (1990) can be used for evaluating "the adoption and assimilation of IT Innovations, it has a solid theoretical basis, consistent empirical support and the potential of application to IS innovation domains, though specific factors identified within the three contexts may vary across different studies", (Oliveira & Martins, 2011, p. 3). The TOE model elucidates at the corporate level three disparate context factors which give guidance on the determinants of technology adoption at an organizational level. These three elements are Technology, Organisation, and the Environment.

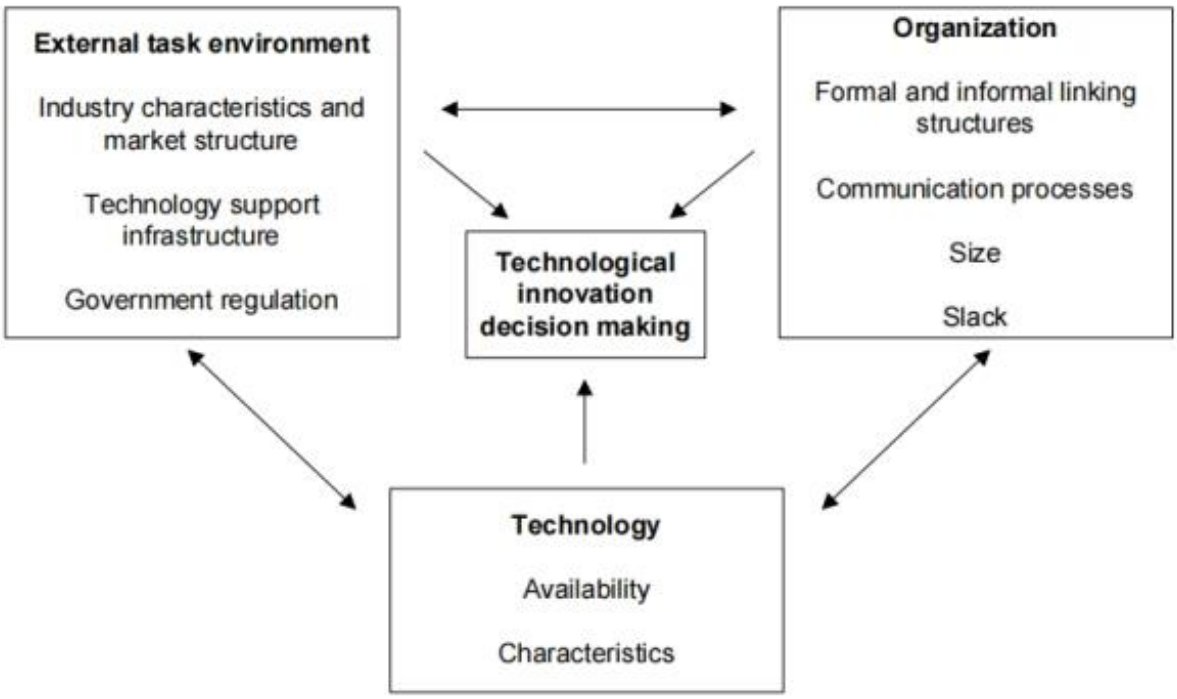


Figure 3.1: TOE Framework

Source: Tornatzky & Fleischer (1990)

3.2.1.1 Technology

Technology as stipulated by Oliveira & Martins (2011) "expounds the internal and external technologies that apply to an organization". This puts into context policies and procedures within an organization, the information systems invested into by an organization as well as its practices.

3.2.1.2 Organisation

Organizational context refers to the pictorial characteristics of an enterprise, which include its scope, size, and top-level organizational structure. As specified by Tornatzky & Fleischer (1990) organizational context is defined by four characteristics which are the formal and informal linking structures, Communication processes, size, and slack.

3.2.1.3 Environment

The environmental context describes the playground in which an enterprise conducts its business, according to Tornatzky & Fleischer (1990) this includes the industry category type, other players in the same business, and government dealings.

3.3 Application of TOE in Other Studies

The value of technology can only be realized if the technology is fully adopted. Many studies have investigated determinants of the adoption of new technologies by organizations through the lens of the Technology, Organisation, and Environment (TOE) framework. One of the papers is by Lippert & Govindarajulu (2006), who scrutinized the correlation between WebServices (representing technology), the Organisation, and the Environment. They used empirical-testing methodologies generalising the study to a widespread of enterprises in different locations. The researchers were able to identify eleven concepts for their proposed model which are Security Concerns, Reliability and Deployability(Technology); Firm size, Firm scope, Technical knowledge and Perceived benefits (Organisation), Competitive pressure, Regulation, Trading partner readiness, Degree and perception of predictability (Environment). Key findings that can be drawn from this study are that it is a worthy cause to investigate the connection between Technology, Environment, and Organisation determinants in the adoption of a certain conceptualized Technology. Also, by understanding these determinants, an enterprise may realize an accelerated return on investments (ROI) from the adopted technology.

Awa et al. (2016) in their study denoted an understanding of important concepts within the TOE model that separate organizations that adopt and those that do not adopt a certain technology. Their study was based on a purposive and snowball sampling methodology of data obtained from surveys done by top Executives from Nigerian SMEs. From the three contexts of the TOE model, twelve concepts were established in their research model which are Technical know-how, ICT Infrastructure, Perceived compatibility, Perceived values, Security (Technology); Subjective norms, size of firms, the scope of business operations, Demographic composition (Organisation); External support, Competitive pressures, Trading partners readiness (Environment). This study extended the focus of the TOE Framework from not only being applied to large corporates but also to smaller ones, in this case, SMEs in Nigeria. Major findings are that adoptions of a technology (ERP) are mainly driven by Technology factors more than Organisational and Environmental factors.

Another study by Kalaitzi et al. (2019) also contributed to this research field through their study focusing on the adoption of blockchain in food supply chains. In their paper, the main agenda was to identify concepts that affect management decisions to adopt blockchain technology as well as the potential benefits of it being adopted. They pinpointed the factors which include Technology (Relative advantage, Perceived challenges, Compatibility), Organisation (Firm size, Top management support, Existing Technical skills), and Environment (Competitive pressure, Trading partner pressure, Regulatory environment, and Customer pressure). They also identified perceived benefits which include cost savings, minimization of lead times, higher customer service, increased flexibility,

traceability, and the inability to counterfeit. Conclusions that can be made after reviewing this paper are that constructs and factors for the TOE Model apply to any type of corporation, whether large or small.

3.4 Research Framework

As defined by Hoti (2015), IT adoption by an organization is when a firm acquires and accepts the use of technology to increase its market share against the competition, its ability to generate value as well as its profitability. TOE framework is a model of choice for this study and many other IS researchers in the IT adoption research field, this is a result of the TOE framework giving a better understanding of the organization study as it looks at a detailed study across environmental, technology, and organizational factors. The research model for this study is as illustrated below, it identifies technological, organizational, and environmental variables that allow successful decision-making to adopt, followed by the actual adoption of blockchain technology:

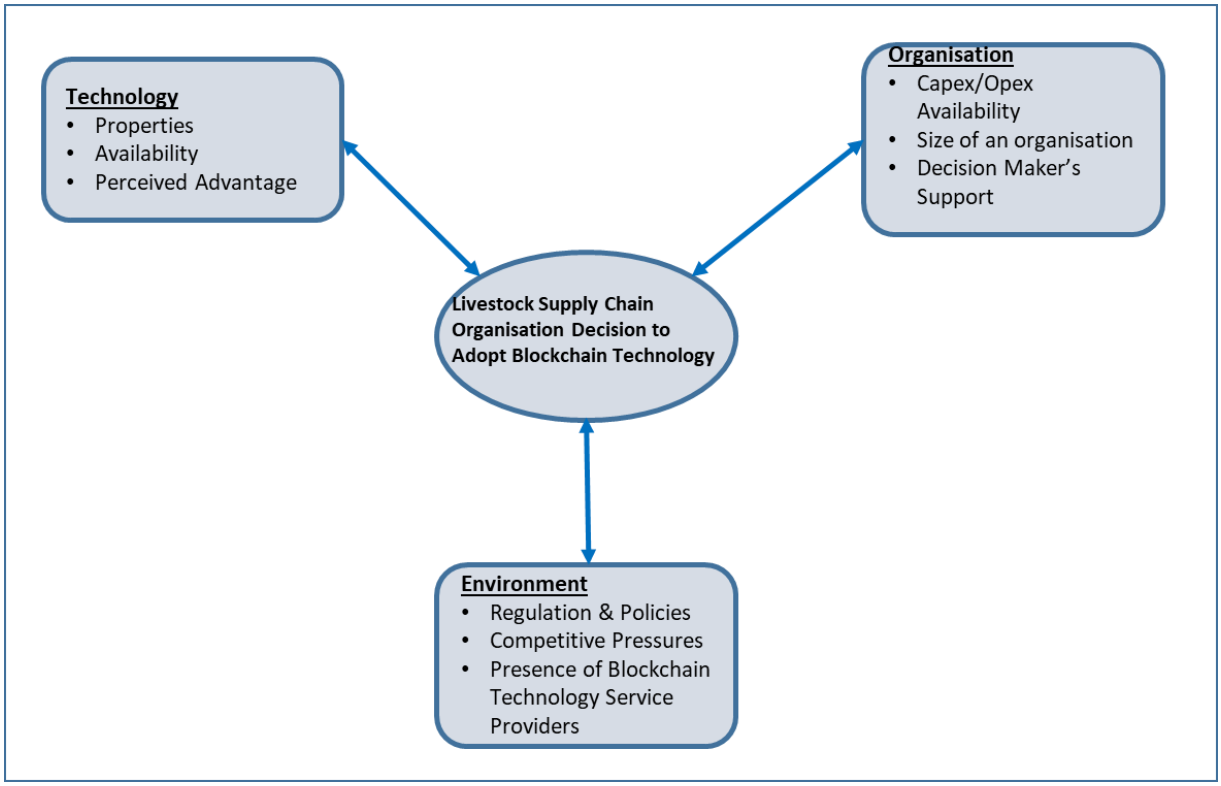


Figure 3.2: Proposed Blockchain Adoption-TOE Model

3.4.1 Technology

In the context of this paper, technology refers to Blockchain and therefore the innovation under this adoption study. Three variables are analysed for this construct which are availability, properties as well and perceived benefits of blockchain

3.4.1.1 Properties

This variable describes the characteristics of the technology and how these functions can bring about advantages if the technology is adopted. As described by Rocha et al.(2021) due to the immutability, transparency, and distributed nature of blockchain, it allows decentralization and inviolable validation of transactions building trust and confidence between the participants. Therefore a need to explore this construct to ascertain, the extent to which benefits promised by the properties of blockchain can lead to its adoption.

3.4.1.2 Perceived Advantages

Rogers (1995) describes the perceived benefits of the technology/ blockchain as the extent to which technology can provide value to the organization. If the perceived advantages are great -based on the effectiveness of the technology, the total cost of ownership of the technology, the ease of integration and compatibility with the organization's ecosystem, and so on directly impacts an organization's decision to adopt the technology, hence the need to study this variable.

3.4.1.3 Availability

Availability refers to, whether the organization has existing technologies already deployed. Thus technologies related to the solution building block to capture data into the distributed database and also the availability of technically skilled resources within the organization. As supported by Baker (2012) this variable is important to be understood in detail in this adoption study because an organization's existing technology ecosystem normally defines the scope and pace of an organization's innovativeness. Baker (2012) also states that an organization that has a capability already built such as tracking assets and resources can easily acquire more capabilities that are related to this to improve process efficiencies.

3.4.2 Organisation

In the context of this study, the organization refers to entities that are within the Livestock supply chain (as illustrated in 2.2, Figure: 2.6). The variables to be studied for this construct are Funding (CAPEX/OPEX) availability, size of the organization, decision makers' support and organizational lead measures.

3.4.2.1 Funding (CAPEX/OPEX) Availability

These are the financial costs that need to be budgeted for incognizant of the direct and indirect expenses for adopting the technology. This needs to be put into consideration in deciding to adopt blockchain and therefore requires analyses in this study. Pichlak (2016, p. 7) in his study of innovation diffusion supports this by explaining that "financial resources allow an organization to conduct effective innovation activities by making use of chance and neutralizing risk, thus absorbing the cost and promoting the development of creative solutions for the actual need."

3.4.2.2 Size of the organisation

The size of an organization is widely studied in most adoption studies, it is mostly assumed that the larger an organization the greater the extent to which it will most likely adopt a new technology or innovation, (Baker, 2012a). This study will analyze this variable using the proposed framework to determine whether the size of an organization does have any impact on the decision to adopt blockchain.

3.4.2.3 Decision Makers Support

This refers to the higher authorities of an organization, the executives, and management who can make decisions regarding the future of the firm. This is a critical variable of study in this adoption study because it is the managerial team that deals with the allocation of resources and the final decision to adopt a technology,(Pichlak, 2016)

3.4.3 Environment

In the context of this paper, environment refers to Zimbabwe, as the operating environment for the organizations in the Livestock supply chain. The variables to be studied for this construct are regulations and policies applied in this sector in Zimbabwe, competitor pressure, market structure, and industry characteristics, to relate how these affect the decision by an organization to adopt technology.

3.4.3.1 Regulation and Policies

The livestock sector is growing and strictly regulated area globally due to the need to protect animals and also to ensure safety in food consumption. As described by (Baker, 2012a) "government regulation can have either a beneficial or a detrimental effect on innovation". For this study it is important to look at the regulations within this industry in Zimbabwe and how this has impacted players in the industry in deciding to improve their businesses by way of adopting blockchain-based.

3.4.3.2 Competitor Pressures

Across all industries including Agriculture, stakeholders always compete for a greater market share and to offer better products and solutions than their counterparts. Technology has always been a differentiating factor, especially in this digital era, setting apart how and the quality of products

provided to the end customer, therefore the need to study this concept in this paper,(Oliveira & Martins, 2011).

3.4.3.3 Presence of Blockchain Service Providers

Technology service providers refer to skilled professionals as well as systems providers, easy accessibility of these is also a subject of study. As explained by (Baker, 2012a) innovation assimilation can be fostered by the availability of the right skills and technology services.

Chapter 4: Research Methodology

4.1 Introduction

This chapter discusses the research process that was undertaken as part of the study. As instigated by Bhattacherjee et al.(2012), the research process defines step-by-step activities of acquiring scientific knowledge using the scientific method to come up with outcomes related to a study. Various stages in the research process which include participant/sample selection, data selection, data analysis, and ethical considerations will is discussed. Below is an illustration of the scientific research inquiry as proposed by Saunders et al. (2007), which summarises the key aspects of research that guide this paper in identifying the research philosophy, approach, strategy, design as well as the data collection and analysis procedures.

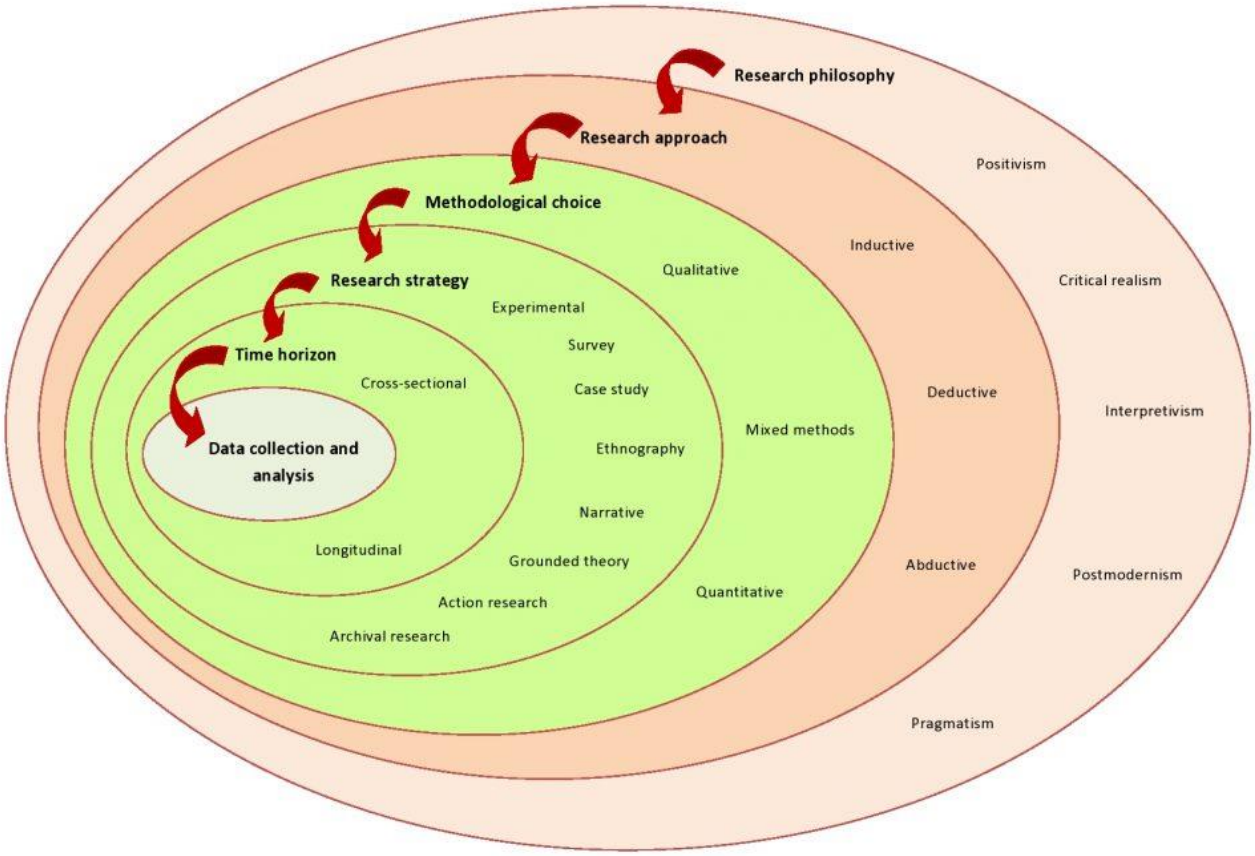


Figure 4.1: Research Onion

Source: (Saunders et al., 2007)

In addition, justification of each implored research process for this study is included. This was done to produce outcomes of this study which investigates factors that affect the adoption of Blockchain technology by organisations in the Livestock supply chain.

4.2 Research Paradigm and Approach

This study applied the interpretivist paradigm as a research philosophy. A research paradigm is explained by Bhattacherjee et al.(2012) as a manner in which different people structure their ideologies and how they view the world differently. Ryan (2018) indicates that there are two common research paradigms, which are positivism and interpretivism. This study adopted the interpretivism paradigm mainly because in positivist research authentic knowledge can be established through scientific methods resulting in reliable data, it is highly dependent on theories that can be proven or tested, (Bhattacherjee et al., 2012).

The study aimed to gain an understanding of the phenomenon of study based on people's experiences and their understanding of them through the lens of the TOE framework. Interpretivism allows this since it states that it is critical to understand and interpret beliefs, motives, and actions to understand social reality (Saunders et al., 2007; Bhattacherjee et al., 2012). Therefore, interpretivism is a justifiable philosophy for this study because it integrates empirical observations with logical reasoning to understand better social reliability. Also, interpretive research is used to unpack social phenomena, data is collected over a timeframe and analyzed to understand data patterns (Rehman & Alharthi, 2016). In addition, interpretive research focuses on subjective reasoning, evaluating and refining interpretive theories thus defining conceptual frameworks while positivist research focuses on an objectivist perspective, thus defining hypotheses and theories based on a stable and unchanging reality (Kivunja & Kuyini, 2017).

To answer research-specific questions that have been stated in this paper and, to draw outcomes and conclusions, the study will adopt an inductive approach. This inductive approach will be used to establish conclusions that will be obtained from data collection as guided by the TOE framework. It will also derive findings and conclusions of the study by analyzing data and discussing or explaining it concerning the existing body of knowledge, thus inductive reasoning. This approach is in line with the interpretivism philosophy as it aims to develop a model while understanding the livestock supply chain as it is from the subjective experience of the organizations involved. Thus the application of interpretivism research paradigm and inductive approach as it aims to unpack a social phenomenon.

Data is collected over a timeframe and analyzed to understand data patterns, (Rehman & Alharthi, 2016, p. 6). In addition, inductive research focuses on subjective reasoning, evaluating and refining

interpretive theories thus defining conceptual frameworks while positivist research focuses on an objectivist perspective, thus defining hypotheses and theories based on a stable and unchanging reality (Kivunja & Kuyini, 2017)

4.3 Research Design, Methodology, and Strategy

According to Wilkinson (2000), research methodology refers to detailed instructions and or techniques that are applied to establish, select, process, and evaluate information about a particular subject of study. Wilkinson (2000, p. 12) further explains that "in a research paper, the methodology section allows the reader to critically evaluate a study's overall rigour. The methodology section answers two main questions: How was the data collected or generated? How was it analyzed?" This study uses qualitative research methods which define the data collection approach and analysis methods that was used to conclude the study.

Qualitative methods are described by Silverman (2010) as a research classification that investigates personal experiences helping to perceive the significance of critical issues for people. The justification for adopting qualitative research methods is based upon the descriptive and explanatory essence of this method. Qualitative methods value participants' perspectives by ensuring participants' feelings and perceptions are incorporated into the research outcomes. In addition, it allows flexibility in incorporating new ideas during the collection and analysis of data. This study adopted the explanatory nature of the qualitative method. As explained by Oates (2006) explanatory research explores the cause of a phenomenon, behaviour, or problem under study. It pursues to identify causal factors and outcomes of the target phenomenon. These characteristics were critical for this study to answer research questions specific to this study as highlighted in the first chapter of this paper.

The qualitative research method was chosen because it is, to a larger extent the best option to explore inductive reasoning behind a social process. In the context of this paper, the reason behind the decision to adopt blockchain technology by organizations in the livestock supply chain (Bhattacherjee et al., 2012). It is appropriate for this study to meet the desired research objective as well as to answer the exploratory research questions, thus; (1)What are the factors affecting blockchain adoption decisions by livestock supply chain organizations in Zimbabwe?; (2)What are the challenges being faced by organizations in livestock supply chains?;(3) What are the characteristics of blockchain that can benefit livestock supply chains and (4) What factors affect the adoption of blockchain technologies in developing countries?

The critical assumptions that were made for this study were to evaluate these factors by engaging directly with players in the livestock supply chain to understand their way of thinking, feelings, and opinions on the matter of adopting a new and innovative technology such as blockchain. Thus an epistemological perspective to the study is described by Saunders et al. (2007, p. 138) as " what constitutes acceptable knowledge in a field of study", meaning the study will provide a model for

enhancing the knowledge base of what leads to the adoption by the stakeholders in the livestock value chain.

Another consideration was the importance of social actors; as highlighted by Saunders et al.(2007, p. 134) “interpretivism epistemology advocates that the researcher must understand differences between humans in our role as social actors.” This emphasizes the difference between conducting research among people rather than objects such as trucks and computers. This led the researcher to adopt a case study as the research strategy for this paper. “This method is well-suited for studying complex organizational processes that involve multiple participants and interacting sequences of events, such as organizational change and large-scale technology implementation projects” (Bhattacherjee, 2012, p. 105). The paper will only focus on Zimbabwe’s livestock sector as a unit of research, it will not look at other organisations outside of Zimbabwe and also other agriculture sectors are out of scope.

4.4 Data Collection

Qualitative case study research, online interviews were used to collect primary data, with secondary data analysis also included as a way of validating the collected data with existing literature. The interview questions guide (APPENDIX C) carries both open-ended so as not to miss any concepts, as well as structured questions where respondents will select an answer from a given set of choices to respond with. According to Bhattacherjee (2012), an interview is a research instrument used to collect information from people about a particular phenomenon. The questions for the interview were drawn in a manner that participants find easy to understand and respond to. Two potential respondents were given the initial question guide to share feedback on the questions developed, to ascertain the quality of the interview question guide. Their feedback was used to revise the questions format before the actual data collection commences. To minimize the cost of data collection and to comply with the COVID-19 pandemic regulations which still apply in Zimbabwe, the interviews were done and recorded through online channels such as Microsoft Teams. A question guide was sent to participants through email before the interview.

Another justification for using online interviews in this study is that participants for this study are in different geographical locations. Because of the distance, it is inexpensive in terms of time and monetary cost to conduct face-to-face interviews. Results also can be obtained quickly and analysis of the data can be done more effectively. Using the online interviews participants’ opinions can be gathered in detail enabling participants to explain their answers in detail. This is supported by Bhattacherjee (2012) who explains that interviews enable diverse data to be collected producing a wide range of insights into the phenomena under study.

To complement data collected through interviews, a secondary data analysis method was also used to obtain additional data. The documents analyzed as part of the literature review and analyses include industry and regulatory reports from livestock farming-related bodies. Bhattacherjee (2012) states that "secondary data analysis is an analysis of data that has previously been collected and tabulated by other sources". The justification for using secondary data is that it provides the needed data to support participants' opinions from the interviews. Also, the cost of conducting the research is lessened as the cost of collecting primary data is eliminated. The study will capitalize on these benefits even though there might be a risk that when data was collected it was collected for a different purpose.

4.5 Data Sampling

To contextualize this study, interviews were done with stakeholders in organizations that are part of the livestock supply chain and with participants who are knowledgeable of the industry's processes and procedures to greater depth, thus a non-probability and purposive approach to sampling. Saunders et al. (2007, p. 258) describe this judgemental approach as "it enables you to use your judgment to select cases that will best enable you to answer your research question(s) and to meet your objectives". The justification for adopting this approach was mainly because it focuses on in-depth studies and uses a smaller sample size. Unlike quota sampling which is conducive for a larger population of study. Unlike probability approaches which "makes an inference from your sample about a population to answer your research question(s) or to meet your objectives" (Saunders et al., 2007, p. 238).

The interviews were done with stakeholders who are in farming, regulatory, retailing, processing, and technology service provider organizations. These organizations encompass the whole livestock supply chain and insights or points of view of all entities of the livestock value chain was gathered. The unit of analysis of the case is limited to organizations in Zimbabwe only. The researcher targeted to interview at most fifteen participants and not less than ten. For each category of the livestock supply chain (farming, regulatory, retailing, and processing and technology service provider) the researcher aimed to have an interview with at least one participant. In total managers in the livestock supply chain categories formed at least half of the interviewees, while the remaining enabled robust and reliable evidence to be created for this study (Baxter & Jack (2015).

4.6 Data Analysis

Analysis of the data collected through the interviews was done through a qualitative data analysis approach. As described by Oates (2006) qualitative data analysis strives to scrutinize information critical to a research study from patterns and data themes (thus oral, verbal, and visual). The researcher concluded the study by way of applying a thematic analysis. This process is described by Maguire and

Delahunt (2017) and Saunders et al. (2007) as a technique for systematically identifying, organizing, and offering insight into, patterns of meaning (themes) to a dataset. The researcher repeatedly read through data gathered from the interviews, code pertinent themes, group the themes into categories, and finally identify and determine the factors that drive the adoption of blockchain technology by organizations in the livestock supply chain in Zimbabwe. This was facilitated by the use of software such as Microsoft Word and Excel while following the six steps indicated below, as described by Maguire & Delahunt (2017, p. 4).:

Step 1 Become Familiar with the data

The researcher reviewed, categorized, and summarized the responses against the components of the conceptual model.

Step 2 Generate initial codes

The summarized transcript gave the researcher a general idea of the codes. At this stage the researcher organized the data in a systematic and meaningful way, thus the keywords was used as the codes. This was done using Microsoft Excel.

Step 3 Search for themes

The researcher then identified themes, which were defined by Saunders et al. (2007) as a pattern that captures important aspects of the research.

Step 4 Review themes

This researcher did a detailed analysis of the identified themes based on the perspective of the research and the research questions. At this stage the researcher made sense of the identified themes, reviewed and modified them as supported with secondary data, to come up with the initial themes.

Step 5 Define themes

Based on the review process, the researcher came up with the final themes of the data set

Step 6 Write up

The researcher then drew interpretation and findings from the themes to answer the research questions. While concluding, the researcher also reflected on their knowledge and perceptions to avoid biases and data misinterpretation.

4.7 Ethical Considerations

Bhattacherjee (2012) explains research ethics by way of adopting the definition by Webster's dictionary which states that it is "conformance to the standards of conduct of a given profession or group". While conducting the research, this paper ensured that ethical issues are considered as research principles are applied. The ethical issues include ensuring that there is the application of good research design and avoiding research biases by ensuring that the participants were spread across both commercial and non-commercial farmers so as not to limit the study

The study complied with the policy set by the Ethics Committee of the Witwatersrand University, Johannesburg. When recruiting participants, the study ensured that all necessary information was shared with participants to allow them to make informed decisions to participate or not, that is the informed consent research ethics principle. In addition, this study ascertained that no conclusions are made before data is collected or analyzed. This will be done by ensuring the purpose of the research is effectively communicated to participants

As highlighted by Bhattacherjee (2012), this study verified that participants are made aware that participation in the study is strictly voluntary. Also during the analysis and reporting of the data, unexpected or negative findings will be fully disclosed, even if they cast some doubt on the research design or the findings. In addition, no harm to humans and animals was intended by this study, thus compliance with anonymity, confidentiality, and non-maleficence aspects of ethical considerations in research.

Chapter 5: Data Analysis and Findings

5.1 Introduction

Based on the research methodology stipulated in the previous chapter (Chapter 4), this study used a qualitative data collection and analysis method. The study employed semi-structured interviews to collect data and a thematic analysis approach to gain further insights into the collected data. This chapter aims to present the analysis of the data collected from ten participants during the interviews. The results from the analyzed data were then used to fine-tune the proposed conceptual framework that was proposed in Chapter 3.2. This was done to incorporate significant factors established from this research study. This refined framework is presented at the end of this chapter.

5.2 Interview Participants

Data was collected through semi-structured interviews with experts in agriculture, animal science, regulatory experts, farmers, digital service providers, and technologists. The interviewees were carefully selected based on their expertise, knowledge of the technology, and their involvement in making blockchain adoption decisions.

To initiate the interviews, a call was made to the participants to give them background information and explain the need for the interview. A formal email was then shared with the participant to confirm their availability for the interview. The email correspondence included the Interview Questions that will be used for the interview, the Participant Information sheet, which summarizes the research, and a consent form for their sign-off. Fifteen participants met the study criteria were invited to participate in the interviews. Out of the fifteen emails sent, the researcher received ten responses within three weeks; these respondents were keen to participate in the study. The researcher accepted all ten respondents to work with, as this was a very manageable number of participants concerning qualitative data. Table 5.1 gives a summary of participants' profiles that were accepted and the type of organizations they operate in:

Participant ID	Job Title	Area of Specialty	Years of Experience	Organization Type	Organization Description	Size of Organisation
1	Innovations Manager	Technology Provider	13	Technology Provider	Digital transformation solutions provider.	Very large corporate
2	Agriculture Business Segment Manager	Agriculture Specialist & Technology Provider	2	Technology Provider	Digital transformation solutions provider	Very large corporate
3	Animal Scientist	Animal Science	8	Technology Provider	Smart Farming Solutions Provider	Large corporate

4	Agricultural Specialist	Agricultural Specialist	17	Technology Provider	Smart Farming Solutions Provider	Large corporate
5	Executive	Digital Service Provider & Senior Manager	15	Technology Provider	Digital transformation solutions provider	Very large corporate
6	Farm Owner	Farming	15	Farmer	Livestock commercial farm specializing in Boer goats	Medium-sized corporate
7	Senior Executive	Agriculture Expert and Senior Manager	16	Regulatory	The government authority is responsible for rural development and industrialization by deploying technology and smart agricultural practices across Zimbabwe.	Medium-sized corporate
8	Operations Manager	Agriculture Specialist	13	Distributor	Abattoir and meat produce distributor	Small corporate
9	Owner	Retailer	12	Retailer/Supplier	Meat and meat products Supplier and Retailer	Small corporate
10	Veterinary Officer	Agriculture and Animal scientist	9	Regulatory	The government department responsible for providing extension and advisory services on good animal health care, hygiene, and husbandry	Medium-sized corporate

Table 5.1 Participants' Profiling

The researcher went on to profile the respondents based on the type of organization they represent, their position, and their expertise in the study area. It was established that 50% of the participants were technology experts with variable knowledge of blockchain technology. While 50% were livestock industry experts, some have, and some do not know about blockchain technology. The figure below summarises the interview participants and their areas:

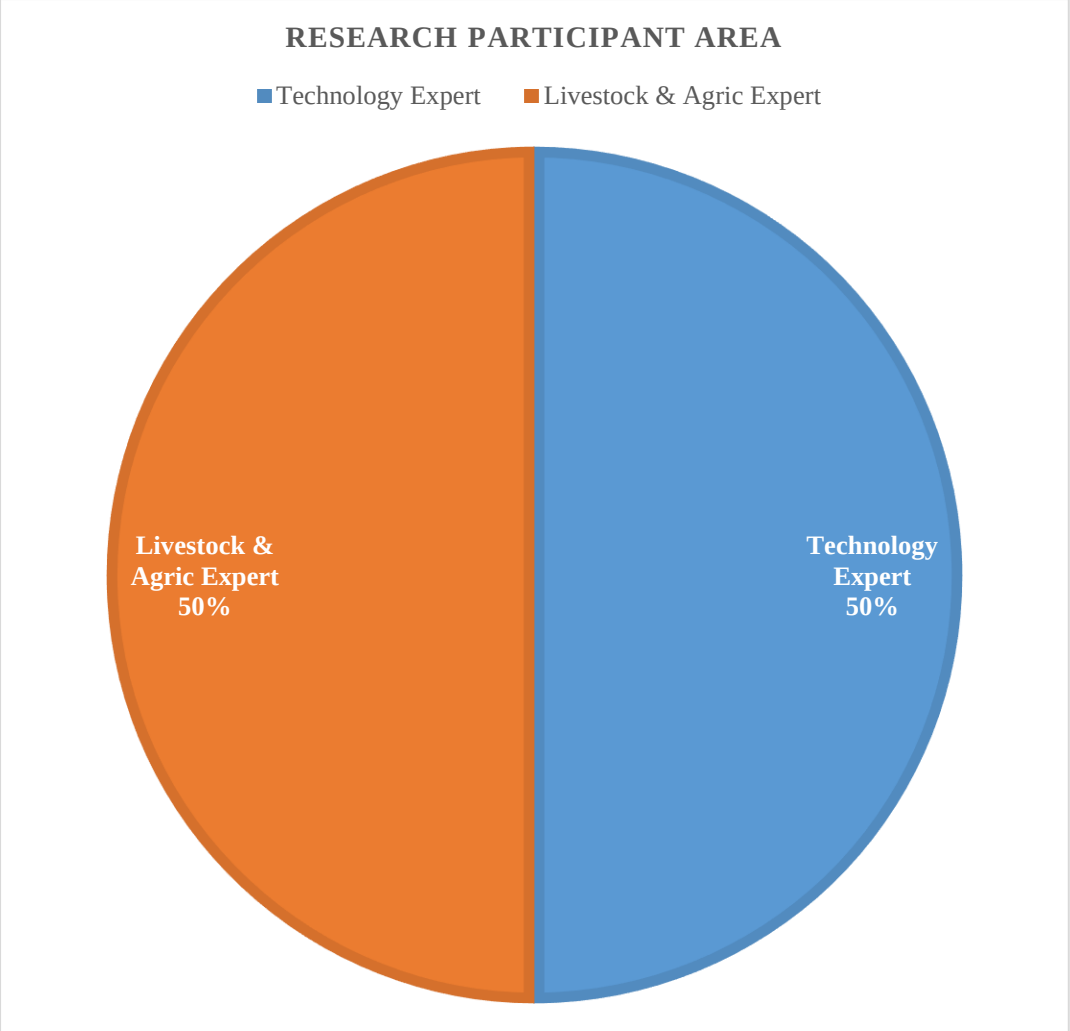


Figure 5.1: Research Participant Area

In addition, interview participants were also profiled based on their specific roles in the organization. Thus, senior-level management, middle-level management, and specialists are needed in the area. The distribution of the participants based on their roles exhibits a good representation of blockchain adoption decision-making based on the position they occupy in the organization and the authority to make decisions. 20% of the participants were senior managers at the executive level, 30% were middle-level managers, and 50% were specialists in their areas of expertise. Table 5.1 below shows a split of the 10 participants based on their role level:

Role Level	Number of Participants	% Split of Participants
Senior Manager	2	20%
Middle-level manager	3	30%
Specialist	5	50%

Table 5.2 Participant Role Level

Participants were also categorized by the number of years in the organization they work in, thus their years of experience. All the participants had at least two years of experience, making all the participants qualify to be experts in their area and appropriate for the study. The qualification of being an expert in the area was based on a definition by Ruocco (2011), who states that an expert is "an individual who by education, training, and experience is a recognized expert on a particular subject, topic, or system". 90 % of the participants have five years and above experience in the area of the study, while the participant with the highest number of years of experience had 17 years. Table 5.2 below summarises the participants based on their years of experience:

Number of Years of Experience	Number of Participants	% of Participants
0 to 11 months	0	0%
1 to 2 Years	1	10%
3 to 4 Years	0	0%
5 to 9 Years	3	30%
10 to 14 Years	3	30%
15 to 20 Years	3	30%

Table 5.3 Participant's Years of Experience

To gain a view of the coverage of participants in organizations that make up the livestock supply chain, the researcher also profiled the participants based on the type of organization they work in.

40% of the participants work as Technology Service Providers, which are enablers of the supply chain, 20% are in the regulatory field, 10% are retailers, 10% are distributors, and the remaining 10% are farmers. Table 5.3 below summarises the participant's organization type information:

Organization Type	Number of Participants	% of Participants
Farming	1	10%
Regulatory	2	20%
Enabler - Technology Service Provider	5	50%
Retailer	1	10%
Distributor	1	10%

Table 5.4 Participant's Organisation Type

To summarise, the details from the above table about participants are a clear indication that the sample of interview participants used for this study is appropriate for the study. The sample is a balanced representation of technology adoption in the livestock industry, with roles cutting across technology providers, farmers, and animal experts. The sample consisted of highly experienced individuals with experience spanning from two to seventeen years. The sample also has a representation of participants in executive management who are responsible for the final adoption decisions. Also, experts in livestock and technology who have relevant experience and are very influential in recommending the adoption decision are represented.

5.3 Interview Questions Profiling

The Interview questions were devised as semi-structured questions in three categories, as illustrated in Appendix C. There are thirty-four questions in total for the study, with 24 questions (70%) dedicated to the main research questions category. This is for the purpose of having adequate responses from the participants on the subject matter and getting detailed insights from the interviewees concerning the

phenomena under study. As depicted in Figure 5.2 below, out of 34 questions, 28 have a 100% response rate of 73% of the total sample. The overall response rate from all 10 participants was 92%, which the researcher regarded as excellent.

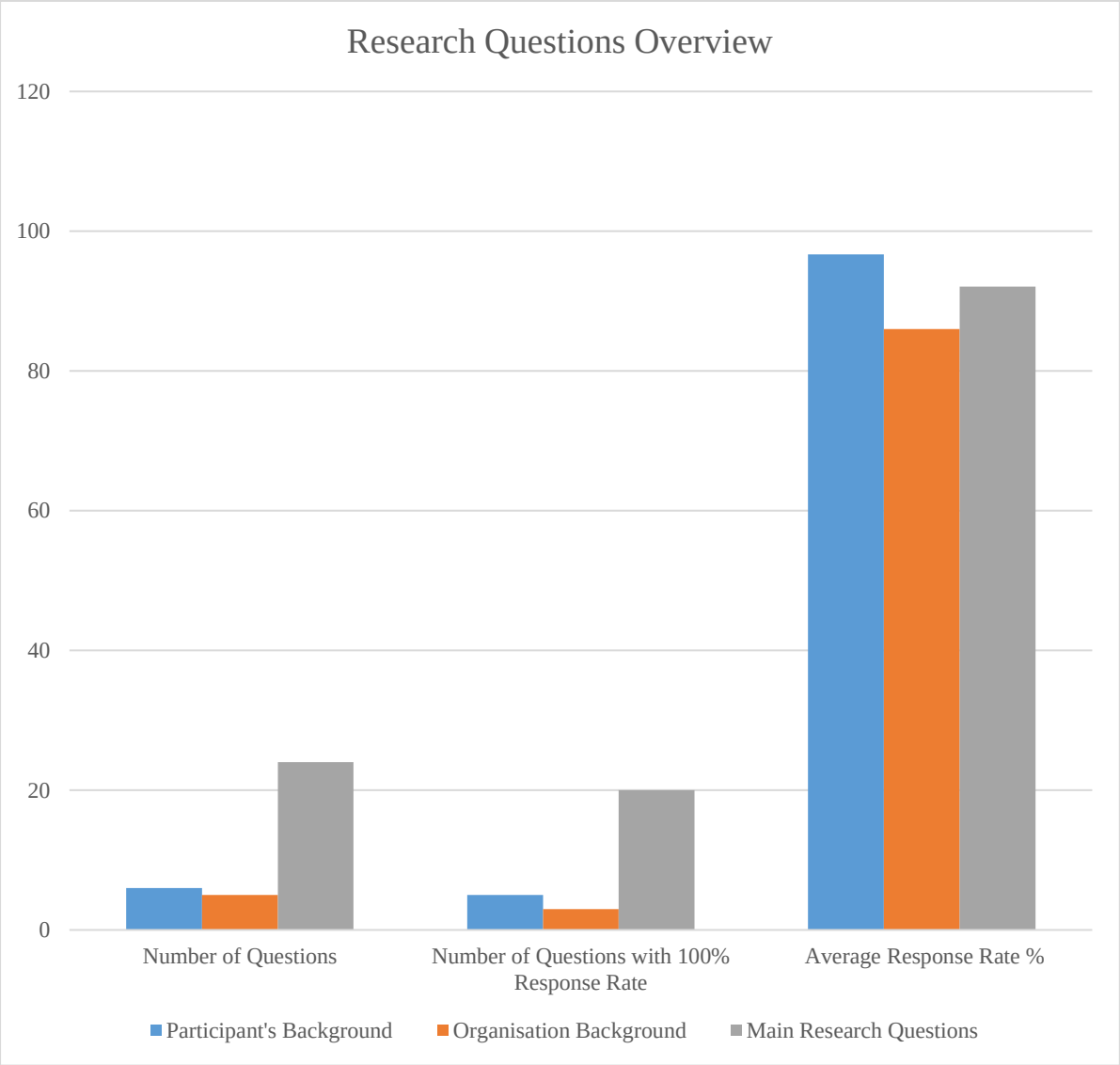


Figure 5.2: Research Questions Overview

In Section 1: Participant's Background, from the six questions in the section, 5 had a 100% response rate. Section 2: Background of Participant's Organisation had five questions, and three had a 100% response rate. The participants answered the questions with passion and enthusiasm. Inferences drawn from this by the researcher are that the participants exhibited confidence and excellent self-worth from the experiences gained so far and what the organizations offer. Table 5.4 below summarises the responses in sections 1 and 2, encompassing 31% of the interview questionnaire guide.

Section 1: Participant's Background and Section 2: Participant's Organisation Background	Count	Related Interview Schedule Questions
Number of questions with a 100% response rate	6	Question: 1.1; 1.2; 1.3; 1.4; 1.5; 2.3
Number of questions with 75-99% response rate	4	Question: 1.6; 2.1; 2.2; 2,5
Number of questions with 50-74% response rate	1	Question: 2.4
Number of questions with 25-49% response rate	0	
Number of questions with 0-24% response rate	0	
Total	**11**	

Table 5.5: Section 1 and 2 Questions Response Rate

Table 5.5 below illustrates the response pattern for questions in section 3: Main Research Questions. Section 3 has 24 questions, which is 69% of the interview questions. 14 questions (58%) of section 3 had a 100% response rate, while nine questions (38%) had over 75 % response rate. All questions in this section had a 50% and above response rate. Almost all participants chose to answer all questions related to adoption and technology based on their knowledge and experiences in the area. However, for questions related to the environment, the response rate was lower than for adoption and technology questions. The researcher noted that all interviewees were very keen and knowledgeable in their areas and easily answered the main research questions. Also, the researcher noted that the semi-structured nature of the research questions made the interviews more interactive and enabled participants to share detailed answers to the questions.

Section 3: Main Research Questions	Count	Related Interview Schedule Questions
Number of questions with a 100% response rate	14	Question: 3.1; 3.2; 3.3; 3.4; 3.8; 3.9; 3.10; 3.11; 3.14; 3.15; 3.16; 3.21; 3.24; 3.25
Number of questions with 75-99% response rate	9	Question: 3.5; 3.6; 3.7; 3.12; 3.13; 3.17; 3.19; 3.20; 3.22
Number of questions with 50-74% response rate	1	Question: 3.18
Number of questions with 25-49% response rate	0	
Number of questions with 0-24% response rate	0	
Total	**24**	

Table 5.6: Section 3 Questions Response Rate

5.4 Analysis of the Qualitative Data

The data analysis process followed an inductive approach. A conceptual framework was proposed in Chapter 3 based on knowledge acquired from existing literature and studies by other researchers. However, the researcher used the data gathered through interviews to interpret insights gained from experts interviewed, looked at the patterns generated from their responses, and refined the key adoption factors. The adoption keynotes from the collected data were then classified into Blockchain Technology adoption factors in the context of this study, such as Technology, Organisation, and Environment factors. All participants had commendable experience in the areas, as evidenced by the years of experience and knowledge they shared in the interviews. Participants also had a good understanding of what blockchain is and its benefits. The participants were also involved in technology adoption decisions as implementers, users, or decision-makers within the organizations they work in.

Most of the participants were of the view that technology simplifies processes for day-to-day activities by improving processes and instilling innovativeness. However, with emerging technologies such as blockchain, artificial intelligence, IoT, and Cloud Computing, the popularity of technology and the benefits it brings directly affect the prioritization it gets by organizations in their technology adoption roadmaps. Concerning this, Participant #1 said *"...In the last six months, we have several*

BC [blockchain] *initiatives on the table, however, these have been paused due to other emerging technologies taking strategic priorities, as they pose a greater threat to the business if not adopted."*

All in all, four key themes were identified, and these were segmented into thirty-seven sub-themes from the data collected. To understand the aspects of the phenomena under study in detail, the sub-themes were further coded into mini-themes. The total number of mini-themes is ninety-eight, as illustrated in Table 5.7:

Theme Name	Sub-Themes	Number of Embedded Codes
Adoption	Decision	5
	Driver	8
	Concern	8
	Buy-in	1
	Benefit	3
Technology	Service Provider	2
	Influence	1
	Threat	1
	Social Impact	1
	Investment	1
	Quality	1
	Regulator Interest	1
	Capacity	1
	Sustainability	1
	Readiness	1
	Agility	1
	Skill	4
	Availability	3
	Decision	2
	Properties	11
	Perceived Advantage	6
Organization	Decision Maker Support	3
	Size	1
	Issues	10
Environment	Political Stability	1
	Economic Status	1
	Competition	11

	Market Trends	1
	Pressure	1
	Regulation	6
Total		**98**

Table 5.7: Research Themes Summary

As represented in Table 5.6, the collected data exhibits that participants had in-depth insights regarding the Technology theme which encompassed 39% of the total number of themes. The environment theme composed 36%, while the Technology theme had 26% and Organisation 14%. Assertive factors materialized in the sub-themes related to Technology properties, these include competition, cost of implementation, criticality, process efficiency, policy-making, productivity management, value, traceability, new markets, challenges, and return on investment. Factors that emerged under competition, a sub-theme of Environment, were also very significant. These include market reach, literacy, income, policies, competitor technology adoption, technology advantage, regulation, and current adoption level and technology interest. The participants comprehensively discussed these themes, and great insights were revealed. The Adoption theme was broadly highlighted by participants and revealed the following dominant insights, of which some are linked back to TOE factors in the sub-sections to follow.

a. Adoption Decision

All the participants shared collaborative input that blockchain or any other technology adoption decision is a strategic decision for an organization. The decision is based on the direction an organization intends to take, thus its immediate and long-term plans. Participant #1 indicated that *"our business strategy is driven experimentation, in driving innovations and seeing how we can incorporate these to business offerings. We have an innovation hub that allows people to come up with new ideas and work with them while evaluating if they can bring benefits to the business. If we see an emerging trend, we evaluate it and see how it benefits the business while improving customer offerings".* Participant #2 supported this by highlighting that *"...We know and believe that technology can reduce operation costs and improve process efficiencies. Hence, we take seriously the use of technology to drive innovations. E.g. We make business decisions using big data and analytics.."* implying that they use insights gained from new technologies such as blockchain to come up with new products and initiatives. However, this strategic decision is considered after a cost and benefit analysis is carefully done as stipulated by Participant #6, who said, "*We look at how much value a technology can bring to us, and if resources permit, we consider the use of it".*

b. Adoption Driver

Seven participants indicated they drive technology adoption in their organization as technology implementers, users, or decision-makers. The driving force for the technology adoption is guiding principles and industry standards, as stated by Participant #1 utters that "…We are also guided by the 17 SDG goals which our innovations must also be guided by". Participant #1 shares the same sentiments and mentioned that "..As a strategic decision-maker, I am involved in all of the above. This is because initiatives we work on directly speak into the ministry's agenda and government performance". It is also critical to note that as many organizations drive technology adoption, society's preparedness to accept blockchain is an issue. Participant #5 states, "…*We have been at the forefront of technological innovations, but the society is not yet at the right level to adopt- socio-economic level, limiting the blockchain use cases we can provide to mobile money services predominantly*."

c. Adoption Concerns

With disruptive changes happening in the digital world, participants raised the issue that organizations must ensure they have relevant skills to drive blockchain technology. In this regard, Participant #3 presumes that *"...Skills are an issue, technology is rapidly changing, and this requires us to continuously learn and also balance with work for us to meet goals set. The business has invested in several learning platforms for our continued learning. Funding can also be strained because of demand because blockchain requires high computing resources".* Participants also raised concerns related to the safety of their jobs as a result of blockchain technology adoption. Participant #10 stipulated that *"...My only concern is the future of work, what will happen to our existing roles, and what skills will be more relevant. Technology keeps changing, and it is difficult to keep up with the pace".*

d. Adoption Benefit

Four participants indicated that blockchain can only be adopted if organizations understand the advantages that blockchain can realize and derive value from the adoption. Participant #6 says, "*Adopting blockchain technology will be a great deal for us, resources permitting. It would mean an expansion of our farm in so many ways. Thus, we will have the potential to try to sell our produce to other countries. Increase the number of livestock and simplify the whole process that entails animal husbandry that is process improvement."*

e. Adoption Buy-in

Participant #3 brought an interesting perspective to the discussion. He indicated that making technological investments as silos will not work. It is important to agree with other players in the whole supply chain for end-to-end blockchain adoption. Participant 3 indicated that *"Buy-in from other players within the supply chain. We adopted a training approach, training farmers and also other producers to understand the benefits of them entering into other niche markets and overall efficiencies."*

In the next sections, the researcher will now unpack the other three major themes that emerged from the data collection concerning the specific research questions:

5.4.1 Challenges Faced by Organisations in a Livestock Supply Chain

The participants interviewed were well-informed and clarified the challenges that organizations in the livestock supply chain face in Zimbabwe. These main challenges are summarised in the section below:

5.4.1.1 Challenges

5.4.1.1.1 Zimbabwe Political and Socio-Economic Status

As supported by Mhlanga & Ndhlovu (2021) and the African Development Bank (2019), Zimbabwe has been interfered with by some political and socio-economic challenges. Among many other issues, the main contributor was the land reform program, popularly known as the Third Chimurenga. This occurred in 2020, although the program was meant to correct land imbalances in the country between the commercial white farmers and the locals, the situation became explosive white farmland invasions. This resulted in over 3500 farmers in the Commercial Farmers Union leaving their farms. Owing to the violent and policy-contradictory nature of the land reform program, as led by the war veterans, a lot of bad attention was focused on Zimbabwe. This attracted international sanctions being imposed on the country, mainly by the European Union and the United States of America.

Mhlanga & Ndhlovu (2021) went on to explain the suspension of budgetary support by the European Union and discontinued financial support for all projects besides those in direct support of the population by the European Union as part of the sanctions. This saw the rapid deterioration of foreign trade and the collapse of the Zimbabwean economy. Poverty levels rose immensely, as analyzed by ratings from the International Poverty Line (2011), 72.3% of the total population was classified as poor. To make the situation worse, Zimbabwe also faced environmental challenges ranging from biodiversity loss, pollution, and inadequate waste management to forest and land degradation. In 2017, climate changes caused challenges such as floods and cyclones, for example, Cyclone Idai,

which hit the region in countries such as Zimbabwe, Mozambique, and Malawi, while repeated tornados ravaged South Africa, causing huge losses of human lives and livestock.

Two of the interviewed participants concurred with the highlights above, and they indicated challenges being faced by their organization as a result of Zimbabwe's political and socio-economic status. Participant #5 implored that *"..drought currently faced by Zimbabwe has reduced headcount by a big margin. Also, sanctions imposed on Zimbabwe drastically reduced our capacity to export beef. Zimbabwe used to be big on this, but now it has been blacklisted and can't export to some European countries. Stock theft has increased lately due to poverty and drought, so we are investing in technical solutions such as cattle tracking, geo-fencing, and so on to eliminate some of these challenges."*

Participant #2 also mentioned similar comments by stating that *"..Transparency property of blockchain can make it easy to comply and participate in lucrative markets. As this helps to demystify bad perceptions people have of Zimbabwe."*

5.4.1.1.2 Manual Record Keeping Methods

Concerning a study done by Muteti et al. (2018), the use of manual record-keeping methods is a tedious process. The data is prone to errors due to manual data capturing processes and incorrect data mapping. Participant #10 said that *"..In my line of work, the main challenge in this sector is record keeping, and we still rely on manual entries with a lot of human interference. If someone forgets to put an entry in the ID book for a vaccination, the information becomes distorted. This makes it difficult to make recommendations and advise on good animal care. And also to make accurate reports on animal disease control among other information which is necessary for the government to make necessary policies".*

Participant #10 also describes the manual data-capturing process, he states that *"..We make use of a manual stamping system on the animal with stamping IDs that represent a province that an animal belongs to manage animal movements. We also make use of manual ID books per family/ household that carry information on how many beasts they have, vaccination history, and so on, updating of the records is sorely dependent on the Agritex officer and the farmer. There are a lot of manual interventions, and it has been a challenge for us to get a suitable system we can use that is of a reasonable cost."* Below is an example provided by the participant of the stock record, which the farmer updates. It must be cautiously done to reflect the true status of the farmers' herd.

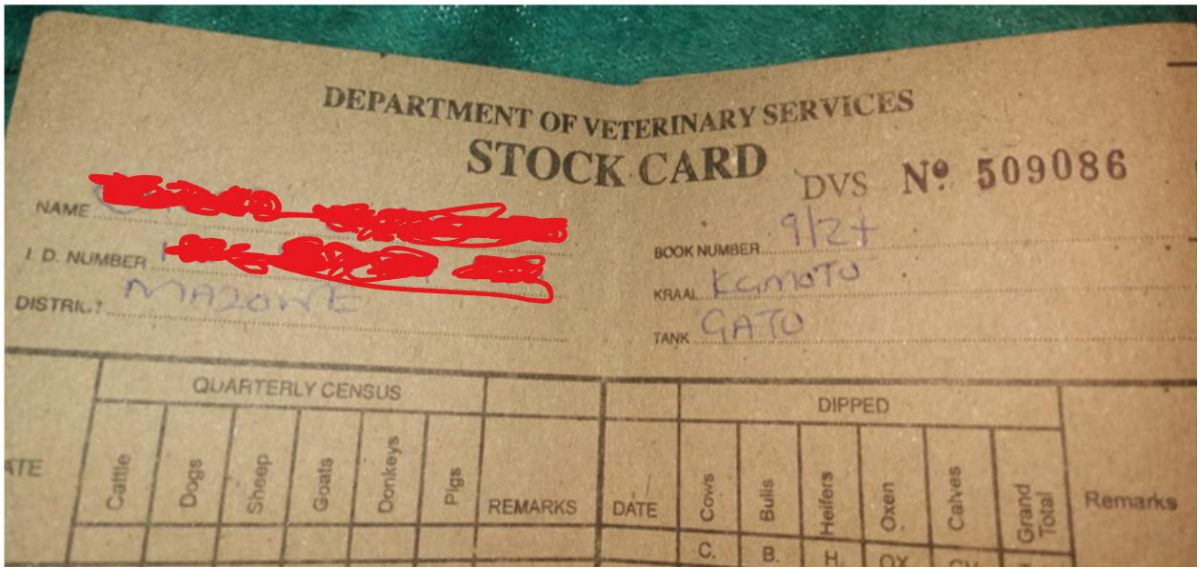


Figure 5.3: Stock card

Participant #3 also indicated that the use of these manual cards directly results in problems related to accurate information sharing. The Participant mentioned that *"..Accurate information sharing by the farmers, for example, concerning diseases and nutrition intake is an issue. This is because some local farmers do not take record keeping seriously, resulting in information gaps*."

5.4.1.1.3 Funding (Capex/Opex) and Government Support

As supported by a study by Chiremba & Masters (2003), small-scale and peasant farmers encompass more than 80% of the agricultural sector in Zimbabwe. These are mostly people who benefited from the land reform program. Although the program was implemented over two decades ago, according to Chiremba & Masters (2003), one of the challenges they face is a lack of equipment and inputs for farmers to improve their livestock farming. This is discussed by Participant #6, who mentioned that *"...Funding availability is an issue. The government encourages us to get financial loans from banks. However, it is difficult for our loans to be approved as we do not have collateral the banks need as a security measure*."

Participants who work in regulatory departments in livestock farming feel the need to adopt technology; however, they still think that the government has to have technology strategy roadmaps and avail funding for necessary investments. Participant 10 mentioned that *".. Technology-driven innovation is acceptable; however, their full utilization depends on the availability of government funding and government strategies as defined by the ministry."*

Another aspect raised by Participant #2 is *"... Government support will give players in the livestock supply chain to get necessary resources and funds being directed where they are needed.* Participant #2 states that *"indeed corruption is at its peak, funds, and supplies for the benefit of farmers and the whole supply chain, are being misdirected and given to a few chosen individuals."*

5.4.1.1.4 Regulation Application and Awareness

Examples of regulation policies that apply to the livestock supply chain include the production and use of animal feed, which are regulated under the Fertilizers, Farm Feeds and Remedies Act and Regulations, and under the National Biotechnology Authority Act and Regulations. Animal welfare is also managed under The Prevention of Cruelty to Animals Act, which prohibits torture or mistreatment. Six of the interviewed participants believe that the Livestock Sector is heavily regulated, as cited by Participant #4, *"This sector is heavily regulated by the government. Acquiring livestock requires clearance by the Police as it involves the movement of livestock. Veterinary clearance and Food handling clearance."*

The participants felt that the regulators were not doing a good job of communicating new policies and changes in existing policies. With the same reasoning, Participant #9 mentioned that *"Also regulation, policies change and communication is not properly done, we also notice a lot of inconsistencies in the application of the policies."*

All ten participants were somewhat unsure if they knew all the regulations about this sector. This can be deduced from the comments raised by Participant #10 that as a regulatory department, "...We do have many regulations, and the amount of repetitive consultations we receive from farmers and service providers is a clear indication *of poor awareness of regulation. BC can enable us to have clearly defined processes and effectively apply regulations."*

5.4.1.1.5 Disease Outbreak and Stock Theft

Zimbabwe faced many livestock disease outbreaks from 2017 to 2021. According to the Government of Zimbabwe (2022), this included the anthrax outbreak, foot and mouth, January disease, and tick-borne disease outbreak. This had diverse effects on the government's livestock growth plan, which is to grow the country's livestock sector to a two-billion USD economy by 2025. The livestock supply chain players were also not spared from the misfortunes of these disease outbreaks. Participant #5 mentioned that *"the disease outbreaks caused meat produce not to be sold in some areas, reducing the farmers' income. Stock theft increased due to poverty and drought, and that's why we are investing in tech solutions such as cattle tracking, geo-fencing, and so on to help solve these challenges."*

Participant #6 also had the same views, indicating that *"…believe that it would have a collective benefit to the community of farmers, especially in the area of disease control. 2020 was a terrible year for us as livestock farmers, and we lost our stock due to the disease in January. If there were a way of identifying areas affected in real time and avoiding animal interactions, it would save us a great deal. Also, livestock theft has been a major threat to us, and we could avert this with the traceability feature of blockchain."*

Additionally, Participant #8 instigated that *"…, with the illegal movement of cattle. Unauthorised animal slaughter, thus bush slaughter, with no health inspection, is also on the rise. This is depriving the Veterinary Department of much-needed income for funding technical support. Marginalized communities are not getting the true value for their livestock due to these informal traders."*

5.4.1.1.6 Skills and Digital Penetration Rate

As the digital transformation continues to unfold and trend, the focus remains on building resilience and sustainability. Skill remains a key asset to this transformation (Accenture, 2017). Digital penetration rate directly implies the adoption of any new technology. In Zimbabwe, the digital penetration rate is generally low, which is a key issue in adopting blockchain technology. Participant #5 indicated the *"Preparedness of the society to adopt the technology. We have been at the forefront of technical innovations, but society is not yet at the right level to adopt- socio-economic level, limiting the use cases we can provide. Tech advancement of the society. The digital penetration rate is currently less than 40%, and fewer people have smartphones, laptops, or use any technology."*

According to Participant # 7, it is difficult to define efficient processes without tech-savvy people within an organisation. The participant highlights that *"Our national annual milk requirement as a nation is over 120 million litres. It has been a challenge for our farmers to meet this demand, which mainly emanates from a lack of skills and resources in our rural farming community. We have tried to solve this by developing programs such as the dairy development program and youth incubation hubs. Which is now contributing 10% of the demand, with 23 milk collection points, and over 200 00 people have benefitted from this. Though there is still a lack of coordination of these points in real-time."*

For players in the livestock supply chain who are at the forefront of driving technology inclusion, however, ensuring they have agile processes to remain flexible and operational is important. Participant 5 mentioned, *"You don't get the technology right the first time, fail fast, and make corrections. We train staff, and this highly skilled staff is at the risk of being offered better opportunities by other organisations."*

Digital literacy remains an issue in this sector, as mentioned by Participant #1, who indicated that *"smallholder farmers control a larger stake in the livestock sector however, they are not digitally*

literate". Organizations need to prioritize training in the new technologies and blockchain to fully equip them to drive technology adoption, as mentioned by Participant # 3: *"We continuously train our staff. Outsource skills if they are not available internally. Make our processes flexible, and we continuously update them, benchmarking with other organizations to remain relevant"*

5.3.1.2 Summary

Perceptions provided by the participants, the researcher concluded that there are several challenges currently being experienced by organizations in the livestock supply chain in Zimbabwe. These challenges have harmful effects on the livestock sector as a whole and its ability to grow. It was also noted, based on the participants' literature and insights, that blockchain's characteristics can provide solutions to these challenges and benefit the sector.

5.4.2 Characteristics of Blockchain that Can Benefit Livestock Supply Chains

The next section will discuss the characteristics of blockchain technology and the benefits it brings to the livestock supply chain based on the data collected and supported by existing literature.

5.4.2.1 Properties and Benefits

With recent momentum and attention around blockchain recently it is very important to understand blockchain as a technology to avoid any misconceptions arising due to limited knowledge of the technology. According to Michael Crosby et al. (2015), understanding the technology's characteristics enables us to understand better the potential that blockchain technology can bring to an organization and its limitations. This helps organizations to be informed about adopting and implementing blockchain. Table 5.7 summarises the properties of blockchain technology and matches these to the benefits each property brings and how it has impacted the challenges mentioned by the interview participants.

#	Blockchain Property	Description	Benefit	Literature Reference	Challenges that can be Solved	Mentioned By:
1	Immutable	• Immutability is when recorded data cannot be modified or erased. When a transaction is agreed upon and recorded in a blockchain, it can never be changed. • This is made possible by way of unique hash codes that are assigned to each transaction, which are referred to as blocks. • The hash codes depend on the content of a block making each hash very unique.	• Security is guaranteed in a blockchain as tempering is prevented through codes. • Immutability enables trust among transacting parties as no one can make adjustments; if modifications are made, the blockchain breaks. • Thus, it also ascertains the source and legitimate source of a transaction	(Bhattacharya & Wamba, 2015); (Conte De Leon et al., 2017); (Sultan et al., 2018)	• Accurate record-keeping, the participants indicated that record-keeping is a major issue in the livestock supply chain as a result of manual methods used for data capturing and lack of interest, especially by the farmers to capture the record. • With the rise of livestock theft in Zimbabwe, stock validation is a necessity. However, an existing challenge as it is difficult to verify proof of ownership of for example a farmer selling livestock products	Participant #3, 9,10
2	Time-stamped and Programmable	• This refers to a minute piece of information that is stored within each block of a blockchain. • This specifies the exact moment a transaction originated and it gives a unique serial to all the transactions.	• This gives a time signature to the transactions enhancing the fact that any data transaction that enters a blockchain becomes legally binding. • It also eases the processes to do with operations and maintenance, as it becomes easy to track transactions within a blockchain network.	(Demestichas et al., 2020b);(Bhattacharya & Wamba, 2015); (Atlam et al., 2018)	• One of the issues indicated by the participants is the issue of validating records of data captured. • Data inputs from players in the livestock supply chain are mainly used by regulatory bodies as input to regulations and policies. • It is also used to track and monitor disease prevalence across the country, and it's very critical that the information provided is accurate and validated.	Participant #2,3,9,10

3	Secure and Distributed	• The secure distributed nature of blockchain refers to its ability to maintain a shared public ledger of transactions. • All key links such as data sharing and access control are made accessible to all parties. Transactions are stored in blocks each identified by a unique serial code hash code, which cannot be modified by unauthorized parties.	• The benefit of this architecture design is that the transaction blocks cannot be manipulated, meaning that all transactions are transparent and can easily be tracked. • Also, the distributed nature inherits the benefits that come with a decentralized system meaning that they are fault-tolerant	(Rocha et al., 2021); (Khan et al., 2022); (Atlam et al., 2018)	• Another challenge mentioned by the participants is the difficulty of the livestock supply chain in validating stock origins. • entering new markets is also another challenge, based on international standards products must be traceable at any point in time, for example, if a QR code is scanned all details about a product its origin nutrient benefits and so on must be derived. • Lack of coordination is also a challenge that could be solved through the decentralisation property allowing participants at different points to have access to the same information	Participant #2,5,5,7,8,9,10
4	Unanimous and Anonymous	• Anonymous in a blockchain refers to the fact that no activity in the chain can be linked to a specific user outside of the information specific to the transaction. • While specific user information remains encrypted, for the records and transactions to be deemed valid within a chain they need to be agreed upon by all participants in the chain -unanimous	• This is a very powerful security feature as it guarantees the security of transactions which is otherwise not possible in the current system of fund transactions	(Atlam et al., 2018); (Hughes et al., 2019a);(Michael Crosby, et al., 2015);	• Two participants mentioned security issues in their interviews as a concern for blockchain adoption. When adopting technology cyber and other security issues become a key consideration • The challenge that can be solved by this property is the accessibility of personal information by unintended participants and also the issue of unauthorized access to critical information for example into data captured by Veterinary officers as input to regulation, disease control, and other issues	Participant 2 & 9

Table 5.8: Blockchain Properties and Benefits Analysis

5.4.2.2 Summary

According to the data collected and analyzed above, the characteristics of blockchain and its advantages were aligned to existing literature and in practice as alluded to by the research participants who are expert professionals in their areas and, therefore a continuous discourse in academia and practice.

5.4.3 Factors Affecting Adoption of Blockchain Technologies in Developing Countries

Zimbabwe has a unique operating environment because of its political, social, and economic status. It has been listed by the International Monetary Fund, IMF (2024) as one of the developing countries with the highest inflation rate. The country also presents several business opportunities because it uses a multi-currency financial system. In this regard, there are many critical factors organizations, especially in the livestock sector, consider when adopting a technology, which the participants of this study mentioned. Using the lens of the TOE framework and in context to the Technology, Environment, and Organisation factors, regulation, competition, the cost of implementing the technology, funding availability, and skills availability were the most mentioned factors by the interview participants.

5.4.3.1 Technology Context

As instigated by Baker (2012), it is important to evaluate technologies based on the type of value they bring to a business, whether it is "competence-enhancing or competence-destroying". In this regard, the participants shared the following critical views:

5.4.3.1.1 Properties

All ten participants agreed that blockchain technology's properties have the potential to solve challenges that organizations in the livestock supply chain are currently facing. As explained in previous chapters, these properties include immutability, security, distribution, and a unanimous and anonymous nature. With the livestock supply chain in Zimbabwe being hampered by enormous challenges, nine participants were very determined to adopt blockchain to help solve these challenges. Kouhizadeh et al. (2021) support this by instigating that due to blockchain's capability to link all transactions with its predecessor, it makes sure that transactions are verifiable, secured, and transparent to all. This has caused many reputable organisations to integrate blockchain into their supply chains, resulting in improved efficiency and performance.

5.4.3.1.2 Availability

Six participants indicated that they have, to some extent, made investments related to blockchain technology in capturing data into the chain. The remaining four participants indicated that either no investments have been made so far in the area or investments in blockchain availability are still plans for their organization, and these are still utilizing manual data-capturing methods. Manual processes are a serious challenge faced in the livestock supply chain. This is supported by Andeme Bikoro (2022), who indicates that traditional supply chains that utilize manual processes incur issues emanating from a lack of shared reliable information. It is difficult for players in the supply chain to guarantee the authenticity and origins of the food products. From the participant's responses, it can be concluded that it is easier for organizations to adopt new technology if they are already using other ITs than for businesses who have not yet invested in any technology. In agreement, Awa et al. (2016) explain that the presence of IT infrastructure in an organization makes the technology adoption process seamless as there is a better understanding of the usefulness of technology.

5.4.3.1.3 Perceived Advantage

As Rogers (1995) emphasised, the benefits that technology can bring to an organization are key determinants towards adopting any technological innovation. All ten participants were well informed on blockchain's benefits if adopted. All ten participants specified that blockchain technology enables their digital transformation journeys. They view it as a strategic focus that can potentially improve their business operations. All ten participants also mentioned process efficiencies as a major benefit that blockchain adoption affords to an organization. Process efficiency is critical for any supply chain's success, as providing service at the right time results in optimum service delivery (Aich et al., 2019).

5.4.3.1.4 Other Factors

5.4.3.1.4.1 Skills

An additional factor derived from participant data collected is the Skills factor. According to Baker (2012), the presence of people with knowledge about a particular technology in an organisation allows an organization to pursue innovations. All ten participants believed skill is an important factor in the adoption of any technology. The slowed rate of blockchain adoption may result from a lack of skilled technology resources. As mentioned by Awa et al. (2016), skill provides proficient know-how, which directly influences the use of technology

5.4.3.1.4.2 Cost of Implementing a Technology

Another factor, as deduced from the participants, is the cost of technology. All ten participants in the study mentioned cost as a factor that impedes their decision to adopt blockchain technology. The cost element includes the training investment value needed to train their staff resource to be experts in the technology and general users. It can be deduced from the respondents that the cost of implementing a technology is also a major issue affecting adoption. This is supported by Jere & Ngidi (2020), who indicate that complex and expensive systems are normally abandoned. System managers also feel that for such systems, it can be costly to train employees and there is a possibility of not wanting to adopt.

5.4.3.2 Organisation Context

5.4.3.2.1 Funding (Capex/ Opex) Availability

Blockchain technology can reduce the cost of transacting in a business, benefitting the farmer and all players in the supply chain. However, as explained by Xiong et al. (2020), it is important to note that capturing data on a blockchain can be very expensive. The same applies to setting up a distributed ledger system, which can be a relative barrier to adopting blockchain technology in agriculture.

Six participants conversed about funding as an enabler of blockchain technology. They indicated that their organizations' operational and capital expenditures in financing blockchain technology are strategic decisions. It is a strategic decision that is part of IT and business alignment. It threatens technology adoption if the top management does not prioritize it in their budget approvals.

5.4.3.2.2 Size of an Organization

According to Jere & Ngidi (2020), the size of an organization directly affects the ability of the organization to adopt a technology. It is easy for smaller corporates to adopt new technologies because they are agile, unlike larger corporates, which have complex internal processes. The participants interviewed were from different-sized organizations, small, medium, large, and very large corporates. It was important to note from the participants that very large corporates that have adopted blockchain and other emerging technologies tend to form smaller business units that drive innovation to allow flexibility in the adoption process.

5.4.3.2.3 Decision Makers' Support

All ten participants indicated that their executive leadership roles are to provide required sponsorship, funding, and direct business strategy. In support, Jere & Ngidi (2020) in their study, highlighted that support by top management is a key determinant in adopting technology. They highlighted that the executive leadership of an organization highly influences the decision to adopt technology because the management has direct authority over decisions that affect the top and bottom lines of the business. Therefore, executive leadership requires knowledge of the technology and its benefits, and failure to understand this negatively affects the decision to adopt blockchain.

5.4.3.2.4 Other Factors

5.4.3.2.4.1 Technical Readiness

Technology readiness is an additional factor in the organizational context derived from the data collected. As highlighted by some participants, technology readiness applies not only to the organization but also to its intended market. If an organization is technically ready but the end customer is not, it creates issues as a result of a lack of usage of the technology. In turn, the overall adoption process is impacted because, with no buy-in, overall advantages to the organization that come through technology adoption are not realized. The participants also indicated that in the Zimbabwean environment they operate in, which is characterized by many uncertainties, it is difficult to predict whether users will accept or not innovations. As posited by Aboelmaged (2014), technical readiness is an important factor in determining an organization's adoption of technology, especially for organizations operating in VUCA (volatility, uncertainty, complexity, and ambiguity) environments.

5.4.3.3 Environment Context

5.4.3.3.1 Regulation and Policies

As instigated by Baker (2012), regulatory policies, especially by the government, can benefit or harm innovations. This is supported by the research participants' agreement that the livestock sector in Zimbabwe is a highly regulated area. A major challenge in this area is the lack of awareness of the applicable laws by players in the livestock supply chain. No technology enforcement policies make the area prone to inconsistent policy application, fraudulent activities, and corruption.

5.4.3.3.2 Competitive pressure

Based on a study by (Jere & Ngidi, 2020b), competition is a factor in adopting new technologies. However, it has a greater impact when there is a clear indication of the value an organization can get upon adopting a technology. From the data analyzed, it can be concluded that organizations weigh the value of technology to the business benchmark with other institutions regarding the technology they are adopting. The decision to adopt will be a response to how much the organization will lose if the technology is not adopted.

5.4.3.3.3 Presence of Blockchain Service Providers

Four participants concurred that blockchain application in agriculture is a new concept; therefore, technology providers in the area are still limited. This has ideally caused some organizations to prioritise other technologies, such as artificial intelligence (AI). Bhattacharya & Wamba (2015) explain that support from technology service providers greatly impacts an organization's decision to adopt. The availability of these service providers directly implies the decision to adopt a technology.

5.4.3.3.4 Other factors

5.4.3.3.4.1 Political and Socio-Economic Stability

As evident from the literature, Zimbabwe continues to experience volatile macroeconomic environmental issues characterized by high inflation rates and poor public services provisioning. This volatility has resulted in a massive toll on the overall growth of the economy (Government of Zimbabwe, 2012; Mhlanga & Ndhlovu, 2021; African Development Bank, 2019). The participants were very environment-conscious. Five participants indicated the political and socio-economic issues in Zimbabwe, thus, the hyperinflation, sanctions, and so on have caused a lot of disparities in the livestock industry, resulting in corruption and marginalization of the society.

5.4.3.3.4.2 Market Trends

With the rise of 4IR and most organizations accelerating their digital transformations, companies are looking for ways to gain a competitive edge by ensuring they remain up-to-date with technology trends that promote efficiencies. Most organizations intend to adopt new technologies, however, adoption rates remain low. A possible cause of this may be prioritizing their technology priorities, delaying adoption (Roberts, 2023). This was supported and highlighted by the participants, who indicated that for an organization to remain relevant, it is critical to adopt technologies, however, for

five participants, their organization has slowed down on blockchain adoption to reinvest in other technologies as part of their strategies.

5.4.3.4 Summary

The researcher summarised that several factors are key determinants of organizations' decisions in Zimbabwe's livestock supply chain to adopt blockchain technology. The major factors mentioned in this section cut across the Technology, Organisation, and Environment constructs. Different participants mentioned some of the factors (such as skill) as important concerns, issues, and benefits for blockchain technology adoption. New factors, such as political and economic factors, were also identified in the environmental context. Supporting literature was determined to support the factors mentioned by the participants. Therefore, the above findings from the data collected remain consistent with the literature reviewed.

5.4.4 Factors Affecting Blockchain Adoption Decisions by Livestock Supply Chain Organisations in Zimbabwe

With systematic reference to the existing literature, the researcher took time to investigate and understand the TOE framework and devised a conceptual Blockchain-Adoption TOE Model. The conceptual model and its relevant factors were then validated using the Zimbabwean case of organizations in the livestock sector, balancing all groups that encompass the livestock supply chain. From the analysis of data collected through interviews, the study revealed that TOE factors in the proposed framework were relevant to the study context. The participants appraised all the factors as critical in the adoption of blockchain by organizations in the livestock supply chain in Zimbabwe. Table 5.8 gives a summarised view of the criticality level assigned by each of the participants to the initially proposed conceptual framework.

Adoption Factors	Technology Context			Environment Context			Organization Context		
	Characteristics of blockchain	Availability of blockchain providers/solutions	Perceived Advantages	Funding Availability	Size of the Organization	Decision makers support	Regulation and Policies	Competitor pressures	The presence of blockchain service providers
Participant 1	Very Critical	Very Critical	Very Critical	Very Critical	Partially Critical	Very Critical	Very Critical	Critical	Critical
Participant 2	Very Critical	Very Critical	Very Critical	Very Critical	Less Critical	Critical	Partially Critical	Partially Critical	Critical
Participant 3	Very Critical	Critical	Very Critical	Partially Critical	Partially Critical	Critical	Critical	Very Critical	Partially Critical
Participant 4	Very Critical	Very Critical	Critical	Less Critical	Critical	Very Critical	Very Critical	Critical	Critical
Participant 5	Very Critical	Very Critical	Very Critical	Very Critical	Less Critical	Very Critical	Very Critical	Partially Critical	Partially Critical
Participant 6	Very Critical	Critical	Very Critical	Very Critical	Not Critical	Very Critical	Very Critical	Partially Critical	Partially Critical
Participant 7	Very Critical	Critical	Very Critical	Very Critical	Less Critical	Very Critical	Very Critical	Less Critical	Partially Critical
Participant 8	Critical	Partially Critical	Partially Critical	Very Critical	Not Critical	Very Critical	Critical	Less Critical	Partially Critical
Participant 9	Very Critical	Partially Critical	Very Critical	Very Critical	Not Critical	Critical	Very Critical	Critical	Critical
Participant 10	Very Critical	Very Critical	Very Critical	Critical	Not Critical	Critical	Critical	Less Critical	Partially Critical

Key	1= Not Critical	2= Less Critical	3= Partially Critical	4=Critical	5= Very Critical

Table 5.9: Blockchain Adoption Factors

The characteristics of the technology factor emerged as utterly critical by nine of the ten participants. Five of the factors (thus, perceived advantage, availability of blockchain solutions, funding availability, decision makers' support, and regulation & policies) were considered to be very critical by 50% to 80% of the participants. At least nine of the participants considered three of the participants to be partially critical. The data revealed that technological factors are mostly what organizations consider when adopting a technology. At least 90% of the participants classified technology factors as very critical.

From the interview data and as supported by literature, technological (skill and cost of technology), organization (Technical Readiness), and environmental (market trends and Political and socio-economic stability) factors emerged to be additional factors that were not included in the initial proposed framework for the adoption of blockchain technology. The researcher identified these five factors as worth adding to this study's end-state conceptual framework.

The perceived advantage factor in the technology context was removed from being a factor that influences the adoption of the technology, but the results or benefits the organization will get from adopting the technology. All ten participants mentioned the benefits of using blockchain in instances where they discussed challenges currently being experienced and how blockchain can solve the issues. For example, Participant #4 highlighted that *"Ease of doing business is improved through the use of blockchain as information sharing and approval processes becomes easy. Movement of caucuses and live livestock, which is an issue now, can easily be tracked with full accountability."* In support, Conte De Leon et al.(2017) stipulated that while the distributed identity of blockchain creates several opportunities, it is crucial to understand this technology and carefully implement it to avoid misconceptions that come from lack of clarity of risks and advantages of blockchain and not having the right skills to implement and support it. Overall, it can be concluded that from the research findings in Table 5.8, the Blockchain-Adoption TOE framework can be applied to understand better blockchain adoption by organizations in the livestock sector in Zimbabwe.

5.5 Final Conceptual Framework

The conceptual framework proposed in Chapter 3 was enhanced based on the findings from the interview process and the significance of additional blockchain adoption factors mentioned by the participants. Figure 7 illustrates the resultant conceptual framework informed by the data analyzed in this study.

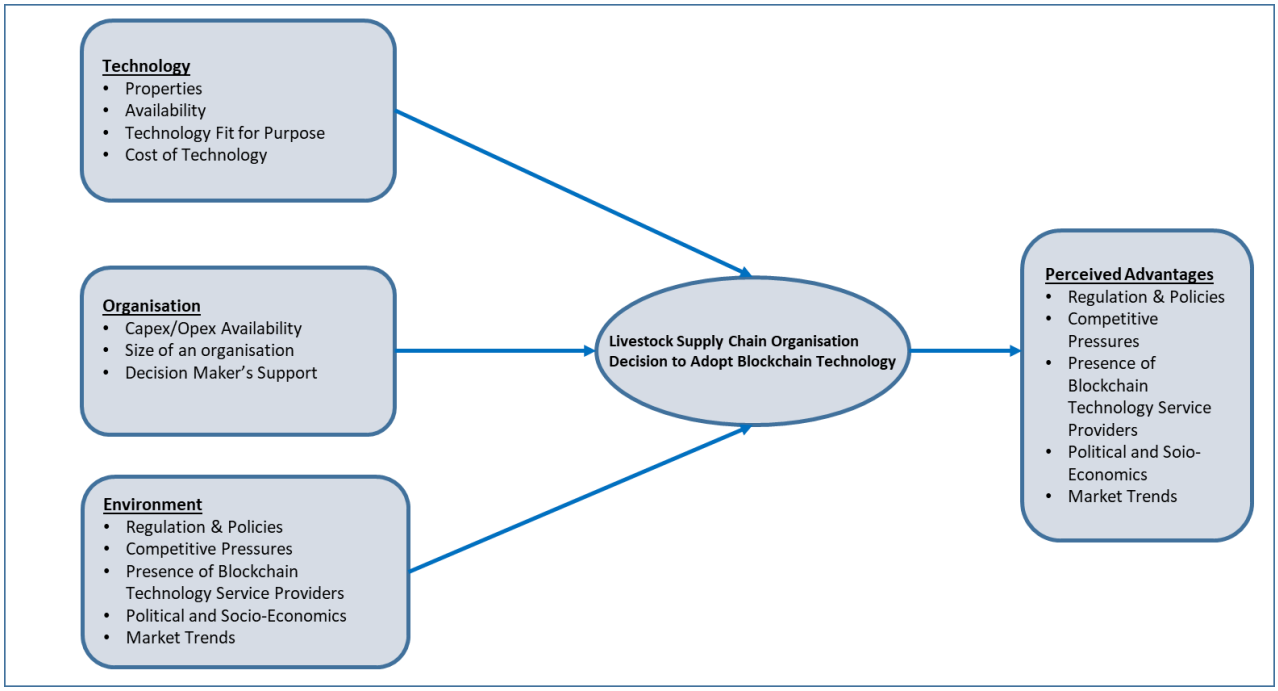


Figure 5.4: Blockchain TOE Adoption Conceptual Framework

As illustrated in Table 5.8, when combining the responses for Very Critical, Critical, and Partly Critical, all factors above were regarded as critical by at least 70% of the participants. Thus, all factors are retained in the conceptual framework. As discussed in detail in this chapter, the study revealed that all the factors depicted in technology, organization, and environment are considered in adopting the blockchain process by organizations in the livestock supply chain in Zimbabwe.

Chapter 6: Evaluation of the Research

6.1 Introduction

This chapter reflects on the study to ascertain if the objectives were met and if the main and specific research questions were answered. The research aimed to understand the key adoption factors for blockchain technology by organizations in the livestock supply chain in Zimbabwe. This chapter also gives recommendations for future studies and discusses the limitations of the research.

6.2 Overview of Chapters

Chapter 1 presented the introduction to this study. It gave particular emphasis on the background of this research, the problem statement, the purpose of the study, the intended contribution of the research, the research questions, and the delimitation of the study.

Chapter 2 introduced blockchain technology, its history, the concepts of blockchain technology, its properties, and the types of blockchain. The chapter also discussed the livestock supply chain and its challenges based on existing literature. It also highlights regulations in the livestock supply chain, particularly in Zimbabwe. Through a systematic literature review, the researcher referred to existing academic literature to deliberate on the applications of blockchain in other supply chains and looked at past research studies on this phenomenon.

Chapter 3 details the theoretical underpinnings of this research by looking at other academic frameworks in studying adoption, such as the institutional theory, DOI, UTAUT, TAM, and TOE, to identify the most suitable model for the study. The TOE framework was selected as the framework of choice, and the model is outlined in detail in this chapter. This chapter also proposed a research framework for the study using the lens of the TOE framework.

The methodology used to conduct this research was delineated in Chapter 4. This chapter presents this study's research paradigm and approach by also detailing the associated design, methodology, and strategy guiding the study. Chapter 4 also highlighted the data collection, sampling, and analysis procedures chosen for this study. In addition, this chapter highlighted the ethical considerations and issues associated with this research.

Chapter 5 presented the empirical data collected and the related findings emerging from the analysis of the data collected from ten (10) research participants through interviews. The results from the analyzed data were used to refine the proposed research framework to a conceptual framework with thirteen significant factors that were key in blockchain technology adoption by organizations in the livestock supply chain in Zimbabwe.

6.3 Research Objectives

This research study investigated the factors influencing organizations' decisions in the livestock supply chain to adopt and not fully adopt blockchain-based technology within Zimbabwe.

The main objective of this study was to investigate and answer the following research question: **What are the factors affecting Zimbabwean organizations' adoption of blockchain technology to support their livestock supply chain?** In this regard, data was collected from ten participants within organizations in the livestock supply chain in Zimbabwe. The data was analyzed and examined using the lens of the TOE framework. Thus, the technological, organizational, and environmental characteristics surrounding organizations were considered, as detailed in Chapter 5.

In general, both the main and specific research questions were answered. Thirteen TOE factors aligned with the reviewed data and literature were validated and considered as the key factors that organizations in the livestock supply chain adopt or not adopt blockchain technology. In addition, five advantages were perceived to be benefits derived from the decision to adopt. The thirteen key validated factors that affect the decision to adopt the technology included properties of the technology, availability of the technology, cost of the technology, skills availability, regulation and policies, competitive pressures, presence of blockchain providers, political and socio-economics, and market trends. The key benefits derived from the adoption decision were evaluated as follows: data integrity, trust between transacting parties, security, affordability, and ease of tracking transactions.

Based on the findings, the study formulated a Blockchain-TOE Adoption conceptual framework, including factors, which can be applied to have an understanding of blockchain technology adoption by organizations in the livestock supply chain.

6.4 Contributions of the Study

This section discusses the shortcomings of this study and proposes areas for further studies. It concludes by highlighting the contributions this study presents to academia and practice.

6.4.1 Limitations of the Study

This study has potential limitations which may be addressed in future studies. This study for blockchain technology was limited to organizations in the livestock supply chain, specifically those in Zimbabwe. This limited scope did not allow the research to study other factors that may arise from similar organizations in livestock supply chains in other developing countries in Africa and beyond. This also meant that only challenges related to livestock management were considered in the study and informed by the Zimbabwean situation. Therefore, the findings from this study may be challenging to apply in different environments because of the uniqueness of Zimbabwe due to the volatility, uncertainty, complexity, and ambiguous nature it poses.

The sample size for the study was limited to ten participants due to coverage and accessibility issues. While the participants were experts who provided in-depth insights, the study may have benefited from perspectives from a wider informant group.

6.4.2 Further Research

Considering all the aspects of this study, including the findings and limitations, this study can be developed further by examining the model in other supply chains in different industries besides the livestock supply chain to gain a broad understanding of blockchain adoption factors.

Blockchain technology is an emerging technology. With the rise of the fourth industrial revolution, other technologies, such as the Internet of Things, have also been integrated into blockchain solutions to enhance supply chains. It is therefore critical to expand this study to include other emerging technologies, their adoption, and how the existence of one technology can result in the organization adopting blockchain technology. In addition, quantitative studies can be conducted to test the framework and make it generalizable empirically.

6.4.3 Contributions

The Blockchain-TOE Adoption conceptual framework could advance Information Systems as a research field if applied by academic researchers in the Zimbabwe Livestock sector. The conceptual framework presents various factors drawn from theories obtained in the literature reviewed in this study through the lens of the TOE framework. The study elicits applicable contexts to investigate technology, organization, and environmental factors that need to be considered by organizations in the livestock supply chain and the perceived advantages when faced with the decision to adopt blockchain technology.

When applied in further studies, this conceptual framework could uncover new factors that can help researchers and practitioners better understand Blockchain technology adoption at the organizational level. The study presents empirical evidence for Blockchain technology adoption so that decision-makers can plan their adoption initiatives and enhance the related processes for successful implementation.

6.4.3.1 For Researchers

The IS research field employs theories from sociology, psychology, economics, and so on as reference theories to investigate and predict phenomena in IS. This study attempts to contribute to the literature and practice in the IS research field. The literature reviewed in this study shows a clear motivation and drive for IS researchers to contribute more to literature and practice. This can be done by conducting detailed studies on the adoption of emerging technologies, particularly blockchain, which was the sole intent of this study.

This study advances IS researchers' knowledge of blockchain technology adoption in livestock supply chain organizations and validates thirteen TOE factors in a developing country. This research contributes towards closing the literature gap of studies focusing on blockchain technology in developing economies. The researcher believes that there is also an opportunity for academia to improve collaboration with industry practitioners by researching the future of blockchain through unpacking "The Future of Blockchain – What Next"?.

It will also be beneficial for new theories or enhancements to the existing ones to be developed that are specific to the IS research field. Thus, catering to emerging technologies such as blockchain significantly contributes to this field of study. This assists practitioners and researchers in better understanding blockchain technologies and their impact not only on organizations but also on individuals and society at large.

6.4.3.2 For Technology Providers

This study's findings, based on the conceptual framework, are helpful for blockchain and other technology service providers. They direct the providers in refining their product offerings and make informed decisions necessary for them to provide beneficial solutions to organizations in the livestock supply chain in Zimbabwe and to other organizations executing their technology adoption journeys. Technology service providers are critical stakeholders in adopting blockchain or any other technologies. Hence, there is a need to collaborate and participate in solving the challenges organisations face and their drive to adopt blockchain technology.

6.4.3.3 For Organisations in the Livestock Supply Chain (Practitioners)

The adoption factors presented in this study are critical for practitioners to consider when making decisions to adopt blockchain technology. Depending on organizational strategies, blockchain may not be in the immediate plans of adoption compared to other emerging technologies such as the Internet of Things, Artificial Intelligence, and so on. With that being said, organizations must consider benefit analysis on what the technology brings to the organization, and how these new technologies correlate to each other. Thus, there is a need to define vigilant roadmaps addressing the future of their IT ecosystems.

This needs to be done with detailed assessments of all technology offerings aligned with the business strategy and taking into account the outcome of due diligence exercises on each potential technology provider. Organizations will need to upskill technical and business resources to understand the technology shift and new operating models that come with such innovations. To prevent impact due to regulatory non-compliance, organizations need to understand policies in their industry and be innovative in reviewing their existing processes continuously.

7.0 Concluding Remarks

Blockchain technology is a new, innovative technology that offers potential benefits and creates new opportunities. It is critical, therefore, for blockchain technology to get the necessary attention that it deserves from researchers and practitioners in the matter of understanding essential and relevant factors that need to be considered by organizations within the livestock supply chain in Zimbabwe and beyond. This research is critical for all livestock supply chain organizations, including farmers, processors, distributors, retailers, consumers, regulators, and technology providers. Researchers in this area contribute to developing this field further to drive adoption while revealing the importance of emerging technologies.

This study adds value by contributing to and enhancing the IS body of knowledge, especially in blockchain technology, through the evaluation of adoption factors that are taken into account by organizations in the livestock sector in Zimbabwe. Through the lens of the TOE framework, the study developed a conceptual framework with thirteen key factors and five perceived advantages. Practitioners and researchers can apply the Blockchain TOE Adoption conceptual framework to guide organizations in adopting blockchain, including other emerging technologies.

Even though the framework was tested using the Zimbabwean context and a limited sample size of ten participants, the researcher has confidence that this conceptual framework can be applied globally. It can be applied across other industries and countries, with practical, beneficial implications to researchers, blockchain/ technology providers, and practice. As recommended in this study, the conceptual framework, as further studies, can be tested in countries with socio-economic conditions different from Zimbabwe's and other technologies such as artificial intelligence, data analytics, the Internet of things, cloud computing, and so on. This will guide the enhancement of the Blockchain-TOE Adoption Conceptual Framework.

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APPENDIX A: Ethical Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SCHOOL OF BUSINESS SCIENCES ETHICS COMMITTEE
CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: CBUSE2082**
PROJECT TITLE	Factors Affecting Blockchain Technology Adoption by Organizations in the Livestock Supply Chain in Zimbabwe
INVESTIGATOR	Pelagia Tambudze
SCHOOL/DEPARTMENT OF INVESTIGATOR	School of Business Sciences
DATE CONSIDERED	20 July 2023
DECISION OF THE COMMITTEE	Approved Unconditionally
RISK LEVEL	Minimal Risk
EXPIRY DATE	31 December 2026

ISSUE DATE OF CERTIFICATE 10 August 2023 **CHAIRPERSON** _____
(Neetu Ramsaroop)

cc: Supervisor: Dr Naomi Isabiyre

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

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

_____ 14 / 08 / 2023
Signature **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

APPENDIX B: Participant Information Sheet



Factors Affecting Blockchain Technology Adoption by Organizations in the Livestock Supply Chain in Zimbabwe

Name of researcher: Pelagia Tambudze (2514806)

PARTICIPANT INFORMATION SHEET

University of the Witwatersrand
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1 Jan Smuts Avenue
Braamfontein
Johannesburg
2000

<Participant Name>
<Participant Position>
<Participant Address>
<Date>

Dear Sir/Madam,

RE: Research Cover letter for Interview

My name is Pelagia Tambudze, and currently, I am pursuing a Master of Commerce Degree in Information Systems at Wits University. To fulfil a crucial requirement of the Master's programme, I have to undertake an academic research project under the supervision of Dr Naomi Isabirye. I have selected to study the Factors Affecting Blockchain Technology Adoption by Organizations in the Livestock Supply Chain in Zimbabwe.

This research paper is a unique attempt, to study Blockchain adoption within organizations within the Livestock Supply chain in Zimbabwe, through the lens of a TOE conceptual framework, which could add value to the Information Systems (IS) field. The main objective of the study is to examine the factors that influence the decision by organizations in the livestock supply chain to fully adopt and or not adopt blockchain-based technology as an innovation in their value chain

In your capacity as a Livestock Supply chain expert, IT decision maker, or someone who contributes to technology decisions for your organization, I humbly request that you please spare me 45 – 60 minutes of your time to participate in this study through an interview process. With your permission, I would also like to record the interview. The interview is structured into three sets of mostly semi-structured questions which cover your background and work history, your company's demographics, and finally, factors (e.g. technology, organization, and environment) that affect your company's decision process to adopt or not to adopt blockchain technology.

There will be no personal costs to you if you participate in this project. You will not receive any direct benefits from participation but there are no disadvantages or penalties if you do not choose to participate or if you withdraw from the study. You may not answer any question if you do not want to. Please note that the company data, your personal information, and responses from the interviews will be strictly confidential, and anonymous and will only be used for research purposes. All research data provided by you will be held securely and not disclosed to anyone else, and you will be granted access to it whenever required.

Please note that this is a voluntary research process and you are by no means compelled to participate; furthermore, you will be permitted to stop the interview or withdraw should you feel uncomfortable at any stage of the process. Permission to conduct this research as well as the interviews has been approved and granted by the Wits University Ethics Committee, protocol number CBUSE2082.
Thank you in advance for your participation, should you have any queries or concerns, please do not hesitate to contact me at 2514806@students.wits.ac.za alternatively send an email to my supervisor: email naomi.isabirye@wits.ac.za telephone +27 11 717 8384.

Yours Sincerely,

Pelagia Tambudze
+27628783939
Master of Commerce: Information Systems, School of Economic and Business Sciences, University of the Witwatersrand, Johannesburg

APPENDIX C: Interview Schedule



Factors Affecting Blockchain Technology Adoption by Organizations in the Livestock Supply Chain in Zimbabwe

Name of researcher: Pelagia Tambudze (2514806)

INTERVIEW SCHEDULE

The questions included in this interview primarily address aspects of the adoption of Blockchain Technology by Organisations in the Livestock sector in Zimbabwe. Written consent must be provided by you (the participant) that you voluntarily took part in the interviews. The following questions will be asked during the interview conducted with you. The interview consists of three sections and all questions will be asked during the interview which will take approximately 45 minutes.

SECTION 1: PARTICIPANT'S BACKGROUND

1.1 Share a brief history of your career and your tenure in the organization you are currently working in.

1.2 What is your job title and state the related responsibilities for your role?

1.3 Who are your key stakeholders in your livestock supply chain and what are their expectations in terms of access to lucrative markets, production systems flexibility, unethical dealers, and regulatory compliance??

1.4 What is your understanding of blockchain technology?

1.5 What experience do you have in terms of blockchain technology as a decision-maker, implementer, or user?

1.6 Has your organization/department adopted blockchain? If so, for how long have you been involved in any blockchain-related initiatives within your organization

SECTION 2: BACKGROUND OF PARTICIPANT'S ORGANISATION

2.1 What is the background of your company?

2.2 What medium to long-term technology goals does your company intend to implement?

2.3 What is your company's staff complement? Discuss the high-level organizational structure.

2.4 What is the role of your department?

2.5 Is your department involved in blockchain-related decisions and initiatives? If so, please explain? ***(ADOPTION)***

SECTION 3: MAIN RESEARCH QUESTIONS

3.1 What is your company's view on emerging technologies, particularly blockchain? **(TECHNOLOGY)**

3.2 How does your company approach technology-driven innovation? **(ADOPTION)**

3.3 Has your organization invested in any of the following technologies that enable data capturing in a distributed ledger (RFIDs, QR Codes, and Barcodes, etc.)? Please indicate what your organization has invested in. **(TECHNOLOGY)**

3.4 What were the key considerations for any technology that your organization invested in? Please share specifics based on recent innovative technology decision-making. **(TECHNOLOGY)**

3.5 Which one(s) from 3.4. were you involved with? Share the key factors that led to the adoption of these solution(s)? **(ADOPTION)**

3.6 Are there specific concerns that you had or have on previous, current, or planned technology adoptions? Please explain each concern. **(ADOPTION)**

3.7 What was the top management's role in the adoption decisions indicated in earlier questions? What have you observed in this regard? **(ADOPTION)**

3.8 How knowledgeable was the top management in terms of blockchain as a technology including its benefits and risks **(ORGANISATION)**

3.9 What challenges are you currently facing in the overall livestock supply chain in your organization, in terms of access to lucrative markets, production systems flexibility, unethical dealers, and regulatory compliance? **(ORGANISATION)**

3.10 How easy is it to penetrate new markets, for your services and products? Is there a way for you to track your product (traceability) and to ensure there is no tampering with the product along the value chain (immutability) **(ENVIRONMENT)**

3.11 How do you think Blockchain technology will be able to solve existing challenges in your organizational value chain? If adopted already how is it solving challenges? **(TECHNOLOGY)**

3.12 How does your organization ensure that blockchain solutions are consistent with the company's existing processes, systems, and skills? **(TECHNOLOGY)**

3.13 What would you say are the advantages and disadvantages of your company's adoption of blockchain technology? **(TECHNOLOGY)**

3.14 Are you aware of any regulations for the industry you operate in? In your opinion do you think blockchain adoption by regulators would have improved/ improved your awareness? **(ENVIRONMENT)**

3.15 Are you aware of other businesses offering the same services and products as yourself? Give examples **(ENVIRONMENT)**

3.16 Have these competitors adopted Blockchain? How has this affected your business? **(ENVIRONMENT)**

3.17 Other stakeholders you interact with, within your value chain, if they are to adopt blockchain will that affect your business and in what way **(ENVIRONMENT)**

3.18 What are the external factors (including stakeholders) that lead to a decision to adopt or not to adopt blockchain? **(ADOPTION)**

3.19 If you are/were not to adopt blockchain technology in your organization's industry, what will be the effects of this decision **(ADOPTION)**

3.20 Are there any blockchain service providers in your industry sector? Give examples **(TECHNOLOGY)**

3.21 Are there any blockchain-skilled resources in your organization? What interventions are utilized to train and up-skill employees for blockchain adoption and implementation? **(ORG-TECHNOLOGY)**

3.22 How do 3.22 and 3.23. affected your decision to adopt blockchain technology **(ADOPTION)**

3.23 In your opinion, how critical are the following factors for the adoption of blockchain technology? **(ADOPTION)**	**Factor**	**5**	**4**	**3**	**2**	**1**
Technology	Characteristics of blockchain					
	Availability of blockchain providers/solutions					
	Perceived Advantages					
Organization	Funding Availability					
	Size of the Organisation					
	Decision makers support					
Environment	Regulation and Policies					
	Competitor pressures					
	The presence of blockchain service providers					

3.24 What other blockchain adoption factor(s) would you add, and why? **(ADOPTION)**

THE END

APPENDIX D: Interview Transcript



Factors Affecting Blockchain Technology Adoption by Organizations in the Livestock Supply Chain in Zimbabwe

Name of researcher: Pelagia Tambudze (2514806)

INTERVIEW TRANSCRIPT

Participant: XXX Interviewer: Pelagia Tambudze Date of Interview: xx/xx/2023	Start Time:	End Time:

APPENDIX E: Interview Consent Form

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Factors Affecting Blockchain Technology Adoption by Organizations in the Livestock Supply Chain in Zimbabwe

Name of researcher: Pelagia Tambudze (2514806)

CONSENT TO TAKE PART IN RESEARCH

I ..... [redacted] ....., voluntarily agrees to participate in this research project. The research has been explained to me and I understand what my participation will involve.

(Please tick, the relevant option from below :)

I agree that I have received the Participant information sheet	Yes **X**	No
I agree that my participation will remain anonymous	Yes **X**	No
I agree that even if I agree to participate now, I can withdraw at any time or withdraw to answer any questions without any consequences of any kind.	Yes **X**	No
I agree that the researcher may use anonymous quotes in his/her research report	Yes **X**	No
I understand that all the information that I provide will be treated confidentially.	Yes **X**	No
I understand that the interview may be audio-recorded.	Yes **X**	No

Signature [redacted]

Name (Participant) ..... [redacted] .....

Place .....Harare.....

Date .....05/11/2023.....

Signature .....



Name (Interviewer) .....Pelagia Tambudze.....

Place .....Harare.....

Date .....05/11/2013.....

APPENDIX F: Illustration of Transcribed Interview Coding and Themes

High Level Theme	Theme	Sub Theme	High Level Code	Code Number	Code Name	Interview Question	Count	Mentioned By
Adoption	Decision	Decision	AdoptionDecision	1	AdoDec	3.1	10	All participants
	Decision	Strategy	AdoptionDecisionStrategy	2	AdoDecStr	1.5 & 3.5	7	P#1;3;6;5;7;9;10
	Decision	Funding	AdoptionDecisionFunding	3	AdoDecFund	3.5; 3.18	6	P#10, 9, 8,7 ,6,2
	Decision	Influence	AdoptionDecisionInfluence	4	AdoDecInf	3.22	3	P#10; 1; 3
	Decision	Technology Advantage	AdoptionDecisionTechnologyPerceivedAdvantage	5	AdoDecTechPerAdv	3.2	1	P#7
	Driver	Driver	AdoptionDriver	6	AdoDr	3.5; 3.6; 3.18; 3.24	10	All participants
	Driver	Regulation Pressure	AdoptionDriverRegulationPressure	7	AdoDrRegPre	3.5; 3.6; 3.18; 3.24	5	P#1; 2;4;5;8
	Driver	Effects	AdoptionDriverEffects	8	AdoDrEff	3.5; 3.6; 3.18; 3.24	4	P#2; 3;4;5
	Driver	Expansion	AdoptionDriverExpansion	9	AdoDrExp	3.5; 3.6; 3.18; 3.24	6	P#1;3;5;6;8;10
	Driver	Technology Capability	AdoptionDriverTechnologyCapability	10	AdoDrTechCap	3.5; 3.6; 3.18; 3.24	3	P#5;6;8
	Driver	Issues to be Solved	AdoptionDriverIssuesToBeSolved	11	AdoDrITBS	3.5; 3.6; 3.18; 3.24	2	P#5;8
	Driver	Strategy Alignment	AdoptionDriverStrategyAlignment	12	AdoDrStrAli	3.5; 3.6; 3.18; 3.24	10	All participants
	Driver	Cost of Technology	AdoptionDriverCostOfTechnology	13	AdoDrCoT	3.5; 3.6; 3.18; 3.24	7	P#2;3;5;6;7;9;10
	Concern	Concern	AdoptionConcern	14	AdoConc	3.6; 3.2	10	All participants
	Concern	Agility	AdoptionConcernAgility	15	AdoConcAgi	3.6; 3.2	6	P#10; 9; 8;7; 3; 1
	Concern	Future of Work	AdoptionConcernFuture of work	16	AdoConcFoW	3.6; 3.2	3	P#1;2; 10
	Concern	Relevance	AdoptionConcernRelevance	17	AdoConcRel	3.6; 3.2	5	P#2;3;8;6; 10
	Concern	Cost of Technology	AdoptionConcernCost of Technology	18	AdoConcCoT	3.6; 3.2	6	P#1;3;5;7;9;10
	Concern	Affordability	AdoptionConcernAffordability	19	AdoConcAff	3.6; 3.2	5	P#2; 7;8;9;10
	Concern	Technologyknowhow	AdoptionConcernTechnology knowhow	20	AdoConcTechKnohw	3.6; 3.2	10	All participants
	Concern	Training Cost	AdoptionConcernTraining Cost	21	AdoConcTrainCost	3.6; 3.2	2	P#2; 10
	Benefit	Benefit	AdoptionBenefit	22	AdoBen	3.19	5	P#6;1;3;9;10
	Benefit	Competitive Advantage	AdoptionBenefitCompetitive Advantage	23	AdoBenCompAdv	3.19	2	P#9;10
	Benefit	Improvement	AdoptionBenefitImprovement	24	AdoBenImp	3.19	3	P#3;9;10
	Buy-in	Buy-in	AdoptionBuyin	25	AdoBuyin			

APPENDIX G: Illustration of Transcribed Interview Coding and Analysis

3. Main Research Questions							
Questions	3.1	3.2	3.3	3.4	3.5	3.6	3.7
	What is your company's view on emerging technologies, particularly blockchain?	How does your company approach technology driven innovation?	Has your organisation invested in any of the following technologies that enable data capturing in a distributed ledger	What were the key considerations for any technology that your organisation invested in? Please	Which one(s) from 3.4. were you involved with? Share the key factors that led to the adoption of	Are there specific concerns that you had or have pertaining to previous, current, or planned technology	What was the top management's role in the adoption decisions indicated in
High Level Theme	Technology	Adoption	Technology	Technology	Adoption	Adoption	Organisation
Sub-theme	Tech-Perceived advantage	Adop-Decision	Tech-Availability	Tech-Properties	Ado-Driver	Ado-Concerns	OrgDecMakSup
Theme	TechPerAdv	AdoDec	TechAv	TechProp	AdoDri	AdoConc	OrgDecMakSup
Codes	P#1; P#10; P#5- Part of Technology Strategy ->TechPerAdvStr; TechPerAdv P#9 -> TechPerAdv; TechPerAdvStr P#8; P#6 ->TechPerAdv P#7 -> TechPerAdvStr; TechPerAdv; TechPerAdvVol P#2 ->TechPerAdv; TechPerAdvStr P#3 ->TechPerAdv;	P#10- Funds availabilty; Adoption Strategy ->AdoDecStr; AdoDecFund P#9 -> AdoDec; AdoDecStr; AdoDecFund P#8; P#1 -> AdoDecStr; AdoDecUpSkil P#7 -> AdoDecStr; AdoDecTechPerAdv P#2-> AdoDecStr P#4-; P#3>TechInv	P#10; P#5;P#3- Fit for purpose; Affordability ->TechAvFfp; TechAvAffor	Implementation; technology criticality ->TechPropCri; TechPropCoI; TechPropVal P#9-> TechProVal; TechProCoI P#7; P#6; P#4 -> TechPropVal; TechPropROI, TechPropCOI P#8 ->TechPropChal; TechProp; TechPropCoI P#1 ->TechPropROI; TechPropVal; P#2 ->TechProp; TechCapacity; TechSus	P#10-AdoDri P#7 -> AdoDriStrAlign P#1-> AdoDri P#5; P#3 -> TechReadiness; TechAgility;	P#10- future of work; skills relevance; agility -> AdoConAgil, AdoConFoW, AdoConRel P#9 -> AdoConcSec P#8- AdoDriTechCap; P#7 ->AdoConcCoT; AdoConcAfford; AdoConcTechKnowhow; AdoConcTrainCost P#1 -> AdoConcTechKnowhow P#3-> TechPerAdv; AdoBuyin	>OrgDecMakSupStr P#8 -> OrgDecMakProvFund; OrgDecMakSupStr P#7; P#6; P#3 -OrgDecMakSup; OrgDecMakSupPrvFund; OrgDecMakSupStr P#1; P#2 -> OrgDecMakSipSTr P#5; P#4 -> OrgDecMakSupStr; OrgDecMakSup
Participant #1	Our business actually sees emerging technologies such as blockchain as game changers, to that extent they have designed processes to adopt these technologies and model the business based on these new technologies. Process re-engineering is a norm in our organization to accommodate these new technologies. We have new businesses set up to drive and leverage on new emerging technologies and providing solutions from these. My entity is one of these business units designed to drive adoption of new technologies and its incorporation to our products for adoption by our customers	Experimentation in driving new innovations and seeing how we can encorporate these. We have an innovation hub that allow people to come up with new ideas and work with them while evaluating if it can bring benefits to the business. If we see an emerging trend we evaluate it and seehow it benefits the business while improving customer offerings	QRcode, Bar codes, adopted so far for data capturing	Return on investment- we are a profit making business and need to gain value. How tech adoption can improve business operations and efficiencies. Socio-impact of the innovation, does it improve social standing of the communities we operate in	All of the above, as I am a key technology driver in my segment-active participant. We are also guided by the 17 SDG goals which our innovations must also be guided by	Skills are an issues, technology rapid change requires us to continuously learn and also balance with work for us to meet goals set. The business has invested in a number of learning platforms for our continued learning. Funding can also be strained because of demand, BC requires high computing resources	Top management has influence, mainly from strategic level. There is leeway though for decisions that I can make for partners we work with, with continuous engagement with top management. They are open to take up our suggestions and make strategic decisions based on that.
Participant #2	We believe technology is the future, we also have dedicated Bus that focus on emerging tech eg. AI	We know and believe that technology can reduce operation cost and improve on process efficiencies and hence we take seriously the use of technology to drive innovations. Eg. We make business decisions using big data and analytics	Yes. There are capex investments also for the next financial year to make further investments	Environmental impact, SHE policies so as not to harm the environment. Revenue impact. Sustainability into the future, can it still be used in the long term, and easeness for continuous improvement. Capacity of the organisation to operate and use the technology			They are key decision makers, responsible for the driving vision of the organisation. Checking strategic alignment of initiatives that we bring to the table
Participant #3	We believe technology is taking over and improves processes, it can improve and benefit the farmers up till the offtakers, enabling elimination of middleman. In zim middlemen normally reap more profits that the producers hence our drive to eliminate these so that the Farmers can realise as much value as possible from their produce	Take pride in being a pioneer using technology to improve processes and efficiencies	YES. In our Fresh produce solution, we use bar codes	Quality. Regulatory compliance issues- what are the requlations and how do we comply, safety and health regulations. Impact this will cause to our market – expected standards and what is needed by the customer – locally in ZIm and Regionally	Implementer- marker analysis and making recommendations for the overall adoption decision	Accurate information sharing by the farmers, eg to do with diseases and nutrition intake. Record keeping- local farmers do not take record keeping that seriously resulting in gaps. Transparency. Efficiencies. Buy in from other players within the supply chain. We adopted a training approach, training farmers and also other produces to understand benefits of them entering into other niche markets and overall efficiencies	Analysing data, making final adoption decision for accrued financial benefit to the company. They were sceptical about the company's reputation, they needed to understand implication if anything goes wrong penalties etc. ISO certification driving, setting our company apart locally and internationally