Exploring the use of blockchain technology to enhance transparency in Namibia's global beef supply chain

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ABSTRACT

TITLE: Exploring the use of blockchain technology to enhance transparency in Namibia's global beef supply chain

KEYWORDS: Blockchain, Supply chain management, Value chain, Transparency and traceability, Competitive advantage, Beef

Namibia is the only African country eligible to export beef to international markets such as Norway, the European Union, the United States of America and recently China. Namibia, being a sparsely populated country, merely consumes 20% of Namibian produced meat, while exporting 80% thereof – hence being a net exporter. It is therefore deemed critical for Namibia to maintain an international marketing status for the continuous export of beef. The cease of exportation, or decline in international market share, will not only decrease Namibia's agriculture contribution of 8,15% to Namibia's gross domestic product, but will have destructive effects on all the supply chain participants in Namibia which include the livelihoods of farmers, their labourers and corporate organisations.

As discussed in this study's literature review, consumers deem and prefer increased transparency and traceability in beef supply chains for health and safety reasons, but also for the verification of fair-trade principles. Therefore, Namibia needs to maintain and increase these elements in its beef supply chain in order to maintain and possibly increase the Namibian market share in international markets.

The stakeholder theory was used to determine that the addition of value to each stakeholder in the Namibian beef supply chain will add value to the Namibian beef supply chain as a whole. This study's primary objective was to explore the use of blockchain in the Namibian beef export industry's supply chain to increase elements of transparency and traceability. Blockchain was in-depth addressed in the literature review, where criteria for the implementation thereof was discussed and applied later in the empirical study. A PEST-analysis was used as a strategic tool to analyse the external environment in which the Namibian beef supply chain operates. This analysis constitutes political-, economic-, social- and technological environmental factors. Secondly, this study used a SWOT analysis to investigate the strengths, weaknesses, opportunities and threats of the Namibian beef industry.

Semi-structured interviews were conducted with eight participants of the Namibian beef supply chain. These participants provided a fair representation of the Namibian beef supply chain, as it included farmers, abattoir representatives, corporate representatives and board representatives.

It was evident from the study that, by exploring the use of blockchain in Namibia's beef supply chain, value could be added to different stakeholders in the Namibian beef supply chain by increasing information transparency in the supply chain, and by creating product traceability for the consumer. The study uses and applies different use-cases to illustrate the effects of blockchain on the Namibian beef industry.

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CHAPTER 1

1 Introduction

1.1 Background

One of the key elements in supply chain management (SCM) can be considered as trust – trusting the previous link in the supply chain whilst earning the trust of the following link (Burnson, 2017). A supply chain is a network of businesses that obtains a series of raw materials and convert these materials into intermediate products and finally into finished products. These products are supplied to a customer through a distribution system (Huang, 2003). These processes include the i) procurement of raw materials from suppliers, ii) the manufacturing of the product by the manufacturer, iii) distribution of this product by a distributor, and finally iv) delivering the product to a consumer (Law, 2017). Every player who partakes in this process is considered a link in the whole supply chain; therefore, it is crucial that every link in the system delivers quality products and can be trusted to assure the quality of these products (Burnson, 2017).

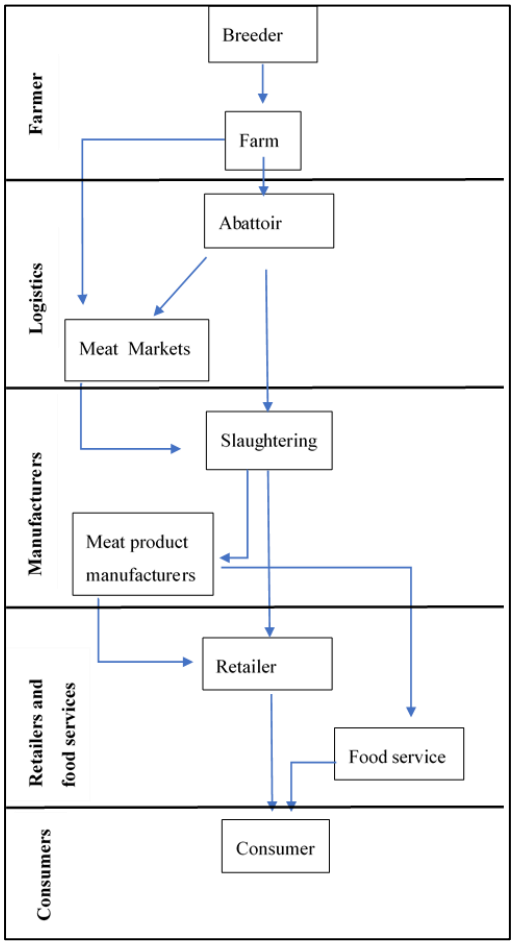
According to Grand View Research (2019), the current global market size of beef is USD 300,6 billion, and is expected to grow to USD 383,5 billion in 2025. Increased market size leads to increased consumers. In turn, consumer trends and needs have evolved drastically during the past years. Consumers have become more health-conscious and are demanding to know the provenance of product ingredients (Stannard, 2018). The increased market size for beef emphasises the need for end-to-end product traceability, quality and safety assurance (Dalton *et al.*, 2018).

1.2 Beef supply chain in Namibia

Cattle farming in Namibia is a key part of Namibia's agricultural industry. Agriculture is regarded as the second most important sector in Namibia due to employment created by this sector (Business Sweden, 2017). According to Statista (2020), the average annual contribution of Namibia's agriculture towards Namibia's gross domestic product (GDP) between 1980 and 2018 was 8,15%. It is therefore evident that Namibia's GDP relies on the growth and sustainability of the agricultural sector.

A typical beef supply chain can be illustrated using the following schematic diagram:

Figure 1-1: Standard beef meat supply chain



Source: Thankappan (2015)

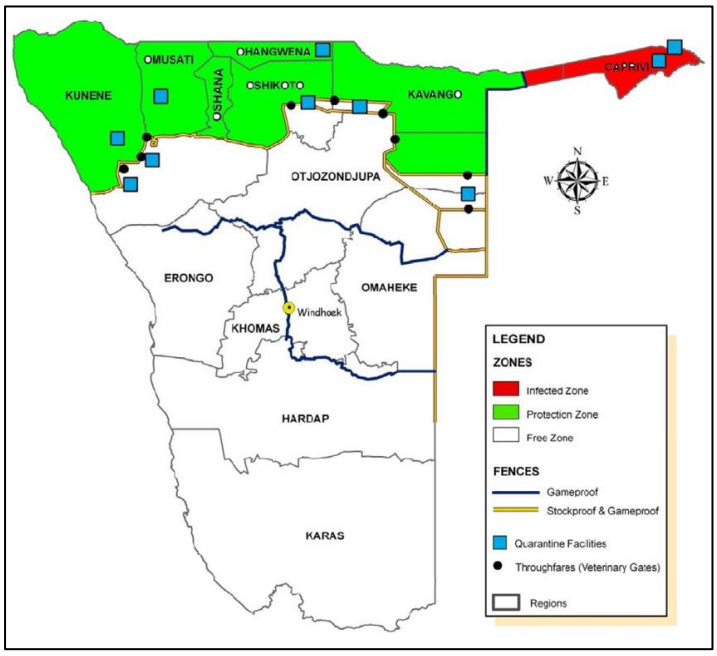
Using Figure 1-1 as a reference, the context and environment of the Namibian beef supply chain will be discussed briefly in the following paragraphs to contextualise Namibia's beef supply chain.

1.2.1 Cattle farming

The breeding of cattle is done on various farms in Namibia both for own use and intention to sell. Cattle farming locations are spread across Namibia, but are more focused in the central and north-eastern parts of Namibia. Between Grootfontein and Rundu, and Tsumeb and Ondangwa, a red-line can be drawn across the country – the Animal Disease Control Checkpoint (refer Figure 1-2, page 3). This checkpoint is a veterinary fence that divides commercial cattle farms south from the line from communal lands north of the line. This line

serves as a precaution against foot-and-mouth disease and rinderpest. Any cattle bred north of the red-line are not allowed to be sold to the south, nor qualify to be exported to global markets (Thiermann & Hutter, 2009). Therefore, the available land for commercial cattle farming in Namibia is limited.

Figure 1-2: Visual map of cattle farm locations and red-line in Namibia



Source: Van Schalkwyk *et al.* (2010)

Figure 1-2 is a map of Namibia and is a visual representation of where the Animal Disease Control Checkpoint line crosses the country. It serves to contextualise the farming environment in Namibia.

*1.2.2 **Logistics and Manufacturer***

Abattoirs

Company A is a meat processor and distributer in Namibia. There are two main abattoirs in Namibia owned by Company A, one in Windhhoek and one in Okahandja. These two abattoirs produce 27 000 tonnes of beef annually (Meatco, n.d.). These abattoirs buy cattle from the farmers, process the cattle by slaughtering and cutting the cattle into different cuts, and transport the cuts to cooling storage houses.

1.2.3 ***Retailers***

From the cooling storages, Company A distributes beef all over Namibia and exports beef globally. The retailers are therefore based both in Namibia and globally. The majority of meat (80%) produced in Namibia is exported to international markets (Mouton & Venter, 2013). These international markets include Europe, the United Kingdom (UK), Norway, Reunion, the United States of America (USA) and North Africa. Regionally, South Africa is Company A's main client (Meatco, n.d.).

1.2.4 ***Consumers***

The Namibian population consumes only about 20% of locally produced meat; hence the country is a net exporter with South Africa and the European Union (EU) as the two most important export markets. Exports to South Africa comprise livestock and livestock products, while exports to the EU and beyond only comprise livestock products, i.e. meat (Mouton & Venter, 2013).

European and global consumers are more judicious in present times. According to Trienekens *et al.* (2012), consumers tend to demand the provenance of a product before purchasing it. Label Insight (2016) gathered statistics about consumer behaviour towards beef and found that:

- 75% of consumers do not trust the labelling on food products;
- 35% of consumers are unsure about ingredients in food products;
- 94% of consumers deem it as important for food manufacturers to be transparent about the food; and
- 37% of consumers are willing to shift to a brand that is more detailed about product information.

With Namibia's beef supply chain originating in Namibia and ending in South Africa, Europe and the USA, it can be challenging to share information effectively and efficiently. Therefore, the Namibian beef supply chain poses numerous challenges.

1.3 Challenges in supply chain management in general

As mentioned above, the potential complexity of supply chains creates numerous challenges. According to Law (2017), these challenges can be categorised into two stages – the planning stage and the coordination stage.

The focal stage of this study will be the coordination stage. With numerous different organisations involved in a supply chain, information sharing can be an obstacle that causes inequality of information and product traceability, especially if the consumer is in a different country – as is the case in Namibia's beef supply chain with an export market. According to Hudnurkar, Jakhar and Rathod (2014), inefficient access to information and product traceability causes:

- difficulties and delays in the supply chain progress;
- delayed responsive actions to disruptive events (for instance when infectious cattle are sold, but cannot be traced to the farm of origin on a trustworthy and effective manner); and
- can affect the cooperation between the entities in a supply chain.

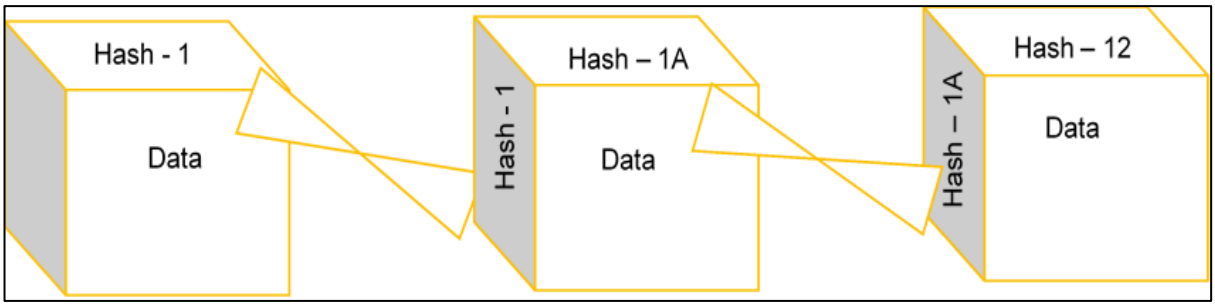
The main challenge that all supply chains face is the need to ensure the safety and quality of products, hence enhancing the need for transparency throughout a supply chain (Marucheck *et al.*, 2011). A possible solution to enhance these aforementioned characteristics in a supply chain, is by the use of blockchain. The latter offers data immutability, transparency and instant product traceability.

1.4 Blockchain

The general perception about the word "blockchain" is the link with cryptocurrency or Bitcoin. However, that is only one of the applications of blockchain. Blockchain was introduced in 2009 in the form of Bitcoin by a group going under the name of Satoshi Nakamoto (DiCicco, 2019). Nakamoto's main objective with Bitcoin was to send a form of cash peer-to-peer without an intermediary – like a bank – to record the transaction in a ledger. Their objective was to develop a distributed/shared ledger to record all transactions transparently; hence the origin of a blockchain.

DiCiccio (2019) describes a blockchain as a distributed ledger in a peer-to-peer (P2P) network, consisting of blocks of data (transactions) – forming the ledger. A P2P network is a network between two or more computers (called nodes) where the nodes share files/data without the usage of an intermediary server (Cope, 2002). According to Iansiti and Lakhani (2017), this "open" distributed ledger records transactions between two or more parties efficiently and can be verified permanently. In a nutshell, blockchain is a ledger between network participants that records transactions/data: i) that happened/were transferred, ii) when it happened, and iii) only if it happened correctly (Dalton *et al.*, 2018).

Figure 1-3: Visual representation of data recorded on blockchain in a straightforward form



Source: DiCiccio (2019)

From Figure 1-3 it is evident that each transaction ("block") consists of three sides (DiCiccio, 2019):

1. The data of the transaction that the user wants to have stored on the blockchain: this data can be used to trace the product in the supply chain for verifiability and transparency.
2. The hash of the block – i.e. the block's identification number. Once an attempt is made to change data on a block, the hash of the block changes. Therefore the hash will not link with the following block and this will be observable to all network participants.
3. The previous block's hash: the first block of the blockchain only has its own hash, thus only two sides.

Data stored on a blockchain is immutable, meaning that once data has been captured, it cannot be manipulated (Dalton *et al.*, 2018). It is therefore evident that transparency, traceability and trust are key characteristics of a blockchain.

It can be suggested that beef supply chains that are transparent, traceable and trusted will add value, not only to its consumers, but also to the tiers in the supply chain itself.

1.5 Competitive advantage

SCM is no longer only about the efficient flow of materials, money and information. SCM is becoming more about improving the performance of the entire value chain or supply chain network (Abdulla, 2009). A competitive advantage is one of the consequences that the successful execution of a competitive strategy has to offer – it enhances and adds more value to the firm, or in this situation – the supply chain. Competitive strategy can be regarded as the search for a complementary competitive position in an industry (Porter, 1985). According to Porter (1996), a firm can only outperform its rivals if the firm has a unique difference it can contain in its original form. Differentiation competitive strategy refers to when a firm's objectives will be distinctive in certain aspects which are extensively valued by its customers (Porter, 1985). For example, if a beef producer's objective is to transform the supply chain of beef products, the outcome can be valuable to its customers in all its markets. Consumers derive value from a traceable and transparent supply chain by securing certainty about product provenance and trusting the quality of the product. In turn, the producer derives value in a monetary form if they expand their market share. Market share is likely to increase where consumer and public trust is earned (Bloom & Kotler, 1975).

It can be gathered that blockchain can provide instant traceability of products in a supply chain, for both distributor and consumer. Traceability can enable the beef distributor to track the progress of farmers' beef upstream and downstream. Using blockchain, parties can monitor which specific cuts were sold, which are still in-store or remain undelivered – all across the globe (Saunders & Daigle, 2014). This may help to improve sales by serving as a differential competitive advantage and contribute to the long-term reputation of a brand. One of the core advantages that a blockchain-based supply chain has to offer, is transparency (Iansiti & Lakhani, 2017). Transparency in supply chains will be discussed in the following paragraph.

1.6 Transparency in the beef supply chain

Transparency refers to the extent to which a company or an industry's actions are observable to an outsider (Ball, 2009). In the current world where consumers are more judicious

(Trienekens *et al.*, 2012), consumers tend to demand the provenance of a product before purchasing it. With the beef market increasing every year, more emphasis should be placed on the traceability and transparency in the supply chain of beef, due to the change of consumer trends and behaviour. According to Spain *et al.* (2019), in the meat supply chain animal products which have an animal welfare certificate tend to be more expensive. A survey was administered in the USA to determine the willingness of consumers to pay more for animal products which have been manufactured under humane conditions (Spain *et al.*, 2019). Results indicated that 78% of respondents claimed that it is important to know that the animal products were produced while complying with animal welfare certification. The majority of the respondents were willing to pay a premium for the before-mentioned animal products (Spain *et al.*, 2019).

This premium that is paid for foods which are known as free-range, grass-fed or non-chemically manipulated, can serve as an incentive for farmers and food producers to conduct their farming and production in a manner that enhances animal welfare. The aforementioned premium might be regarded as an opportunity and can, unfortunately, serve as an incentive to misuse the premium. Manufacturers and farmers can manipulate their animal welfare certification and sell products at a premium to the next link in the supply chain, whilst claiming the product is humanely produced (Southey, 2020). This action, called counterfeiting, may have the ability to breaking the trust and transparency in the supply chain in order to maximise the farmer's/producer's revenue and contribution margins. It can therefore be possible that the main challenge in a supply chain is that it is prone to distrust due to lack of transparency. If consumers and stakeholders are unable to verify the legitimacy of the processes in an instant and effective way, it can be suggested that the beef industry's supply chain lacks complete transparency and traceability.

Namibia's beef market prides itself on the fact that all cattle are grass-fed, free-range and hormone-free (Nyaungwa, 2020). Therefore it is critical for the Namibian beef market to be trusted by consumers. Secured verification of these promised free-range and grass-fed high-end meat will likely increase this trust.

During 2013, the Horsegate scandal exposed several cases of fraud where horse meat was sold, but advertised and promoted as beef (Southey, 2020). Between 1997 and 2017, 413 reports of fraud were reported in the beef supply chain, where 42.9% of the cases were due to

counterfeiting (Robson *et al.*, 2020). In a fully transparent and traceable supply chain, consumers will be able to verify and trust the provenance of their product, hence eliminating the chances for counterfeit beef.

*1.6.1 **Advantages of a transparent supply chain***

If transparency is enhanced in a supply chain, it may be suggested to benefit various tiers of the supply chain. Duckworth (2018) argues that increased transparency in a supply chain will create opportunities for companies to connect with consumers and to build trust. He further states that organisations will achieve better visibility in certain areas in a supply chain where there is room for improvement, and to react in an effective and faster manner when problems occur. It is thus suggested that enhanced traceability will give farmers a sense of pride, knowing that consumers can be able to trace the end-products back to their farm – this will ensure that farmers maintain compliance to Namibian meat standards.

Although advancements in technology have made it possible to address the challenges in the coordination stage of a supply chain, these challenges can still be addressed more effectively. The problem statement will be addressed in the next section.

1.7 Problem statement

Consumer behaviour towards meat has changed during recent years, calling for increased transparency and traceability up and down the beef supply chain. Namibia's beef industry contributes an average of 8,15% towards the country's GDP (The World Bank, 2019), while 80% of beef meat is exported each year (Mouton & Venter, 2013). This makes the Namibian beef supply chain heavily dependent on foreign consumption and consumers. As 80% of the consumers are outside Namibia, the sharing of information regarding the beef provenance and processes is hampered. If these consumers have reason to believe Namibia's beef is not produced in a manner that enhances animal welfare or lack traceability, the demand for Namibian export beef may decrease. A decreased export market will not only harm Namibia's GDP and in turn increase unemployment, but will affect the missed opportunity to capitalise in an increased market share of the growing global beef market. Blockchain has the potential and ability to fully transform a beef supply chain due to its core characteristics which consist of transparency, traceability and trust. However, limited research has been conducted on the use

of blockchain to enhance traceability and transparency in a beef supply chain; hence this will be the first attempt at exploring the usage of blockchain in the Namibian beef supply chain.

1.8 Objectives of the study

The following objectives have been formulated for the study:

1.8.1 Primary Objectives

Exploring the possible use of blockchain technology to enhance traceability and transparency in Namibia's beef supply chain.

1.8.2 Secondary objectives

To achieve the primary objective, the following theoretical and empirical objectives have been formulated for the study:

- Reviewing literature around (blockchain-based) SCM, and the beef supply chain both globally and in Namibia, while considering the concepts of transparency and traceability (Chapter 2).
- Presenting the chosen research methodology appropriate for this study (Chapter 3).
- Gathering qualitative data from interviewees to explore the possible use of blockchain technology in Namibia's beef supply chain to enhance traceability and transparency (Chapter 4).
- Concluding and making recommendations on the gathered qualitative data and literature (Chapter 5).

1.9 Theoretical framework

1.9.1 Theoretical foundation of the study

According to Kessler (2013), the stakeholder theory enhances the idea that organisations who care for a wide range of stakeholders will operate more effectively and create more value. Stakeholders are defined as any group or individual who can influence, or be influenced by, the achievement of organisational goals and objectives (Freeman, 1984). These stakeholders include customers, suppliers, employees and communities.

This study will make use of the stakeholder theory to investigate what effects a traceable and transparent beef supply chain will have on the stakeholders of a beef supply chain. In this research, the key stakeholders are regarded as Namibian farmers who supply cattle for the beef industry and can therefore influence Namibia's beef supply chain's objectives. The next key stakeholder is a meat producer in Namibia. Lastly, the Namibian beef retailers and Namibian, but also non-Namibian, consumers will be considered as stakeholders. These parties either influence or are influenced by Namibia's beef supply chain. Therefore it can be argued that the theoretical foundation of this study is the stakeholder theory.

1.10 Research design and methodology

Crotty (1998:3) defines methodology as "the strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes."

This study will consist of a literature review and an empirical study.

1.10.1 Literature review

The purpose of the literature review is to survey previous studies/literature in respect of SCM and blockchain. The objective of the literature review is to identify gaps in the current knowledge of integrating blockchain technology with SCM, as well as common threats and weaknesses that meat supply chains face. The literature review will be done to explore the new terrain of competitive SCM with the concept of competitive advantage. Furthermore, the significance of the supply chain integration in beef supply chains will be determined. Finally, previous studies and literature will be surveyed to explore the integration of blockchain in SCM as well as the benefits it will bring to the table.

1.10.2 Empirical study

1.10.2.1 Target population

The target population refers to the group of individuals from whom the researcher wants to gather information (Glen, 2019). The target population of this study will comprise the key stakeholders of the beef supply chain in Namibia. Stakeholders are defined as any group or

individual who can influence or be influenced by the achievement of organisational goals and objectives (Freeman, 1984). In the Namibian beef supply chain, these stakeholders will consist of farmers, a Namibian meat producer and food retailers who represent the consumers. The researcher will include a charted accountant in the target population to emphasise the need for supply (and value) chains to be managed effectively and efficiently. Management accountants are key role players in supply chain management, due to their responsibility for management information that is used for company decision-making (Martinez Ramos, 2004).

1.10.2.2 Sampling method

The sampling method that will be used to choose samples from the target population will consist of non-probability sampling in a purposive manner. Purposive sampling refers to where the researcher will rely on his/her judgement when choosing members from the target population (Foley, 2019).

1.10.2.3 Chosen samples with whom interviews will be conducted

The researcher aims to conduct at least 8 interviews.

The researcher will interview Company A's logistical and marketing executive, who is an agricultural economist, to gather knowledge about Namibia's beef supply chain. The objective of this interview is to gather information to assist in achieving the secondary objectives regarding Namibia's beef SCM. Furthermore, a management representative from Company A's abattoir and factory will be chosen for the interview to gain more knowledge about their supply chain management and controls.

Whether or not enhanced transparency in the supply chain will benefit farmers, will be determined by interviewing representatives from a minimum of three beef farms in Namibia. The farms that will be chosen will be specific beef cattle farms with slaughter-beef that are exported by Company A.

A representative of the Namibian Meat board will be interviewed to gather opinions about the current transparency and the need for transparency in Namibia's beef industry. This interview is critical since the Namibian Meat Board is responsible for the quality and standard of Namibian meat and the implementation of controls to maintain this standard. The same

questions will be directed in an interview with the Namibian Agricultural Union's executive manager to view the union's opinion on the need for global transparency and traceability.

1.10.2.4 Data collection method

According to De Villiers and Fouché (2015), the most common type of data collection for qualitative studies are interviews. This study will use this qualitative empirical method to collect data. The objective of the interviews will be to gain the insights and perceptions of representatives of the different stakeholders of the Namibian beef supply chain.

This study's interviews will be semi-structured with open-ended questions. According to David and Sutton (2004), semi-structured interviews are used when the researcher does not test a specific hypothesis – as is the case with this study. This strategy of interviewing allows the researcher to ask supplementary questions to achieve a better comprehension of the information obtained from the interviewees.

1.10.2.5 Using the data gathered during interviews

The data gathered from the interviews will merely be used as a tool to gather information in order to build a knowledge foundation of Namibia's beef industry's SCM.

The researcher will do a system description of the current SCM in Namibia's beef industry where the strengths, weaknesses, opportunities and threats will be discussed. A study conducted by Diaconu and Alpopi (2014) consisted of a SWOT (strengths, weaknesses, opportunities, threats) analysis of SCM in general to analyse the system.

To determine whether the SCM's traceability and transparency will be improved by the usage of blockchain, the SWOT analysis that is done on Namibia's SCM system will be compared to a "theoretical" blockchain-based SCM system description. The SCM will be improved if the strengths are more competitive, the weaknesses less, opportunities easily accessible and if threats can be mitigated.

Performance measures addressed in a study conducted by Shukla *et al.* (2011) will be used to determine and conclude the improvement in Namibia's beef SCM due to a blockchain-based SCM system. These performance measures will be addressed in Chapter 2, the literature review.

1.10.3 Paradigmatic assumptions and perspectives

1.10.3.1 Epistemological assumptions

Epistemology refers to the relationship the researcher will have with the research and how knowledge will influence the research. Epistemological variances refer to qualitative and quantitative research methods. These methods respectively consist of positivism and interpretivism perspectives (Rolfe, 2006). The interpretivism perspective is based on a subjective approach of data collection such as interviews and observations (Dudovskiy, 2018). Grix (2004) explains that interpretivism is centred on real-world phenomena. This means that our knowledge and the world does not exist independently from one another.

Research on the SCM of beef meat in Namibia will be done subjectively to gather knowledge about the farmer through to the consumer. Due to the subjective way in which the research will be done, this study will follow an interpretivist epistemological approach.

1.10.3.2 Rhetorical assumptions

Qualitative research refers to research that provides expressive data which is obtained through the researcher's perceptions and experiences (De Villiers & Fouché, 2015). The researcher will gather qualitative data by conducting interviews with various stakeholders in Namibia's beef supply chain. The researcher is therefore mainly no more than an instrument for the gathering of data. According to De Villiers and Fouché (2015), the qualitative paradigm utilises inductive reasoning and concludes observations that the researcher has made. Through the inductive approach, the researcher will condense raw textual data into summary formats. As a consequence, the rhetorical assumption this study will comprise, is inductive and qualitative of nature.

1.10.3.3 Ontological assumptions

The ontological position of interpretivism is relativism (Scotland, 2012). Relativism refers to where reality is different from person to person, due to the subjective view people have on reality (Guba & Lincoln, 1994). The reality of SCM initially evolved around the efficient flow of materials, money and information. Presently and in general, the reality of SCM is more about adding value throughout the supply chain; hence enhancing the value chain (Abdullah, 2009).

The value-adding SCM is a phenomenon that has to be understood by investigating the effects of a transparent and traceable supply chain on all the stakeholders of Namibia's beef supply chain.

1.11 Ethical considerations

The imperativeness of ethical considerations in research cannot be stressed enough. This study will be based on the following five ethical principles (Trochim, 2006):

1. **Informed consent**: All interviewees will be informed that they will be used to gather information from. They will be made aware that these information will form part of the research.
2. **Voluntary participation**: All interviews conducted will be conducted voluntary. All interviewees will be free to withdraw at any time they feel necessary.
3. **Do no harm**: The interview questions are structured in such a way that they will have no emotional harm or stress on the interviewees.
4. **Confidentiality**: Any information interviewees feel should be kept confidential, will not feature in the research. Only the research coordinator will have access to this information.
5. **Anonymity**: The identity of all interviewees will remain anonymous, only the sector they are chosen from will be mentioned in the research.

1.12 Health and safety considerations

Due to COVID-19 and the health risk of face-to-face interviews, the interviews will preferably be conducted using an online meeting platform. If this is not possible, face-to-face interviews will be performed and the interviewer will put the following safeguards in place (European Society for Opinion and Marketing Research, 2020):

- Prior to the interview, the interviewer will contact the interviewee to determine whether the interviewee is in self-isolation or not. If the interviewee is in self-isolation, the interview will be suspended until the self-isolation has ended.
- Social distancing will be practised at all times by both the interviewee and interviewer.
- Prior to the conducting of the interview, both the interviewee and the interviewer will sanitise their hands with a prescribed alcohol-based hand sanitiser.

- After the interviewer and interviewee's hands have been sanitised, both the interviewer and interviewee's body temperatures will be checked and documented. The interview will only proceed if both the interviewer and interviewee's body temperatures are below 37 (thirty-seven) degrees Celsius.
- The interviewer will ensure that both the interviewer and interviewee are provided with a face mask and that the face mask will be worn throughout the interview.
- After the interview, both the interviewee and interviewer will sanitise their hands again before exiting the venue.

The next section will consist of various referenced terms and their definitions.

1.13 Terms of reference

The following are definitions of the keywords regarding this study:

Blockchain: Blockchain is an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way (Iansiti & Lakhani, 2017).

Supply chain management: It is the active management of supply chain activities to maximize customer value and achieve a sustainable competitive advantage (Handfield, 2020).

Value chain: A value chain is a set of activities that an organisation carries out to create value for its customers (Porter, 1985).

Transparency: Transparency refers to the extent to which a company's or industry's actions are observable to an outsider (Ball, 2009).

Traceability: Traceability refers to the ability to identify, track and trace elements of a product or substance as it moves along the supply chain from raw goods to finished products (Rouse, 2016).

Competitive advantage: A competitive advantage is an advantage over competitors gained by offering consumers greater value, either through lower prices or by providing greater benefits and service, that justifies higher prices (Porter, 1985).

1.14 Chapter layout

The study will comprise the following chapters.

Chapter 1 – Introduction

The introduction sets the background and context regarding the key concepts and identifies a problem for which a solution is suggested and researched. The background information consists of paragraphs that describe the beef supply chain in Namibia, challenges in supply chain management in general, blockchain, competitive advantage and transparency in the beef supply chain.

Chapter 2 – Supply chain management and blockchain

The purpose of the literature review is to survey previous studies/literature in respect of SCM and blockchain. The objective of the literature review is to identify gaps in the current knowledge of integrating blockchain technology with SCM. The first secondary objective will be addressed in this chapter.

Chapter 3 – Research methodology

The focus of this chapter will be on the research design and methods that will be used in the study. That will consist of the chosen research techniques as well as why these techniques were chosen. The study's research approach and data collection methods will also be discussed in this chapter.

Chapter 4 – Empirical study

In this chapter the results obtained through interviews with the interviewees, as mentioned under 'empirical research' and 'data collection method', will be analysed. The analysis will be supported by a discussion of the data gathered during the interviews.

Chapter 5 – Conclusion and recommendations

The conclusion will give an overview of the key points discussed in the previous chapters and will provide recommendations based on the findings of Chapter 4. In addition, this chapter will

determine whether the problem statement and the research objectives have been effectively addressed. Finally, the limitations of the study will be discussed and possible areas of further research identified.

The next chapter will therefore consist of a literature review.

CHAPTER 2

2 Literature review

2.1 Introduction

According to Webster and Watson (2002), a review of previous and relevant literature is an imperative part of a research project due to the firm foundation it creates for advancing knowledge. This chapter aims to address the first secondary objective, as stipulated in Chapter 1 (refer paragraph 1.8.2, page 10). Firstly the global beef industry, and more specifically in Namibia, will be discussed briefly. Following the description of these environments, different definitions from the extant literature regarding supply chains and SCM will be discussed. Thirdly, this chapter will explore the new terrain of competitive supply chain management (SCM) and supply chain integration. The current threats that beef supply chains are facing will also be overviewed, but as the focus of this study is on Namibia's beef supply chain, this country may face different challenges. [Chapter 4 will, however, address these challenges in depth.] This section will be followed by reviewing literature involving concepts of transparency and traceability to determine the effect they have on beef supply chains, while the next section will survey extant literature on the integration of blockchain technology in supply chain management.

The main aim of this chapter is therefore to discover relationships between different works of literature regarding beef SCM, blockchain-based SCM, and transparent and traceable beef supply chains. These relationships will make it possible to identify themes, concepts, critical gaps and disagreements to support and/or enhance the empirical findings of this study.

2.2 Global and Namibia's beef industry

In addition to the description provided in Chapter 1 (refer section 1.2, page 1), a brief overview of Namibia and the global beef industry will follow.

The global demand for beef is on a continuous growth trend. The global production of beef is set to grow with 1 022 million tonnes towards 2021, while global exports are forecasted to grow with 441 million tonnes (United States Department of Agriculture, 2020). Additionally, niche beef markets such as free-range, grass-fed and antibiotic-free beef, are on the rise in

European countries, creating a market space for export countries (Sartorius von Bach, 2018). Namibia, a country that prides itself on a wide range of these particular beef products, could capitalise on this opportunity.

Namibia is a country in South-West Africa with an estimated population of 2,5 million people (Worldometers, 2020). Namibia is primarily a livestock producing country with about 3.2 million cattle (Mouton & Venter, 2013). Livestock rearing contributes predominantly to the livelihood of the majority of local farmers. Namibia is one of a few African countries where livestock can be raised under free-range conditions on natural grazing without any artificial means to induce or enhance growth (Mouton & Venter, 2013). In Chapter 4 – the chapter dedicated to the empirical research – a PEST analysis will be performed to analyse the external environment in which the Namibian beef industry operates. Currently Namibia exports 80% of its beef products processed, while in turn only 20% is consumed locally (Mouton & Venter, 2013). Therefore, due to Namibia's small population and low local meat consumption patterns, the meat industry is export-dependent. There is therefore a need for access to a multitude of sufficiently high-value export meat markets, and the opportunity to negotiate favourable trade arrangements with those markets. For this to become a reality, Namibia's beef supply chain should include strong elements of efficiency, global-transparency, and global end-to-end traceability.

The next section will provide an in-depth review of the literature with regard to supply chains and supply chain management.

2.3 Supply chain management

Due to the nature and age of SCM, the core literature encompassing SCM was done more than two decades ago; therefore, the referenced studies regarding SCM will be historic of nature. Supply chain management will be presented under section 2.3.1 by providing various definitions from the literature regarding supply chain management.

*2.3.1 **Defining supply chain and supply chain management***

As mentioned in Chapter 1 (refer section 1.1. page 1) a supply chain is a network of businesses that obtain a series of raw materials and convert these materials into intermediate products and finally into finished products. These products are supplied to a customer through a distribution

system (Huang & Lau, 2003). On the other hand, the literature around SCM comprises numerous definitions. According to Christopher (2011), the terms 'value chain' and 'supply chain' were not always used interchangeably, until the continual outsourcing and vertical disintegration of core competencies have resulted in value chains of firms being extended beyond their boundaries, and therefore supply chains became value chains. Table 2-1 summarises some of the definitions and expresses key ideas about SCM. Although this study focusses specifically on the beef SCM, agricultural SCM also encompasses beef SCM. Therefore, the key ideas about agricultural SCM are listed below.

Table 2-1: Definitions and key ideas regarding SCM

Author(s)	SCM definition	Key ideas
Scott and Brook (1991 cited in Shukla, 2011)	"The chain linking each element of the manufacturing and supply process from raw materials to the end-user, encompassing several organizational boundaries."	This definition highlights the importance of coordination and collaboration among the supply chain members.
Ellaram (1991 cited in Shukla, 2011)	"The integration of the processes, systems, and organizations that control the movement of goods from the supplier to a satisfied customer without waste."	This definition highlights the effectiveness of integration between the different members in a supply chain.
Lee and Billington (1992 cited in Shukla, 2011)	"Networks of manufacturing and distribution sites that procure raw materials, transform them into intermediate and finished	The authors attempt to give an overview of the traditional functions of a supply chain.

	products, and distribute them to customers."	
Berry *et al.* (1994 cited in Shukla, 2011)	"SCM aims at building trust, exchanging information on the market needs, developing new products and reducing the supplier base to a particular original equipment manufacturer to release management resources for developing meaningful, long-term relationships."	Berry *et al.* (1994) aim to emphasise the significance of relationships between the firms in a supply chain. A key concept of this definition suggests that supply chain relationships should be built on trust.
Monczka and Morgan (1997 cited in Shukla, 2011)	"Integrated SCM is about going from the external customer and then managing all the processes that are needed to provide the customer with value in a horizontal way."	This definition promotes the need for a flat organisational structure that should be focused on the consumer's needs.
Houlihan and Houlihan (1999 cited in Shukla, 2011)	"The integration of various functional areas within an organization to enhance the flow of goods from immediate strategic suppliers through manufacturing and	Strategic suppliers should be considered, as well as integration between different supply chain members.

	distribution chain to the end user."	
Porter (1985)	"… a value chain is a collection of activities that are performed by a company to create value for its customers."	The emphasis is put on all the processes required to deliver a product of value to the end consumer.

Source: Shukla *et al.* (2011)

These different definitions mentioned in Table 2-1 suggest that SCM involves the whole value chain and addresses the management of raw materials from extraction to usage by the consumer, with the main objective to maximise value for the consumer with each process. Due to value chains forming part of business strategy and competitiveness, the following section addresses the competitive landscape of current SCM.

2.3.2 ***Competitiveness of supply chain management***

Due to the globalisation of different industries, consumers have bigger varieties to choose from that fit their respective needs. The end consumer has evolved to become the most dominant and influential stakeholder in a supply chain (Payne, Storbacka & Frow, 2008; Prahalad & Ramaswamy, 2002, 2004, 2004); therefore they are no longer satisfied with what is pushed through the supply chain if it does not meet their standards. With consumers, being the most significant stakeholders, having access to a global market, it becomes evident from studies conducted more than a decade ago that supply chains can be seen as a competitive landscape where the different members in a supply chain become components of competitive analysis (McCarter & Northcraft, 2007). A competitive analysis is a process used to acquire knowledge of a certain market space in order to develop a certain competitive strategy (Pono, 2018).

Abdulla (2009) explains that supply chain members decided to focus on their core competencies rather than aiming to compete on all processes required to deliver their products. In the 1990s, the aforementioned resulted in the outsourcing of non-core processes, which in turn led to supply chains consisting of independent companies aiming to align their interdependent processes to satisfy consumers' needs (Prahalad & Hamel, 1990). It is thus accurate to suggest that the competitive environment of firms shifted from firm versus firm to firm networks – i.e. networks of supply chain members competing with other networks of supply chains. Ireland and Webb (2007) suggest that a supply chain that has the potential to fulfil a consumer's demands effectively and efficiently, has become a strategic capability that can result in a competitive advantage. As stated two decades ago, the design of a SCM system should therefore be designed, configured and managed complementary to the competitive specifications of the underlying product or service (Fine, 2000).

With beef supply chains consisting of different interdependent processes that extend across various supply chain members, these supply chains must be well integrated. Beef SCM is characterised by inter-organisation coordination where, according to Uddin *et al.* (2011), the success lies in how the different firms coordinate, cooperate and integrate information in order to gain a competitive advantage. The next section will aim to address the significance of supply chain integration.

2.3.3 ***Importance of supply chain integration***

Li *et al.* (2006) stress the fact that the capability to manage a supply chain is critical. Past studies explained that different members in a supply chain should be well integrated for all the members to be able to succeed and compete (Boyer & Hult, 2005). Certainly, the mission of aligning incentives and objectives along a supply chain is considered very difficult, particularly when the supply chain is made up of different members. Therefore, the different independent members must build a strong, sustainable and everlasting relationship. A major part of SCM literature comprises the management of inter-firm relationships such as alliances and the governance of these relationships to gain a competitive advantage (Uddin *et al.,* 2011). Kannan and Tan (2005) argued that a decline in market-space competitiveness can be attributable to the lack of emphasis on supply chain relations – whereas collaborative planning together with information sharing in these supply chain relations may lead the entire supply chain to be a source of strategic competitive advantage. In an agricultural supply chain, O'Keefe (1998)

stated in the 1990s that firms are more competitive if they work together in a supply chain in a cooperative environment; hence the term “co-operating to compete”.

The World Health Organisation (2020) called for greater collaboration between governments, producers and consumers to help ensure food safety in supply chains. It is evident from a study conducted more than two decades ago that trusted long-term relationships could lead to decreased political, social and economic risks (Loader, 1997). These are also the main risks that can have an impact on a supply chain. “Co-operating to compete” has set a trend in SCM to build and form relationships between strategic suppliers and customers. A successful relationship depends on the extent of interdependence and trust between the partners (Gattorna and Walters, 1996). However, not every relationship is without any risks and vulnerabilities. The following can be regarded as obstacles that hinder supply chain relationships:

- fear of opportunism (Dyer & Nobeoka, 2000);
- political and economic risks;
- fear of being bound with a supplier of low quality; and
- inter-firm rivalry (Park & Ungson, 2001).

If a supply chain relationship is in any way hindered and the trust disappears, the whole supply chain is set up for failure. Thus, if supply chain partners have a strong and sustainable relationship, this relationship can prosper and lead to better supply chain performance. Therefore it can be suggested that a trade relationship in a supply chain is a prerequisite for supply chain integration.

Abdulla (2009) explains that the core objective of supply chain integration is to possess the ability to assimilate consumer preferences and to manage all the diverse resources from all the supply chain members to finally meet the consumer demands efficiently and effectively. It is therefore suggested that firms should realise that competitive advantage is not solely dependent on their resources and capabilities. Alternatively, competitive advantage depends on how the firm efficiently and effectively identifies, integrates and manipulates combinations of resources to their disposal to create core competencies that will deliver a sustainable competitive advantage.

Khan (2013) expresses the need for the evaluation and benchmarking of an SCM system's performance. Measuring an SCM system is critical to find out which areas in a supply chain require more attention in order to endure in a competitive market. The following section will give a brief overview of the necessity of supply chain evaluation and will also address certain measures.

2.3.4 ***Supply chain management performance measures.***

Bhagwat (2007) explained more than a decade ago that performance measurement describes the feedback on operations used to satisfy customer demands and strategic decisions. Khan (2013) states that a measuring model should integrate all the functions of a supply chain and should measure the overall performance of the supply chain. Table 2-2 gives a broad overview of different criteria established more than a decade ago to evaluate supply chain performance.

Table 2-2: Criteria for supply chain evaluation

Author(s)	Criteria for performance measurement	Key ideas
Lambert and Cooper (2000)	Process-based	For an SCM to be successful, the managing of individual functions should be changed to integrated activities within the key supply chain processes.
Coyle *et al.* (2003)	Strategic alignment	The performance measurement system should be accordant with the overall strategy of the supply chain. For instance, if a beef supply chain's strategic objective is to deliver meat of high trusted quality, the logistical strategies that emphasise low cost could be in conflict.
Coyle *et al.* (2003)	Instrument for improvement	The performance measurement system should serve as a tool to focus on improvement.
Gunasekara *et al.* (2004)	Comparability	The supply chain's performance should be enabled to be benchmarked to a set of standards

Source: Shukla *et al*. (2011)

Table 2-2 summarises key ideas regarding different criteria that literature used to evaluate the performance of an SCM. The key ideas in Table 2-2 emphasise that performance measurement should consist of identifying, evaluating and selecting the performance measures and criteria that are entity-specific to assess the supply chain's performance – whether it is process-based, strategic alignment, or simplicity. The main theme presented in Table 2-2 suggests that a supply

chain – and specifically a beef supply chain – should be measured by whether the overall strategy in a supply chain is aligned to form one consortium. This therefore includes criteria such as integration, simplicity and strategic alignment.

Uddin (2011) concluded nine years ago that the key success factors in the beef industry's supply chain could be considered to be interdependent relationships with strong elements of transparency, traceability and knowledge flow. The next section of the literature review will address the concepts of and need for transparency, traceability and sharing of trustworthy information in a supply chain.

2.4 Complimentary elements of a beef supply chain

Socially-responsible policymakers and modern consumerism are pressurising meat firms and supply chains for increased transparency by disclosing more information about respective supplier management activities (Castillo *et al*., 2018). Duan (2019) examined the effect of supply chain transparency by disclosing and sharing information regarding supply chain processes and supplier management activities. From the aforementioned study, it was evident that the sharing and disclosing of the mentioned information improved individual consumer evaluations, sentiment and brand equity, and therefore the supply chain's performance. Before the first element of transparency will be addressed, an explanation from the literature will be given as to why transparency in a supply chain is needed.

*2.4.1 **Corporate social responsibility***

More than a decade ago, the World Business Council for Sustainable Development (WBCSD) (2004) defined Corporate Social Responsibility (CSR) as "the commitment of a business to contribute to sustainable economic development, working with employees, their families, the local community and society at large to improve their quality of life". It can therefore be suggested that this definition connects well with the definitions of *sustainable supply chain management* (presented in section 2.4.2) and the stakeholder theory. As stated in Chapter 1 (refer paragraph 1.9.1 page 10) the stakeholder theory enhances the idea that organisations that care for a wide range of groups or individuals who can influence, or are influenced by the organisation (Freeman, 1984), will operate more effectively and create more value. All the groups and individuals mentioned in the definition of CSR can, according to Freeman's

definition of stakeholders (1984), be regarded as stakeholders of the underlying organisation. According to Albuquerque *et al*. (2018), CSR has been a strategic responsibility for modern firms. Yet, the literature around the effect that CSR has on firms and supply chains are inconclusive. In Table 2-3 extant literature is summarised to illustrate the differing views.

Table 2-3: Literature on the effect of CSR on supply chain performance

Authors	**Literature's perception**
Old literature	
Friedman (2005)	CSR is a firm's donation/hand-out to different stakeholders and results in a reduction of a firm's profits.
Jensen and Meckling (1976)	CSR is a compromise resulting from conflicts between stakeholders and firms' management.
Leenders and Blenkhorn (1988)	From a cost perspective, CSR engagement leads to firms' operations being sub-prime.
Min and Galle (1997)	The main effect CSR has on a firm is that it impedes and hinders their financial performance. The hindering effect can be caused by CSR attributable costs and compliance barriers.
More recent literature	
Golicic and Smith (2013)	These authors claim that it is evident that CSR practices provide potential value for firms.
Albuquerque *et al*. (2018)	CSR engagements can be used as a differentiation strategy that lets firms maximise their profits.
Luo and Bhattacharya (2009)	There is a complementary relationship between CSR engagements and consumer

	loyalty – therefore a firm can experience an increase in pricing power.
Hilger *et al.* (2018); Ailawadi *et al.* (2014)	It is evident from these studies that firms whose products have CSR features can increase either their sales or their selling prices.
Kang *et al.* (2016); Albuquerque (2018)	Their empirical studies conclude that there is a negative correlation between a firm's CSR engagement and the same firm's risk. It provides evidence that CSR decreases firm-level risk whilst increasing firm value.
Minor and Morgan (2011)	CSR engagements can protect a firm from losing reputation when an unfavourable event occurs.

It is evident from Table 2-3 that the former literature scholars rather clung to conventional forms of increasing firm performance and building stakeholder value rather than engaging new forms, like CSR in particular. In turn, modern and recent literature urge practices like CSR to assist in securing firm value and building a firm's reputation.

Duan (2019) proved in a study that sustainable and transparent SCM can improve the performance of an organisation. Hence, when an organisation's performance is enhanced, value is created for the stakeholders of the respective organisation, whether this value is derived in the form of quality products for consumers, enhanced industrial economy or just improved quality of life for its stakeholders. It can therefore be suggested, as reflected by the definition of CSR, that transparency in a beef supply chain forms part of CSR. With improved transparency along a supply chain CSR can improve and finally, according to Duan (2019), the whole supply chain's performance could be enhanced. The next section will address the concept of sustainable SCM and transparency in a supply chain.

2.4.2 ***Supply chain transparency***

Sustainable supply chain management (SSCM) was defined by Carter and Rogers (2008) more than a decade ago as "the strategic, transparent integration and achievement of an

organisation's social, environmental, and economic goals in the systemic coordination of key inter-organisational business processes for improving the long-term economic performance of the individual company and its supply chains". The framework of SSCM's definition provides four facets, of which the main facet is transparency (Carter & Rogers, 2008). Supply chain transparency was defined recently by Bell *et al.* (2016) as "the information communicated by a company to its stakeholders (consumers, shareholders, suppliers, customers, governments, and agencies) regarding the sustainability (health, safety, ethics, etc.) of the supply chain products, materials, supply systems (manufacturing, warehousing, transportation, etc.) and services". As reflected by this definition of supply chain transparency, it can be suggested that transparency became the means for organisations to communicate, engage and aim to interact with external stakeholders to reach an enduring improvement in a supply chain.

According to Doorey (2011), it can be beneficial both in the long term (industry-wide collaboration) and short term (improved reputation) to share knowledgeable information with stakeholders. Kassahun *et al.* (2016) state that a key concern in beef supply chains is the obstacle to provide chain-wide transparency - meaning that it is difficult for food operators and stakeholders to capture and share data across the supply chain in a verifiable manner. It can be suggested that the first step of achieving supply chain transparency, is for organisations to employ increased efforts in monitoring and identifying activities along a supply chain that can result in knowledgeable information worth sharing with stakeholders. Supply chains where knowledgeable information is refrained from being shared transparently can create information asymmetry in business relationships (Hailu & Van Schalkwyk, 2016). It can be suggested that information asymmetry in supply chain relationships refers to transactions where one party has better access to information than another party. This, according to Hailu and Van Schalkwyk (2016), results in an imbalance of power where one party can derive an unfair benefit at the expense of the other. A report by the European Committee on the Internal Market and Consumer Protection (2016) supports the aforementioned suggestion. The report state that there is limited market information available that addresses key stages in beef and meat supply chains, namely those at the meat processing and gathering stages. According to the report, this lack of transparency in information puts consumers and other supply chain stakeholders at a disadvantage and erodes market trust. As will be discussed briefly in the next paragraph, the possible asymmetry in information caused consumers and regulators to call for increased beef supply chain transparency.

According to a recent memo of the European Commission (2019), consumer demand patterns are evolving in a more complex manner over time. Presently, consumers are more attentive towards different quality aspects that go beyond the pricing extent of the products (meat provenance, organic food, grass-fed, free-range, etc.). The demands for transparency are further stressed in a recent report from an economist, Ben Laine. Laine (2019) argues that consumers are pushing for a higher sense of connection to where animal products are produced, and at the retail level they are looking for trusted labels that indicate humane farm management practices. Furthermore, The Food Wise 2025 Outlook Report (2015) claims that food scandals across the world seem to have negative impacts on consumers' trust towards meat producers and increase their awareness of the dangers that a complex supply chain can pose. The report explains that the rebuilding of trust will require verifiable trust, value and transparency.

An ideal transparent, chain-wide system will empower meat processors to manage *internal* transparency regarding data within their facilities, and to share transparent data with other stakeholders along the supply chain – hence *external* transparency (Bosona & Gebresenbet, 2013). Internal transparency requires the recording of information involving the events taking place within the process of preparing and finalising the meat for distribution (Kassahun *et al.*, 2016). These events include, but are not limited to, the following (Kassahun *et al.*, 2016):

- Events regarding the cattle in particular:
    - The date of birth of the calf
    - The type of feeding the cattle receive
    - The treatment the cattle receives
    - How and when the cattle are moved
    - The date the cattle were slaughtered.
- Events regarding the meat in particular:
    - The splitting of the carcasses
    - The cutting of meat into different cuts
    - The mixing of meat – if applicable
    - The date and manner of transportation
    - The type and period of storage.

To be able to share this internal transparency with external stakeholders, all meat operators across the whole supply chain should be connected to one central system.

To reach transparency in a supply chain, verifiable traceability systems should be in place. The concept of traceability in a meat and beef supply chain will be discussed in the next section.

*2.4.3 **Meat traceability in a beef supply chain***

Traceability is different from transparency – traceability emphasises the exchange of operational activities and information in a supply chain visibly, whereas transparency refers to the disclosure of voluntary information to external stakeholders (Bell *et al.*, 2016). More than a decade ago, Monteiro (2007) suggested that traceability is a kind of information system through which different members in a supply chain share details of product characteristics; these characteristics can include the product's provenance, attributes and processing technologies. Monteiro (2007) further implied that traceability systems should not be regarded as a solution to meat safety problems, but rather as an instrument to assist in the management of meat supply chains. Therefore, this study does not regard the addressed system of blockchain as a substitute for current technologies, but rather as a complementary technology.

Several trends are deeming meat traceability in a beef supply chain, namely with regard to foot-and-mouth disease, "free-from" products and globalisation of food networks, of importance.

- A cattle farm faces a major risk in the form of foot-and-mouth disease in cattle. In the past few years, foot-and-mouth disease triggered import and export bans in several countries. For instance, Argentina had a foot-and-mouth outbreak in 2000 which resulted in the USA banning all beef imports from Argentina, lasting until as recently as 1 November 2018 (Brown & Hillman, 2016; Henderson, 2019). With a secure, verifiable, transparent and trusted traceability system, the importer could be able to verify whether the particular imported beef was not infected with the foot-and-mouth disease. Therefore, exporting countries can widen their markets without these complications.
- Consumers are lately more concerned with issues relating to hormone-free meat, animal treatment, and organic beef – commonly known as "free-from" products – be it free from added hormones, steroids or animal by-products (Loria, 2020). According to the National Sanitation Foundation (2020), 43% of consumers "always" or "often" buy meat raised

without antibiotics and hormones. This caused manufacturers to label their meat with "promises" that the meat complies with these standards. This suggests that a demand has been created to verify the legitimacy of these promises. Due to the current internet era where rapid information sharing is possible – both false and factual – it can be suggested that big data is used to influence consumers' behaviour (Fang & Li, 2014). This study suggests that a trusted and transparent traceability system can reassure all stakeholders in a beef supply chain that the promises regarding the meat can be demonstrated as verifiable.

- Due to globalisation of food networks, and especially regarding the exportation of Namibian beef (Mouton & Venter, 2013), the distance between the processing of meat and the consumption thereof became larger – resulting in beef supply chains becoming a complex network. The complexity of this network poses hindering obstacles when the objective is to implement accessible, international and transparent traceability systems. Castillo *et al.* (2018) advise that to achieve traceable and transparent supply chains, organisations should consider how to disclose their sustainable supply chain practices to their stakeholders. If the system is efficient and trusted, it implies corporate integrity, boosts stakeholder trust and reduces product and performance uncertainties. Kassahun (2016) already suggested six years ago that regulatory requirements are not strict enough to cover the needs of all stakeholders to mandate greater transparency and traceability. Since the European Commission's memo about implementing transparent and traceable systems was published only one year ago, namely in 2019, it can be argued that the current supply chain systems in place are still not adequate.

This study aims to suggest that the use of a blockchain-based SCM system will enhance transparency and traceability in a beef supply chain. With blockchain, it is possible to digitise physical assets and create a decentralised and immutable record of all preceding transactions. This enables supply chains to track the asset from production to usage by the consumer – providing evident history and transparency (Laaper *et al*., 2017). The following section will explain what blockchain is, as well as the different characteristics of blockchain. Following that section, available literature regarding blockchain-based supply chains will be reviewed.

2.5 Blockchain

Blockchain was introduced more than a decade ago, namely in 2009 (Nakamoto, 2009), by a group of unknown people with the pseudonym Satoshi Nakamoto. However, since 2017 blockchain has become a popular catch word, frequently referred to as a "scam" or a "get-rich-quick" scheme. The general perception – and available literature – claim that the blockchain phenomenon is a "bubble" and that it will struggle to reach a stage where it enjoys widely spread usage by the majority (Iansiti & Lakhani, 2017). For instance, the innovation of Transmission Control Protocol/Internet Protocol (TCP/IP) – the era of transmitting information by the use of internet protocols - had similar expectations to transform the business world. However, it took as long as 30 years for this revolution to be realised (Iansiti & Lakhani, 2017). It can be suggested that blockchain may follow the same path.

According to Mzuku (2019), blockchain has been labelled as a foundational technology, rather than a disruptive one; instead of disrupting extant business models, blockchain can be regarded as supportive towards these models and to be used rather than to create new systems. Blockchain can sit "on top of" these existing systems and can be connected through Application Programming Interfaces (APIs). The following section will discuss what blockchain is, the history thereof, and what it comprises.

2.5.1 ***What is blockchain and how does it work?***

As referred to in Chapter 1 (refer section 1.4, page 5), blockchain is an open, distributed ledger that can record transactions between multiple parties efficiently and in an invincible and indefinite way (Iansiti & Lakhani, 2017). Transactions in a blockchain are time-stamped and verified by a consensus of a majority of nodes in the system (Laaper *et al*., 2017).

There are five basic principles on how blockchain works, and these principles are also the foundation of blockchain's key attributes. These principles are illustrated in Table 2-4:

Table 2-4: Underlying principles of a blockchain

Principle	Explanation
Distributed database	The blockchain's database and history are accessible to all the parties connected to the blockchain. The data and information are not controlled by a single party; hence every party can verify the information on the blockchain without using an intermediary.
Peer-to-peer transmission	The nodes (parties in the network) in the network communicate directly with each other, meaning each node stores information and sends it on to the next node, resulting in a central node or intermediary not controlling the communication.
Transparency with pseudonymity	All transactions and its underlying details are observable to the participants on the blockchain. Each participant (a node) is assigned a *private* key and a *public* key. The private key is used by a node to generate the user's digital signature and should remain undisclosed. The public key is a unique alphanumeric identification number known as a wallet address. The public key is used as a form of the node's identification in a transaction to be traceable to the specific address. The participant has autonomy on the degree of identification it wants to share.
Irreversibility of records	As soon as a transaction is processed, verified and approved by the network, it will be recorded in the database and updated across all the nodes. These records cannot be adjusted at this point because it is linked

	to each preceding transaction record – thus a "chain" is formed. According to Pilkington (2015), the adding of transactions to the blockchain is accomplished by participants – known as miners – by solving computational algorithms. These computational algorithms ensure that the records are permanent, in sequence, and accessible to all the nodes.
Computational logic	Due to the digital nature of blockchain, blockchain transactions are tied to computational logic and can thus be programmed. Therefore, a set of rules that results in transactions being triggered automatically, can be set out (smart contracts).

Source: Iansiti & Lakhani (2017)

It is evident from Table 2-4 that transparency, traceability and trust link with the key principles of blockchain.

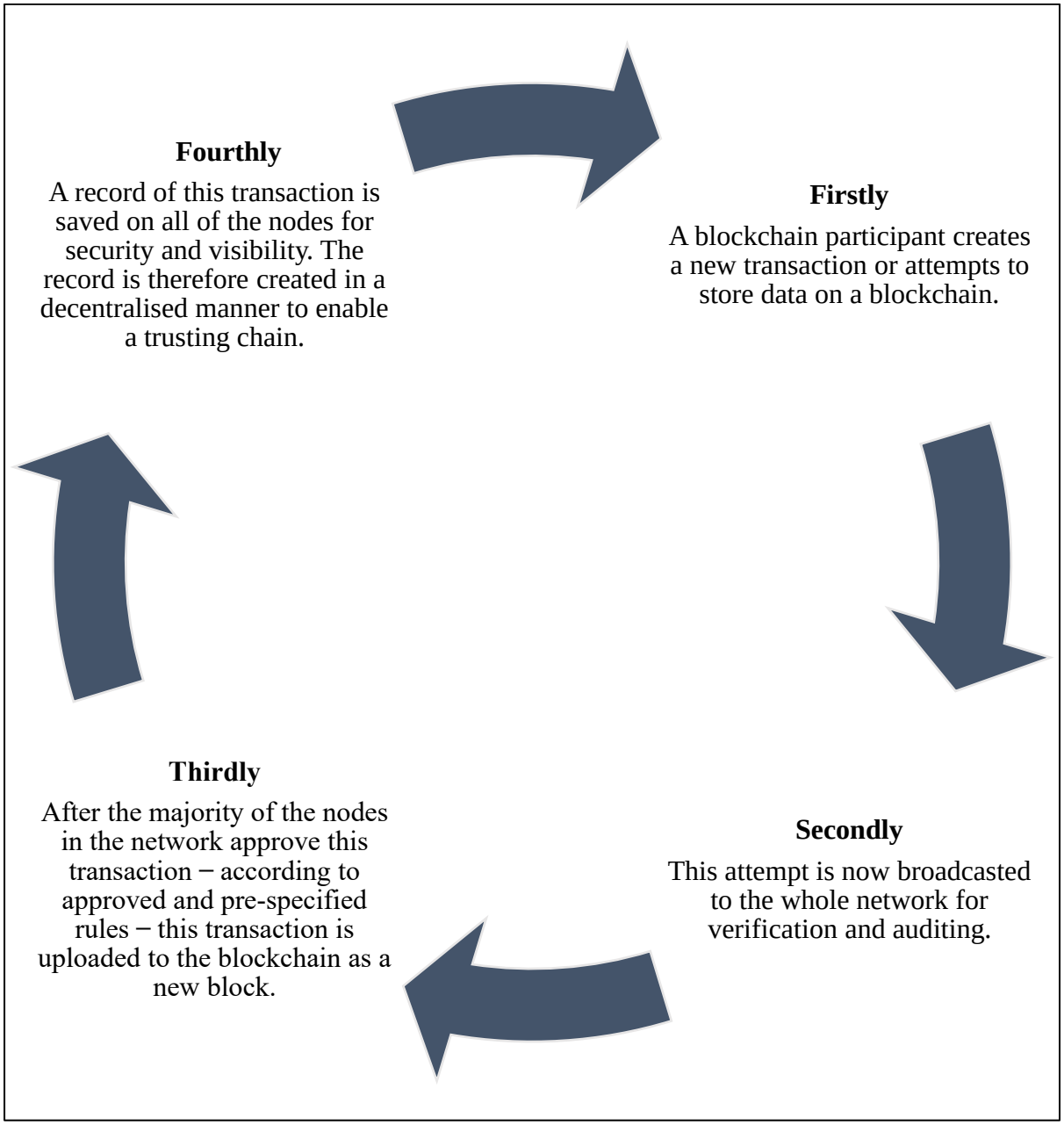
Another function that blockchain offers, is an adaptable smart contract feature. The next paragraph will give a brief overview of what smart contracts are about.

Smart contracts are digital coded contracts that self-execute when certain pre-set conditions are satisfied (Jaiswal *et al.*, 2019). This code is triggered when a message is sent to a certain blockchain address, i.e. when the terms of the contract are honoured (Jaiswal *et al.*, 2019). Dalton *et al.* (2018) explain that the function of a smart contract can be referred to as an "If-This-Then-That" function. According to Dalton *et al.* (2018), smart contracts can reduce "time-to-market" in a supply chain by eradicating manual processes combined with the usage of paper documents. Smart contracts can be programmed to assess the status of a transaction and automatically execute actions such as 1) releasing a payment, 2) recording and updating ledger entries, and 3) flagging exceptions that need manual intervention (Gaur & Gaiha, 2020). From

the above explanation, it is evident that smart contracts can have an immense impact on a blockchain-based supply chain system.

Figure 2-1 explains how a blockchain works when a participant attempts to add either data or a transaction to the blockchain.

Figure 2-1: The transaction process in a blockchain



Source: Saberi *et al.* (2019)

Every new transaction is validated by all the nodes in the network, and these nodes are known as “miners”. In order for the miners to add records to the blockchain, they should perform complex calculations to show a proof of work (Laaper *et al*., 2017). In theory, no participant in the network can tamper or overwrite past data (Gaur & Gaiha, 2020). Gaur and Gaiha (2020) explain that by attempting to do this will result in needing to rewrite and re-compute all subsequent and preceding blocks on all distributed and copied blockchains. This feature of blockchain will disable any party from recreating the entire blockchain with tampered data in order to replace legitimate copies.

From Figure 2-1 it is evident that blockchain can verify and add new data in real-time. This feature of blockchain suggests that it can enable the opportunity to increase transparency across a supply chain. The following section will elaborate on the integration of blockchain and supply chains through the discussion of blockchain-based supply chain systems.

2.5.2 ***Blockchain-based supply chains***

Firstly, it should be noted that blockchain will not act as a replacement for internal systems such as transaction processing and management control functions currently performed by Enterprise Resource Planning (ERP) systems. Alternatively, blockchain will integrate and interlink with technology systems across all participating parties (Gaur & Gaiha, 2020). Gaur and Gaiha (2020) explain that each participant will generate blocks of transactions/information from their internal ERP systems and add it to the blockchain – enabling easier transactional and informational flows in the supply chain.

It can be suggested that blockchains which are distributed, immutable, transparent and trustworthy databases can be influential to supply chain networks. Tracking potential social and environmental conditions can be regarded as an important application focus for the blockchain (Adams *et al.*, 2018). A blockchain-based supply chain provides reliable evidence for a product’s quality and fair manufacturing practices (Saberi *et al*., 2019). When applied, it can be suggested that in the event of a transparent record of a product’s production history, buyers of the product and other stakeholders are assured that these products are supplied from verified and ethically-sound sources.

There are three types of blockchain system designs, namely 1) public blockchains, 2) hybrid blockchains, and 3) private blockchains. These blockchain systems are explained in Table 2-5:

Table 2-5: Types of blockchains

	Public blockchain	**Hybrid/consortium**	**Private blockchain**
Overview	The system is fully decentralised with no central authority.	Quasi-centralised where a consortium of organisations control the records' authenticity. The parties in the network know each other and there is limited anonymity.	One authority or entity implements and controls the blockchain. They act as a trusted intermediary.
Permission	No permission required – anyone can read the blockchain and add data to it.	The network is permissioned to a degree – selected participants can read and add data.	Fully permissioned – only one central organisation has write-permissions.
Transaction/data verification	A majority of the miners reach consensus to verify the authenticity of records.	The consortium verifies the transactions.	The central authority verifies the transaction.
Data storage	A copy of the entire blockchain is available to all participants in the network; hence fully distributed.	The blockchain is only distributed throughout the whole consortium.	The central organisation stores all records and data.

Transaction cost	Transaction costs tend to be low.	The consortium agrees on the distribution of the transaction cost.	Only one organisation absorbs the transaction cost.

Source: Laaper *et al*. (2017)

It can be suggested that all the stakeholders in a supply chain form part of one consortium. Thus, taking note from Table 2-5, a hybrid or consortium-blockchain may be most suitable for a blockchain-based supply chain. This is suggested because a consortium is a group of organisations or entities that strive for the achievement of a common goal – as is the case in a supply chain with different organisations and stakeholders. Supply chains, therefore, require elements of a private blockchain among known parties, not public blockchains among anonymous users. This is needed so that the actors in the supply chain can discover the source and quality of products together with the identity of the ownership of each product (Saberi *et al*., 2019). It should thus be kept in mind that in a supply chain that evolves around blockchain, a predetermined level of privacy is critical.

Successful blockchain-based supply chain systems will have to include 1) elements of permissioned blockchains, 2) new standards for transactions, and 3) new rules to govern a system. Based on the afore-mentioned, different roles have to be fulfilled in a new blockchain-based system and can be allocated to certain participants and stakeholders. These roles can be assigned to four types of groups (Steiner & Baker, 2015):

- The registrars:
    - These are the authorised organisations that provide unique identities to the different actors in the network.
- Standards organisations:
    - These organisations are responsible to implement and define standards such as “Fairtrade” for supply chains, as well as blockchain implementation policies and technical requirements such as the degree of combining Internet of Things (IoT) with blockchain, including the use of smart contracts.

- Certifiers:
    - The certifiers are responsible for providing the required certifications to the actors for them to participate in the supply chain.

- Actors:
    - These organisations are those who participate in the supply chain together with the stakeholders; including, but not limited to, farmers, abattoirs, processors, distributors and consumers. These actors need to be certified by a registered certifier to preserve trust.

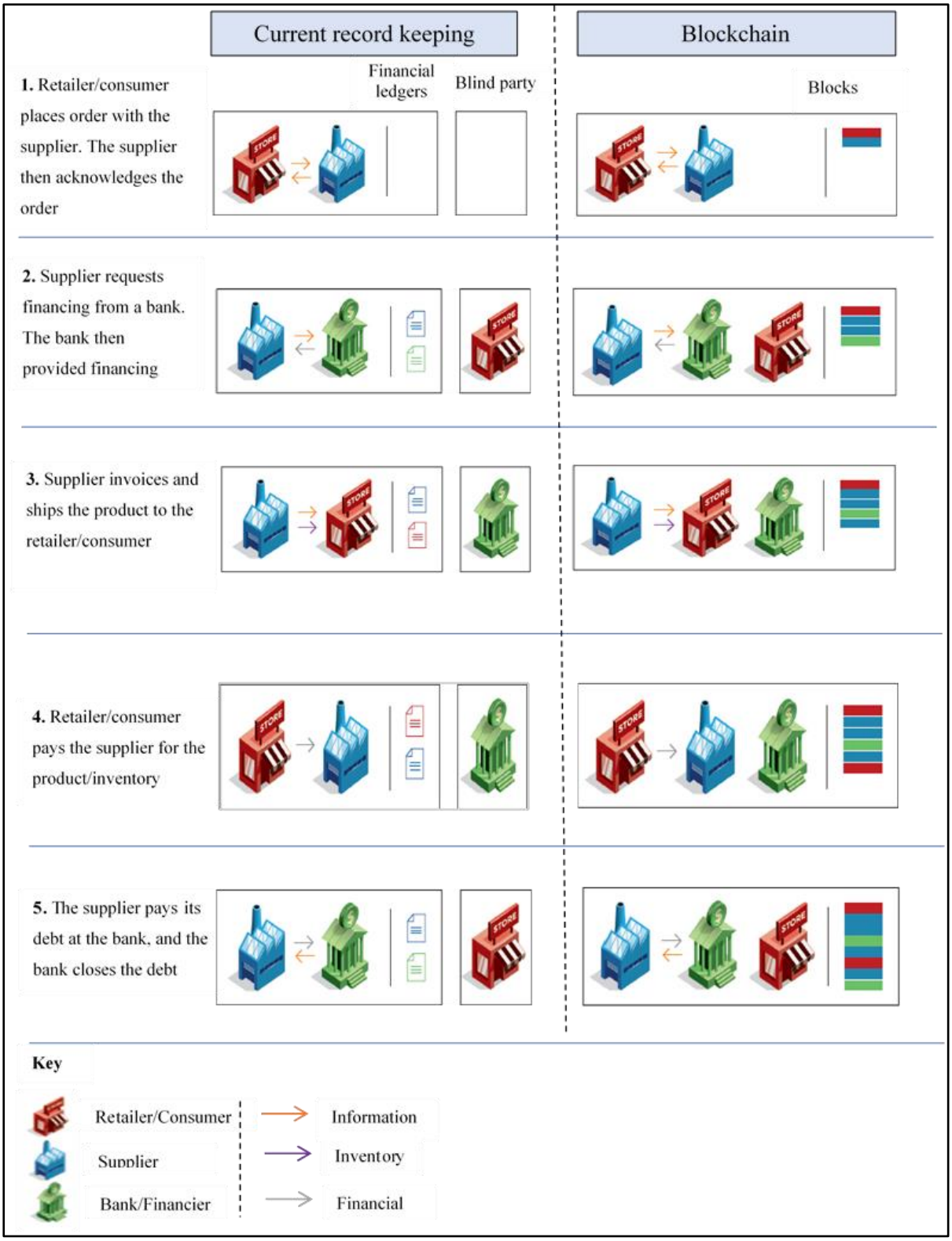
These different organisations that occupy the aforementioned roles should have direct digital access to the different products in the supply chain. This can be attained by the registrars allocating a digital presence (a digital token) of particular products on the blockchain. Tian (2017) explains that it is important for applicable security measures to be in place to limit access. This can be achieved by the standard organisations granting access to specific information to only the parties who have the correct digital keys. This is because the decentralised nature of blockchain may pose a risk to data privacy and can potentially be misused for competitive intelligence (Gaur & Gaiha, 2020). However, the informational flow-management characteristic that blockchain has to offer, can give supply chains elements of transparency in the form of decentralised record keeping. The next sub-section will discuss the benefits blockchain has to offer regarding information sharing in a supply chain.

2.5.2.1 Benefits of blockchain's information-flow characteristics

Current financial ledgers and ERP systems do not necessarily grant different parties in a supply chain the relevant visibility regarding information-, inventory- and financial-flows. Blockchain-based supply chain systems have the ability to eliminate these opacities. With blockchain record keeping, items such as inventory, loans, or sales-orders are allocated a unique identification element that serves as a "digital token" – similar to what was described above. Furthermore, all permissioned actors in the blockchain are given digital signatures that they use to add blocks to the blockchain. With every stage in the supply chain – either when a

product changes location or sales orders are initiated, this “step” is recorded on the blockchain as an “added block”. In essence, every time the corresponding digital token is transferred from one actor to another, a new block is added to the blockchain (Gaur & Gaiha, 2020). Figure 2-3 illustrates this flow of a transaction in the form of 1) inventory flow, 2) financial flow, and 3) information-flow:

Figure 2-2: Comparison between current record keeping versus blockchain-based record keeping in a supply chain



Source: Gaur & Gaiha (2020)

Figure 2-2 shows the value of blockchain in a visible way. It is suggested that the value lies in the sequential strings of blocks combining all three information-flows of a transaction while capturing details that are not normally recorded in current ledgers and database systems.

Considering Figure 2-2 (refer section 2.5.1, page 44) in a practical example, a simple transaction will be used to illustrate this use-case's benefit for financiers and suppliers in the beef industry. A buyer of meat (retailer) generates a supply-order of specific meat cuts and quantities, and then this order is sent to the supplier/meat processor. At this point in the transaction, there is no exchange of goods and therefore in a normal ledger and database, no entries will be recorded. However, with blockchain, a retailer records the digital token allocated to the order on the blockchain and attempts to "add a new block". In turn, the meat supplier accepts and recognises the order by giving consensus to the attempt to add the block to the blockchain – consequently, the detailed order is uploaded to the blockchain and appears visible to the selected parties' blockchain ledgers. After the supplier has accepted the order, it would normally request for working capital financing from a financier to finance the transaction. The financier, who will have access to the blockchain, will be able to verify the existence and commercial substance of the contract on the distributed blockchain ledger. The financier will then be able to approve the loan and record the loan's digital token to the same blockchain. This can enable financiers to make better and more efficient financing decisions, and in turn for suppliers to attain financing easier and more efficiently.

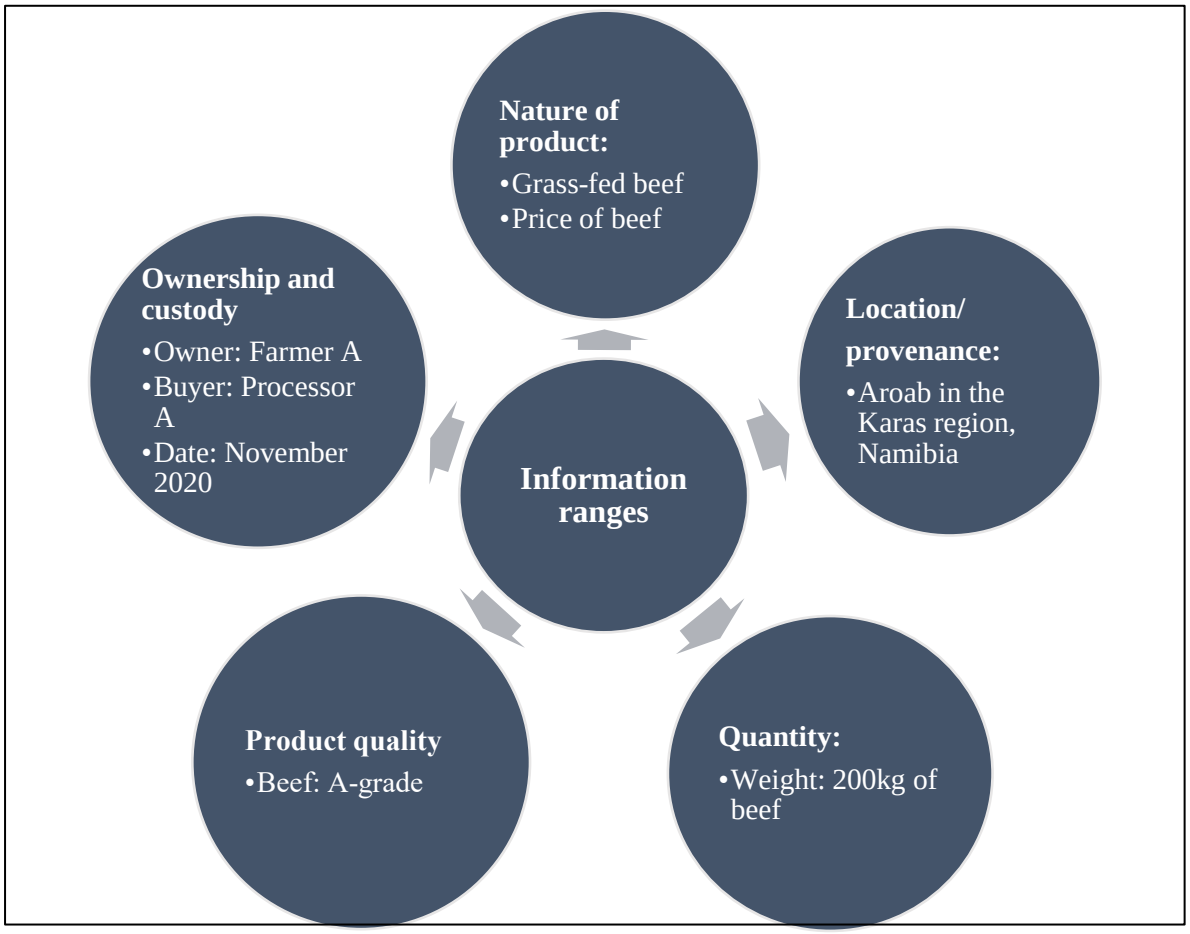
By virtue of these characteristics, it is suggested that blockchain provides a complete, trustworthy and tamperproof audit trail of all three information-flows of a transaction in a supply chain. This may therefore enable actors in a supply chain to review transactions, identify errors, and to be able to hold counterparties responsible for their actions. However, if a blockchain-based supply chain's main goal is to verify efficient and trusted traceability, information such as orders, invoices and financing do not need to be included on the blockchain. The next subsection will discuss how blockchain-based supply systems will enable a trusted and efficient traceability system in a beef supply chain.

2.5.2.2 Beef traceability blockchain systems

Blockchain has a wide range of product information that can be selected and viewed by different participants in the blockchain network. This information should align with supply

chain practices, but also with consumer trends and purchase drivers. As a nexus can be formed between IoT devices such as Quick Response (QR) codes, Radio Frequency Identification (RFID) chips, and Near Field Communication (NFC) devices with blockchain (Laaper *et al.* 2017), these ranges can at least include the information as portrayed in Figure 2-3.

Figure 2-3: Example of minimum product information captured on a blockchain



Source: Saberi *et al*. (2019); Laaper *et al.* (2017) (adapted)

In this way, as portrayed in Figure 2-3, blockchain allows all stakeholders and actors to inspect the continuous chain of product-custody and product-history. The information in Figure 2-3 would be automatically updated in the distributed ledger for all actors to have access to. This gives blockchain an attractive traceable characteristic. Blockchain can therefore replace the need for a trusted intermediary or central organisation that operates and maintains the traceability of a current supply chain. Figure 2-3 also includes all the information regarding cattle and meat, as mentioned in section 2.4.2 (Supply chain transparency, page 30).

The next section will present four blockchain use-cases that can be implemented in a beef supply chain. These use-cases were suggested by Dalton *et al*. (2018) and adapted when needed in the study.

2.6 Blockchain use-cases

Four blockchain use-cases will be presented as follows: the first use-case will illustrate blockchain's ability to form an end-to-end traceable blockchain. This use-case also allows stakeholder-engagement that in turn lets the consumers instantaneously verify and confirm the beef product's authenticity. Secondly, a use-case that shows blockchain's ability to prove any "labelling-assurance" will be presented. The third use-case is an elaboration of Figure 2-2 where blockchain can assist with trade finance in a beef supply chain. Finally, the last use-case will present a way to change the storage, management and sharing of beef certifications. These blockchain use-cases are from a report published by Deloitte (Dalton *et al.* 2018).

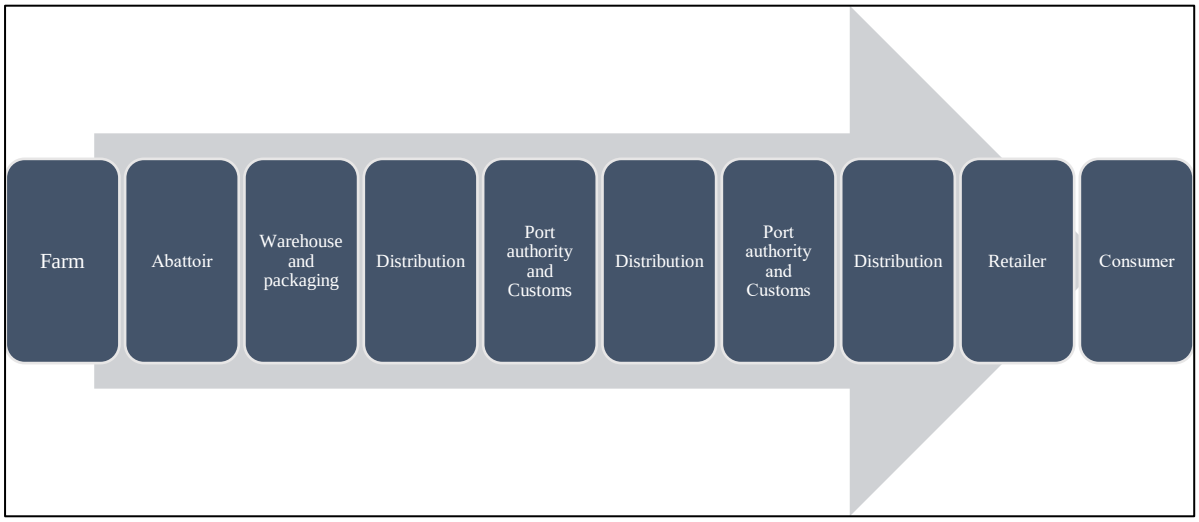
2.6.1 ***Use-case 1: End-to-end traceability***

As mentioned earlier, blockchain provides an established and entrenched audit trail of a product's information from its provenance until its usage (Dalton *et al.*, 2018). This "single-source-of-truth" audit trail can therefore prove to market regulators, retailers and consumers that the provided beef complies with the applicable policies, processes and procedures. Furthermore, blockchain technology can be used to specifically identify when cattle and beef products change ownership (Dalton *et al.*, 2018). This could improve transparency while making the chain of ownership visible, resulting in end-to-end traceability. According to Dalton *et al.* (2018), blockchain achieves end-to-end traceability, because it provides a visual, open and interconnected supply chain network and continues to put real-time information to all the participants' disposal.

As mentioned in section 2.5.2.2 (refer page 45), selected participants will have different access to reach full supply chain disclosure – whether it is write-access, read-only, or audit functions. This enables stakeholder engagement by strengthening their trust in the beef's quality and safety (Pólvora *et al.*, 2020). Current practices and labelling share product information with the consumer such as 1) product description, 2) best-before dates, 3) the origin of the meat and 4) quality standards, which are, however, seldom verifiable (Dalton *et al.*, 2018). With blockchain,

an IoT device such as a QR-code can be located on the meat packaging that will give the consumer read-access to all the information stored on the blockchain (Dalton *et al.*, 2018). This information includes the information mentioned in Figure 2-3 and section 2.5.2.2 (refer page 45). In essence, the QR code will put the consumer on a verified journey starting at the farm and ending with the consumer. This supply chain journey and how a blockchain-supply chain will look like, is illustrated in Figure 2-4 and Figure 2-5.

Figure 2-4: Current export beef supply chains

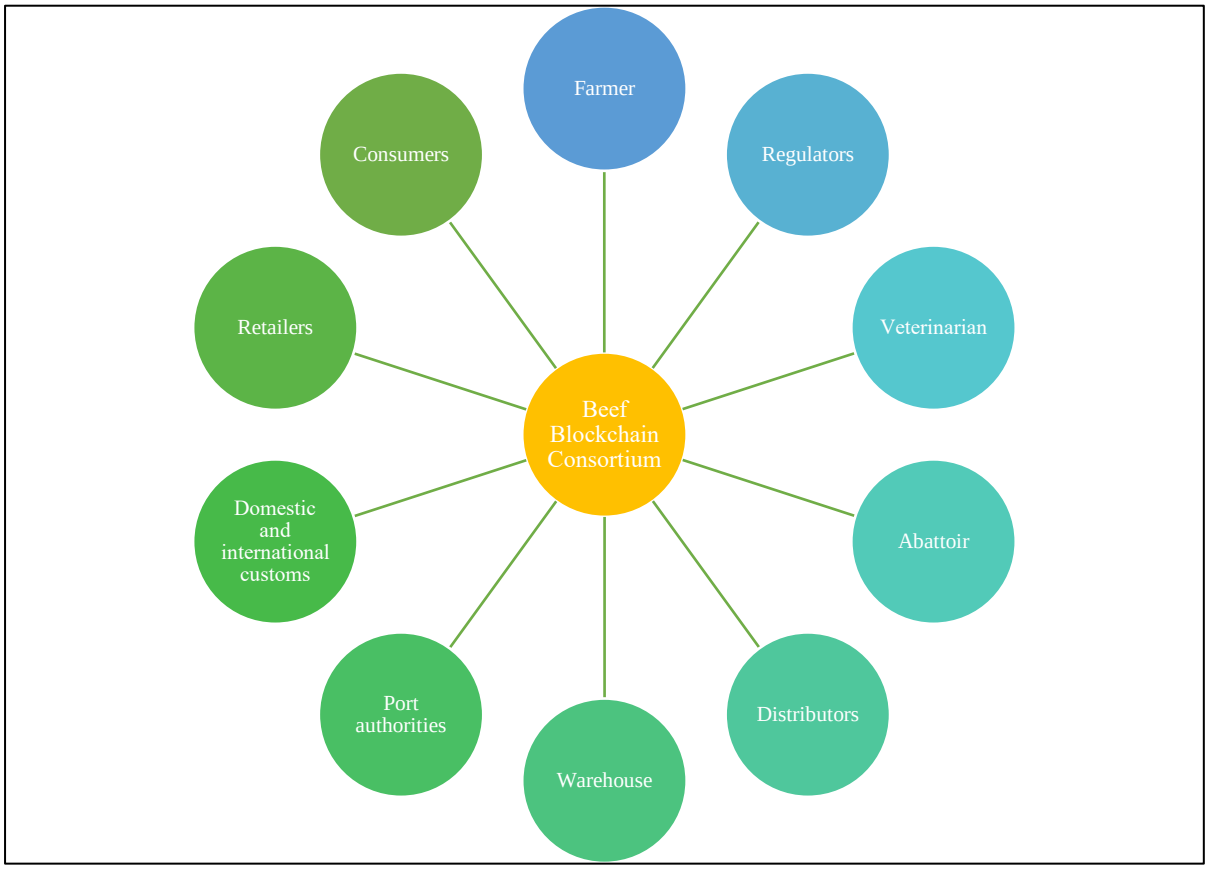


Source: Dalton *et al*. (2018)

The "journey" of meat in current export supply chains are normally recorded on a centralised system to which only one party usually has access to (Dalton, *et al*., 2018). Due to the complexity and multi-nationality of an export beef supply chain, inefficient access to information can hinder efficient delivering of a product and thus slowing down a supply chain (Hudnurkar, Jakhar and Rathod, 2014). Adding to this, where only one party has full access to information could cause information asymmetry, as referred to in section 2.4.2 (refer page 30).

In the next paragraph, a visual illustration will be presented of a decentralised supply chain that is stored on blockchain.

Figure 2- 5: Blockchain-based export beef supply chains



Source: Dalton *et al*. (2018)

Figure 2-5 illustrates how all the stakeholders of a supply chain are connected with each other due to the blockchain consortium they form part of – in contrary to the current supply chains where stakeholders are only connected with the preceding and following supply chain participant (Figure 2-4). With regard to the blockchain-based export supply chain in Figure 2-5, the following information will be deemed to be uploaded and viewed by, or to be available to, each actor in the supply chain network to achieve the desired end-to-end traceability (Dalton *et al.*, 2018):

- The Farmer (adding of information)
    - Their registered name;
    - The cattle's birth date or arrival date;
    - Their own quality assurance certificate;
    - The cattle's health and dietary history.

- The Veterinarian (adding of information)
    - Date of visits to the cattle;
    - Nature of the visits;
    - The cattle's health report, vaccination treatment, and history.
- The Abattoir (adding of information)
    - The cattle's arrival date;
    - The name of the farmer who owned the cattle;
    - The cattle's health status;
    - Date of cattle's slaughter and way of slaughter (e.g. is it Halaal compliable?);
    - Recommended use-by date;
    - The different cuts made from the cattle.
- The Distributors (adding of information)
    - The details of the courier used;
    - The batch's delivery details;
    - The condition of the batch beef;
    - The conditions that the batch was shipped in (e.g. the temperature of the cooling storage in transit);
    - The batch's bill of loading document;
    - The necessary exporting documents.
- Warehouses (adding information)
    - The beef batch's arrival date;
    - The batch's condition upon arrival;
    - The date of departure from the storage warehouses.
- The Port authorities (view and add information)
    - View the batch's details;
    - Date of arrival and departure.
- The domestic and international customs (view information and add)
    - View the batch's details;
    - View the export documents;
    - Approve the shipment by signing off the details.
- The Retailers and consumers (view and add of information)
    - View the history of the beef batch;

- Sign off the specific details.

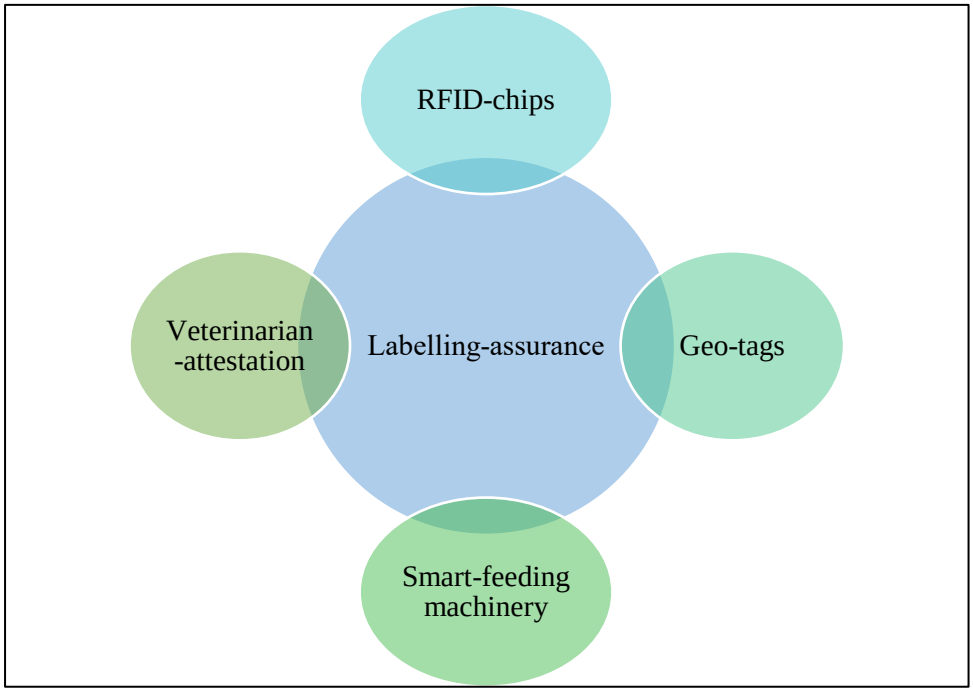
This enables end-to-end traceability of which consumers as well as regulators can benefit from (Dalton *et al.* 2018). Consumers could have the ability to view the beef's life cycle from its provenance to the shelf and may have the option to write reviews. For the regulators, the auditing of the policies could be easier and more efficient due to the digital and verifiable information with regard to certifications stored on the blockchain.

The next use-case that will be presented is the labelling-assurance that blockchain can provide.

2.6.2 ***Use-case 2: Labelling-assurance***

Namibia, who prides itself with beef that are physically labelled as free-range, grass-fed and antibiotic-free beef, longs to the ability to give an instant and objective assurance to market regulators, retailers and consumers (Sartorius von Bach, 2018). Blockchain, however, has the ability to prove with reliance to global market regulators, retailers and consumers that Namibian export slaughter-beef are primarily free-range, grass-fed and antibiotic-free (Dalton, *et al.*, 2018).

Figure 2-6: Labelling-assurance blockchain system



Source: Dalton *et al.* (2018) (adapted)

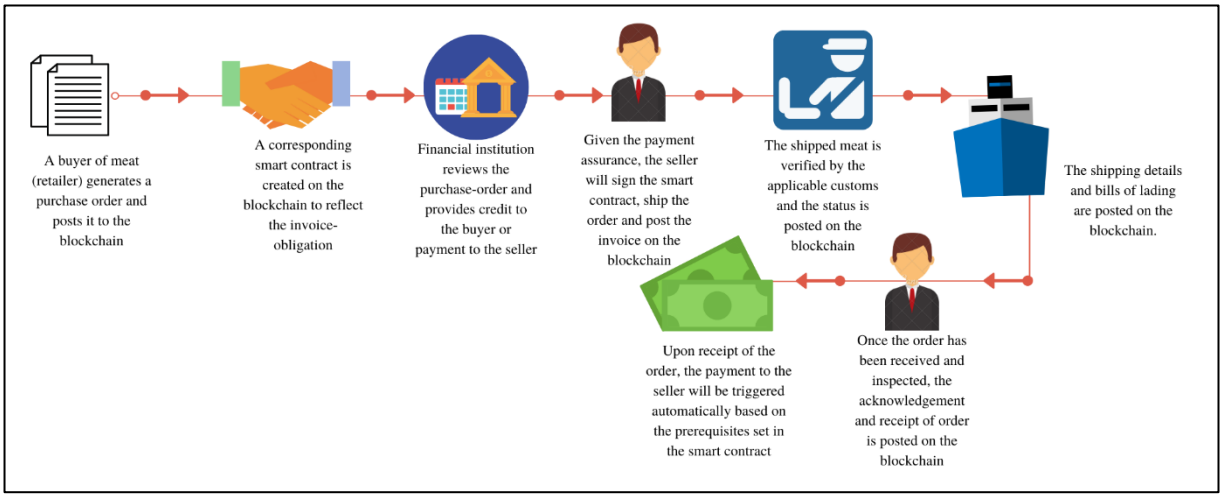
Figure 2-6 illustrates how blockchain has the ability to communicate in nexus with any existing IoT devices on a farm such as RFID-chips, Geo-tags and smart-feeding machinery. These IoT devices in turn post unaltered and objective information to the blockchain. This information provides a rigid audit trail of the cattle's free-range grazing (geo-tag and RFID-chips), grass-feeding (smart-feeding machinery), and antibiotic-free conditions (veterinarian's attestation to the blockchain). This blockchain system can therefore provide assurance regarding the labelling-promises to market regulators, retailers and consumers (Dalton *et al.*, 2018). Due to blockchain's sharing of data amongst blockchain participants, these parties could be able to have read-access to the blockchain to verify the labelling-promises.

*2.6.3 **Use-case 3: Blockchain's assistance in trade finance***

According to Dalton *et al.* (2018), the following problem areas exist in an export beef supply chain. These identified problem areas were supported by the feedback of the interviews conducted in the study. These problem areas are as follows:

- **Multiple platforms**
    - Each party across the countries operates on a different platform which leads to opportunities for miscommunications.
- **Invoice factoring**
    - Namibian exporters mostly use invoices to acquire short-term financing from financial institutions.
    - Additional risk is adding towards the financier as well as the exporter if the delivery of meat fails.
- **Delayed timeline**
    - There are multiple intermediaries in the process to check and verify the shipment of meat, and these numerous communication points tend to delay the shipping time.

Figure 2-7: Visual illustration of blockchain-based information-flow



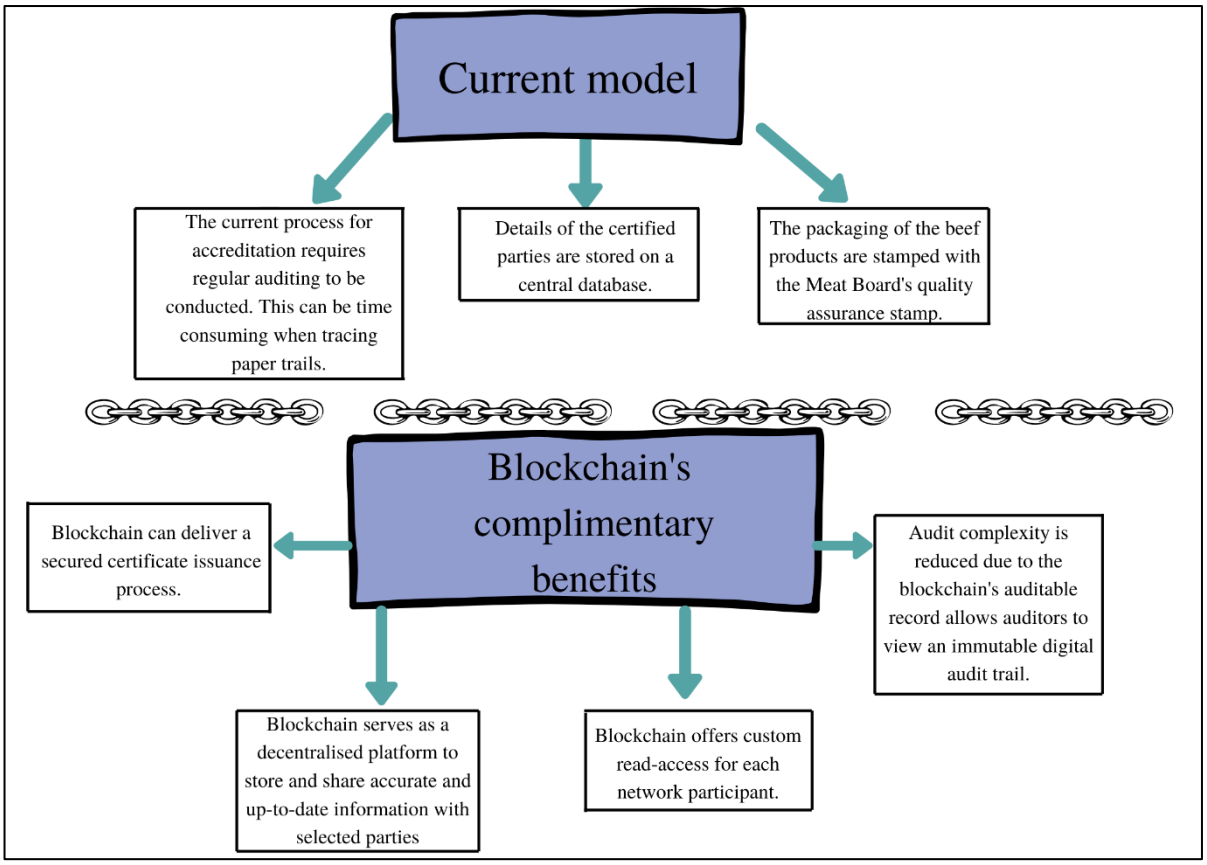
Source: Dalton *et al.* (2018) (adapted)

Figure 2-7 illustrates how full access and transparency of an order can be achieved end-to-end, from an order to a delivery. This process can allow for all parties to be connected on a single platform. The second problem area is also mitigated by the use of self-automated payments via smart contracts, as well as financial institutions having efficient access to the invoices' "status" that is used for short-term financing. The delayed time of an order is also shortened by this model, due to the real-time review and approval of documents. Lastly, due to the consistent availability of trusted information, customs will be able to link the beef that are in-transit in a country and exported, to the beef that has arrived in the country.

*2.6.4 **Use-case 4: Certification***

Blockchain has the ability to transform how certifications are stored, managed and shared between the applicable supply chain participants (Dalton *et al.*, 2018). Dalton *et al.* explain that numerous retailers, consumers and market regulators rely on quality and practice accreditations when assessing food quality and safety, and approving exportation of meat. It is thus suggested that an accurate and up to date register of accredited farmers, suppliers and beef processors is an imperative tool in the ensurance that standards are maintained. Figure 2-8 illustrates what the current certification model consists of, and how blockchain will contribute towards it by adding possible benefits.

Figure 2-8: Blockchain's suggested role in current certification models



Source: Dalton *et al.* (2018) (adapted)

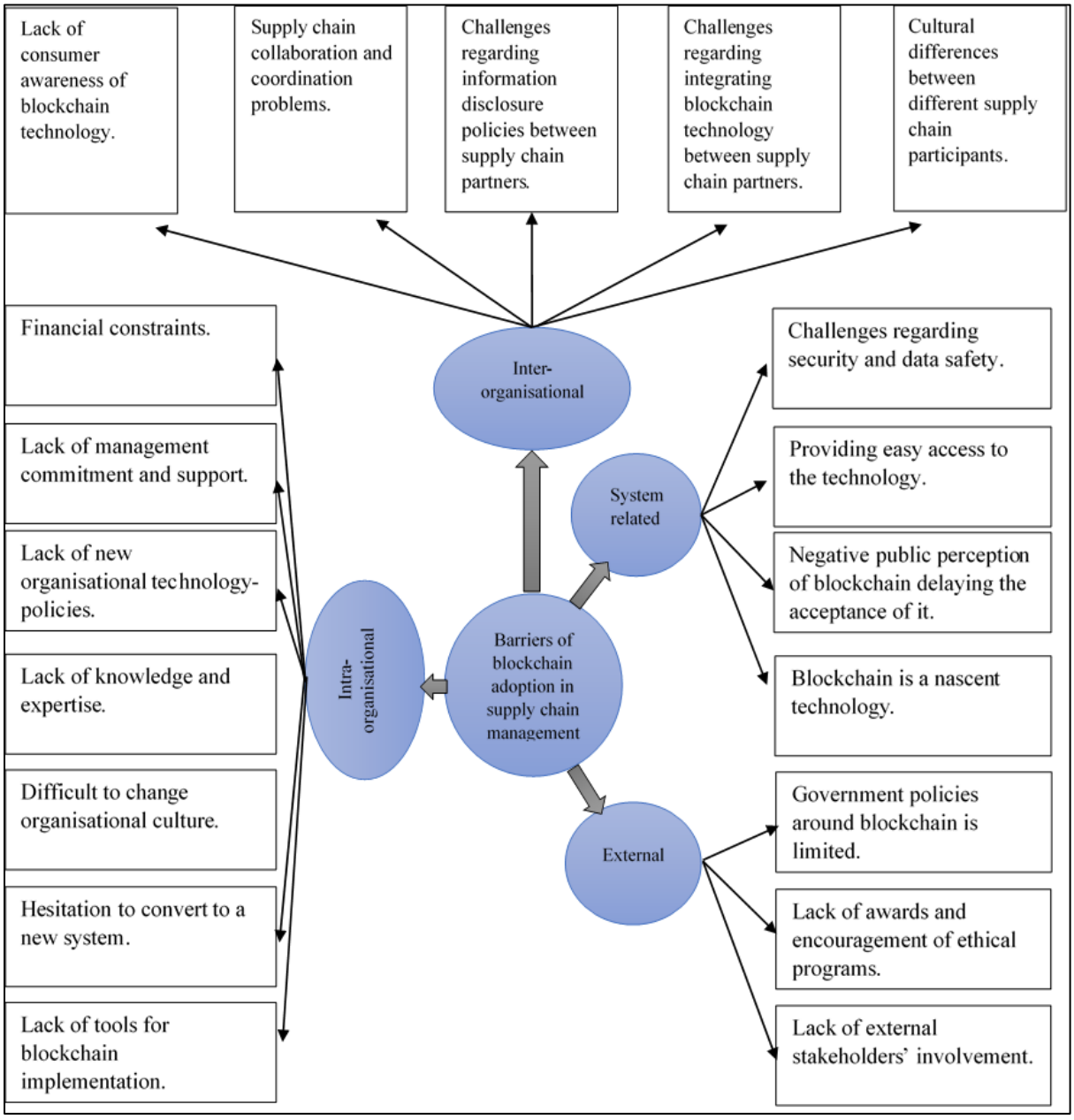
In theory, it sounds promising to integrate blockchain into beef SCM, but there are some barriers to the implementation of blockchain. These barriers will be addressed in the next section.

2.7 Barriers and adoption of blockchain

Blockchain, being a nascent technology, tends to pose several obstacles that can hinder the implementation thereof. Laaper *et al.* (2017) explain that there can be integration concerns that require significant changes or replacements to current systems. In addition, concerns about linking physical assets to digital assets can occur. Currently, the digitalisation is done with IoT devices, but to ensure the sustainable flow of information in a supply chain, all the steps of the supply chain should be "tagged". However, in supply chains where IoT devices already play a big role, this concern can be easily mitigated.

With blockchain representing a remarkable shift to decentralisation, it may be difficult for old-fashioned users and operators to adopt this technology. This can result in barriers categorised in intra-organisational, inter-organisational, system-related, and external barriers (Saberi *et al*., 2019). These different categorised barriers are summarised in Figure 2-9.

Figure 2-9: Summary of blockchain implementation barriers



Source: Saberi *et al.* (2019); Laaper *et al.* (2017)

Although Figures 2-9 highlight several barriers resulting in hesitancy in the implementation of blockchain, it is critical to keep in mind the immaturity of blockchain technology and its

integration with SCM systems. Whether or not it will be efficient in a beef supply chain, depends on the beef supply chain's environment and the need to adopt it. Therefore, criteria to evaluate whether a supply chain needs and can adopt blockchain have been established from the literature (Laaper *et al*., 2017). These criteria are summed up in Table 2-6:

Table 2-6: Criteria for adoption of blockchain in a supply chain

Criteria category	**Questions in relation to the supply chain**
The need for traceability in a blockchain.	1. What is the need for traceability? 2. Who should enter all the data? 3. Who would need access to the data? 4. What data needs to remain confidential?
Material characteristics. Due to the digital nature of blockchain, interfacing the data tracked in the blockchain to the physical product requires other technologies.	1. What size is the product being tracked? 2. What technologies are available to connect the physical material to its digital persona? 3. What physical transformations are applied to the materials in the manufacturing process?
Supply chain layers and participants. In order to realise consensus to implement blockchain in a supply chain with various participants involves a lot of stakeholder engagement.	1. How many supply chain layers are involved in the supply chain? 2. Will the supply chain participants follow the lead of a main participant and collaborate? 3. Is there a risk for multiple partners in the supply chain to collude and change records?
Technology environment	1. What is the effort needed to connect all the current systems and data structures? 2. How will a transition be made from the current data structure to the blockchain structure? 3. What geographies do the materials flow through during the supply chain? 4. Is it easy to add technology interfaces in the abovementioned environments? 5. What are the current usage of IoT devices in the supply chain?
Regulation	1. In which countries does the supply chain span?

	2. Should the product adhere to certain prerequisites in order to be exported to these countries?

Source: Laaper *et al*. (2017)

Table 2-6 suggests five attributes that can help to determine whether blockchain implementation is needed or not. These criteria will be applied to the feedback from the empirical study in order to determine the adoptability of blockchain in the Namibian export beef supply chain.

2.8 Summary

The aim of this chapter was to address the first secondary objective (refer Chapter 1, section 1.8.2, page 10). A brief introduction of the global and Namibian beef supply chain was provided. The literature review considered three topics, namely supply chain management and integration, transparency and traceability, and the implementation of blockchain into supply chains. With regard to supply chain management, extant literature attested that supply chains as a whole are competing against each other, and not as individual organisations. It was further found that there is a requirement that organisations in a supply chain should build sustainable relationships that synergise efficient information-flow in the supply chains. Furthermore, through the literature review, different performance measures were summarised to demonstrate whether a supply chain is operating as efficient or as inefficient. Table 2-2 concluded that a supply chain should be measured to establish whether the overall strategy is aligned to form one consortium.

Section 2.4 determined that enhancing transparency and traceability in a supply chain forms part of the CSR of organisations. It was further determined in the literature review (refer Table 2-3) that scholars found a parallel correlation between enhanced CSR and firm-performance. This literature study therefore suggests that an increase in the elements of supply chain transparency and traceability will improve the supply chain's performance as a whole. In turn, the concept and necessity of transparency and traceability in beef supply chains were addressed. Blockchain was introduced as a possibility to improve transparency and traceability in beef supply chains.

The concepts of blockchain were explained and addressed in section 2.5 of the literature review. It was determined that blockchain technology can revolutionise the management of supply chains. Table 2-5 compared the different types of blockchain networks and suggested an applicable network for supply chain management. Figure 2-1 explained what the process of adding information to a blockchain consists of. In turn, Figure 2-2 illustrated how the decentralised visibility of information will improve operations such as working capital financing.

Following this, four use-cases (Figure 2-4 to Figure 2-8) as set out by Deloitte (Dalton *et al.* 2018) were presented to illustrate the use of blockchain in a beef supply chain. This use-cases will be referred to in Chapter 4.

Finally, the literature review concluded with the different barriers a supply chain faces concerning the implementation of blockchain (Figure 2-9) and suggested criteria to use to determine whether an organisation can adopt blockchain (Table 2-6).

The next chapter will present the research methodology that has been followed in this study.

CHAPTER 3

3 Research design and Methodology

3.1 Introduction

This chapter aims to address the second secondary objective, as referred to in Chapter 1 (refer section 1.8.2, page 10), to find and present an appropriate research methodology to achieve the main objective of this study. The chapter will firstly address the research paradigms applicable to this study. After determining the applicable research paradigms, the most suitable research approach for this study will be chosen and motivated. The chapter will further define and discuss the various terms associated with research design and research methodology. In short, this chapter will discuss the appropriate research paradigm, ontological and epistemological assumptions, the most suitable research methodology and the data collection methods. The chapter will end with the imperativeness of ethical considerations during a research study, as well as this study's ethical clearance.

3.2 Research paradigms

Firstly, for a researcher to understand the difference between qualitative and quantitative research methodologies, the researcher should comprehend what paradigms are (De Villiers & Fouché, 2015). Paradigms were explained more than 30 years ago by Kuhn (1970) as accepted examples of scientific practices that provide models for scientific research. Additionally, a paradigm can also be defined as either a belief-system or a worldview that is pursued by a researcher and which includes the choice of methods, ontology and epistemology (Guba & Lincoln, 1994). Guba and Lincoln (1994) further state that a paradigm represents a certain worldview that defines the following: 1) the nature of the world, 2) an individual's place in the world, and 3) the relationship an individual can pursue with this world and its parts. In the following two paragraphs, ontology and epistemology will be defined.

Ontology addresses the researcher's beliefs regarding the nature of reality and humanity, and of what can be known about this world (Ritchie & Lewis, 2003). Tuli (2010) explains that there are two kinds of ontologies, namely objectivism and constructivism. Respectively, objectivism believes that reality exists independently, whereas constructivism views reality because of social processes (Tuli, 2010).

Secondly, epistemology focuses on the theory of knowledge. This includes methods, validation and ways to gain knowledge of social reality (Vogel, 2019). Grix (2004) explains that epistemology addresses the knowledge gathering process which results in developing new and enhanced models and theories. Just as ontology, epistemology has two distinctive paradigms of quantitative and qualitative research – namely positivism and interpretivism (Rolfe, 2006). Positivism enhances the idea that empirical facts exist separately from people's ideas and thoughts (Tuli, 2010). Furthermore, Guba and Lincoln (1994) suggest that positivists presume that the researcher and the research object are independent bodies. On the other hand, the interpretivism perspective is based on a subjective approach of data collection such as interviews and observations (Dudovskiy, 2018). Grix (2004) explains that interpretivism is centred on real-world phenomena, meaning that the world does not exist independently of our knowledge.

In this study where the use of blockchain in Namibia's beef supply chain is explored, the researcher seeks to gain an understanding of the Namibian beef supply chain and the situation in which it finds itself. It is critical to approach the research subjectively, therefore this study will be based on an interpretivist paradigm.

The next section will discuss what a research approach is, as well as the research approach of this study.

3.3 Research approach

Research approaches are categorised into three different worldviews: 1) quantitative, 2) qualitative, and 3) mixed methods (Creswell, 2014). Quantitative approaches include both positivistic and post-positivistic views, with measurement and numbers as focal points. On the contrary, qualitative approaches include constructivism and metamorphic worldviews where the focus lies on words and images (Creswell, 2014). Finally, Creswell (2014) explains that a third approach – mixed methods – is a combination of the quantitative and qualitative approaches.

De Villiers and Fouché (2015) explain that qualitative research provides expressive and vivid data which is obtained through the researcher's perceptions and experiences. It can be suggested that, in qualitative research, the researcher is an instrument for the gathering of data,

because – as Bryman and Burgess (1984) state – the researcher goes on an expedition of discovery rather than verification. Thus, qualitative research can unlock new leads and pathways that can serve as a base for newer research (Bryman & Burgess, 1984). According to Hathaway (1995), the paradigm that fits qualitative research the best is interpretivism. This is an underlying paradigm of realism that makes use of inductive reasoning while forming conclusions based on observations.

Creswell (2009) states that interpretive paradigms are all about comprehending a phenomenon about 1) the perspectives of individuals, 2) the exploration of the interaction between individuals, and 3) the different cultural and historical contexts occupied by individuals.

To address the primary objective of this study, an understanding of the current Namibian beef industry and supply chain should be gained. Furthermore, the phenomenon of the Namibian beef supply chain should be grasped, as well as the potential benefits that the integration of blockchain into the beef SCM has to offer for all the respective stakeholders.

This study will therefore follow the interpretive paradigm which aligns with a qualitative research approach.

With the research approach established for this study, it will be applicable to discuss what a research design comprises of, as well as what this study's research design will be and the tools that will be used in the study. With that said, the following section will address this study's research design.

3.4 Research design

According to De Vaus (2001), the purpose of the research design is to ensure that the evidence collected from the study will enable the researcher to address the primary objective unequivocally. As this study is a qualitative research study, the research design is not a phase that is completed early in the study, but it is rather a constant process that requires a constant reviewing of decisions and research approaches (Ritchie & Lewis, 2003). It can therefore be suggested that a research design forces the researcher to constantly create practices of innovation. Furthermore, it was stated by Bechoffer and Paterson (2000) that research designs require imagination, invention, and the eagerness to avoid the obvious.

According to Groenewald (2004), phenomenological research is a type of research where the researcher describes how a certain phenomenon affects the experiences of the lives of the participants of the study. This research design conventionally involves conducting interviews with certain participants (Creswell, 2014). This study aims to understand Namibia's beef supply chain through the perspectives and experiences of important stakeholders that are directly involved in the supply chain. Furthermore, the effect that blockchain can have on Namibia's beef supply chain will be evaluated, as well as its effect on the supply chain's stakeholders. In conclusion, it can therefore be said that this study follows a phenomenological research design.

3.5 Research methodology

Tuli (2010) describes research methodology as a strategy that converts the ontological and epistemological principles into guidances which stipulate how the research should be conducted. It can be suggested that the research methodology controls the study, instructs the manner of acquiring data, presents the data in a logical relationship, and determines the approach for clarifying and combining data. In a nutshell, Leedy and Ormod (2010) summarise that there are two primary functions of research methodology; that is 1) to dictate the data acquisition, and 2) to extract meaning from the acquired data. To conclude, research methodology suggests how the fundamental meaning of data becomes perceivable and results in conclusions that will lead to an expansion of knowledge (Vogel, 2019).

This study's adopted research methodology will be categorised under the following headings:

1. Sampling and site collection; and
2. Data collection methods.

3.5.1 ***Sampling and site collection***

Higginbottom (2004) explains that the method of sampling is determined by the research methodology. Law *et al*. (1998) add to this by stating that sampling performed for qualitative research should be purposeful, and the process followed to identify and select participants should be clearly described. Three sampling methods are used in qualitative studies. These methods are presented in Table 3-1.

Table 3-1: Qualitative sampling methods

Method	Description
1. Convenience sampling	This method of sampling is the least rigorous method as it involves selecting participants that are the least demanding with regard to time, effort and money. This method will most likely result in data lacking in quality and credibility.
2. Theoretical sampling	Theoretical sampling requires the researcher to form interpretive theories from the gathered data and to select new samples to study and elaborate a particular theory. This method is widely associated with grounded theory research.
3. Judgemental/Purposive sampling	Purposive sampling is the most common sampling method used in qualitative research. This method is used to identify and select participants with valuable information regarding a phenomenon that is being studied. Purposive sampling strategies are used to gain a better understanding of specific participants' experiences. Using this method, the researcher selects participants for a specific goal, and not randomly.

Sources: Marshall (1996); Higgenbotton (2004); Palinkas *et al*. (2013); Devers & Frankel (2000); Law *et al*. (1998)

Table 3-1 distinguishes between three different sampling methods. The following paragraph will state what sampling method has been adopted for this study and will provide reasons why this method was chosen.

For this study, it was necessary to obtain information from individuals who had valuable knowledge and expertise in the Namibian beef industry and supply chain. Therefore, purposive sampling was used in this study.

As referred to in Chapter 1 (refer section 1.10.2.3, page 12), eight individuals were identified in the sample and could possibly increase to 10. These individuals included farmers (4), a corporate member (1), an agricultural union leader (1), an abattoir representative (1), a Namibian Meat Board representative (1), and a chartered accountant (1). According to Vogel (2019), the Namibian Government indicated in 2007 that the Meat Board of Namibia is responsible for determining the conditions which needed to be met before a beef export permit could be issued. It can thus be suggested that the Meat Board is acting on behalf of the Government's policies. It is important to note, however, that the Meat Board does not establish and form these policies, but only enforces the policies.

The study conducted by Vogel (2019) about the sheep industry in Namibia consisted of responses of eight individuals with whom interviews had been conducted. Namibia's beef supply chain features limited players (consisting of farmers, Company A, the Namibian Meat Board and the Namibian Agricultural Union), and the researcher of this study chose representatives from each of these players from whom to gather qualitative information. This study, which comprises describing Namibia's beef supply chain and exploring the use of blockchain in it, uses these interviews with the selected stakeholders to derive meaningful information to understand the Namibian beef industry in order to achieve the primary objective of this study.

The interviews aimed at gaining an insight into the Namibian beef supply chain and industry and to determine all the stakeholders' ideas of a transparent Namibian beef export supply chain. The selection process was also aimed at ensuring that the identities of all selected parties would be protected. There were agreed upon confidentiality requirements that were maintained, and it was stipulated that no further details and information about the participants would be provided.

*3.5.2 **Data collection methods***

There are many different data collection techniques. The following techniques stipulated in Table 3-2 are generally utilised in qualitative research studies.

Table 3-2: Qualitative data collection methods

Technique	**Description**
Surveys	This collection method comprises a fixed set of questions. It can be conducted in different manners, including by pen and paper, on the internet, or even in the form of an interview with a strict script.
Interviews	Interviews normally consist of a one-on-one discussion between the researcher and the research participant. The goal of interviews is to obtain information relating to specific topics between these two parties. In the year of the COVID-19 pandemic, it will be suitable for the interviews to be performed on an internet-based communication platform.
Focus groups	Focus groups comprise group discussions. The goal of focus groups is to obtain information about the topic being discussed in the group.
Observations	During observations, the researcher does not participate in any kind of interaction, but rather observes the actions of the research participants. However, it is necessary to attend to the possibility that the presence of the researcher can influence the activities that are being observed.

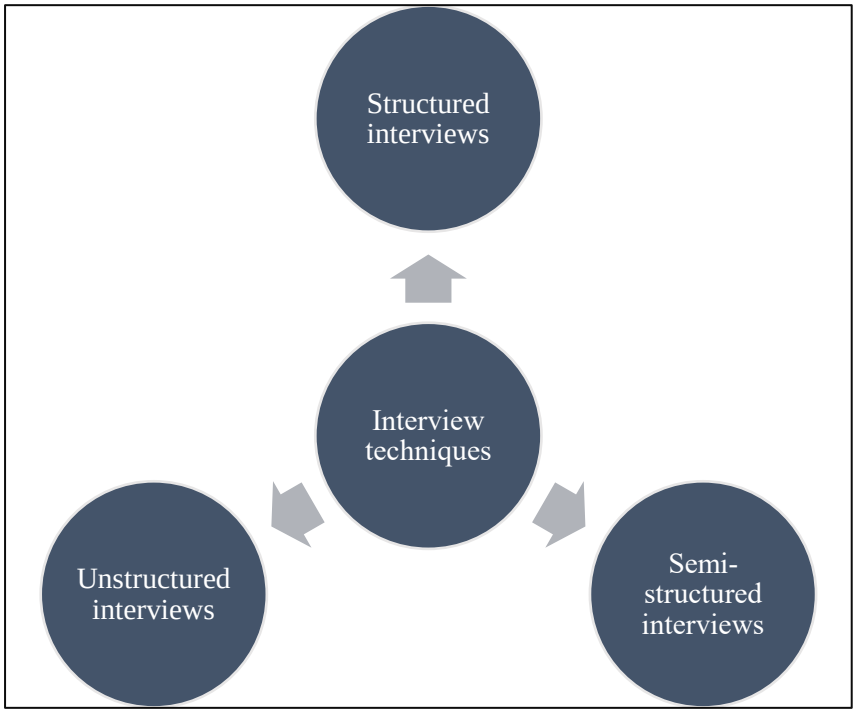
Extractions	This collection method consists of collecting data from archival sources such as documents and records.
Secondary data sources	Secondary sources refer to datasets which already exist and which were already compiled by another researcher.

Source: Harrel and Bradley (2009)

Table 3-2 explains the different qualitative data collection methods. The following paragraph will state what data collection method was utilised in this study.

This study used interviews as method for data collection. Potter (2005) defines interviews as the collection of data from humans where they are verbally asked questions and information is derived from their responses. By using interviews, the researcher can get an in-depth understanding of how an interviewee experiences a certain phenomenon, due to the one-on-one nature of the discussion. Figure 3-1 illustrates the three basic interview techniques.

Figure 3-1: Interview techniques



Source: Adhabi and Anozie (2017)

Figure 3-1 illustrates the three different interview techniques. These techniques will be explained briefly, followed by a description of the technique used in this study.

Structured interviews are fully controlled by the interviewer, who possesses all the power. This results in the interviewee having less room to be adaptable and casual (Stuckey, 2013). Due to the principles of a structured interview, Adhabi and Anozie (2017) claim it is evident that the interview environment is tense and can scare or unease participants, which may result in baseless responses. The nature of questions in a structured interview is short, and the participants are expected to respond similarly to short and straightforward answers. In conclusion, Adhabi and Anozie (2017) indicate that structured interviews are unfavourable for qualitative studies.

Contrary to structured interviews are unstructured interviews. Adhabi and Anozie (2017) explain that, based on the current understanding of research done previously, no interviews can be qualified as solely unstructured. However, some interviews have characteristics that make them seem unstructured. In some research topics, researchers have to become "one" with what they are studying – this enables them to observe the core participants and ask them informal questions while taking notes (Stuckey, 2013). According to Stuckey (2013), this form of an interview can be conceptualised as a type of unstructured interview. Adhabi and Anozie (2017) conclude that unstructured interviews can be considered as an imperative tool for qualitative data collection.

Concerning semi-structured interviews, Alshenqeeti (2014) points out that it is the most used qualitative data collection method. Semi-structured interviews, however, have some characteristics of structured interviews with regard to the questions being prepared by the researcher (Stuckey, 2013). In contrast to structured interviews, Stuckey (2013) explains that semi-structured interviews do not have the strict adherence as structured interviews have. The implementation of semi-structured interviews depends on the flow of the interview and how the interviewee responds to the questions and topics lodged by the researcher. Semi-structured interviews are most suitable in a qualitative study where the researcher is not attempting to test a specific hypothesis – as is the case with this study. This technique allows the researcher to ask additional or follow-up questions, if necessary (Harrel & Bradley, 2009). The objective of follow-up questions is to obtain a better comprehension of information obtained from the interviewees. In conclusion, semi-structured interviews are best used when the researcher – as

the interviewer – aims to delve deeper into a topic in order to gain a rigorous understanding of the answers provided to the questions (Harrel & Bradley, 2009).

This study employed semi-structured interviews with open-ended questions. The open-ended questions and the semi-structured nature were chosen to enable the interviewer to engage with follow-up questions in order to gather in-depth information about the participants' experiences. Some of the interviews were performed on a face-to-face basis, while other interviews were performed via an internet-based communications platform (due to COVID-19 regulations). All interviews were recorded by the researcher with the signed consent of the interviewees. The questions were developed considering some factors affecting the Namibian beef industry and supply chain, as well as considering some knowledge derived from the literature review (refer Chapter 2).

*3.5.3 **Data analysis***

Hatch (2002) defines data analysis in the research methodology as a systematic search for meaning. It is a method of refining qualitative data, which in turn enables the researcher to communicate that which has been learned to other people. It is argued, however, that data analysis is the most complex and least understood stage of a qualitative study, as well as the stage that receives the least attention when discussed in the literature (Thorne *et al*., 2000). There are different data analysis strategies – which are presented in Table 3-3.

Table 3-3: Data analysis strategies

Data analysis strategy	**Description**
Constant comparative analysis	This strategy consists of taking a single piece of data and comparing it to other pieces of data. An example can be to compare different interviews with one another to identify possible relationships. The comparison of data continues until all data has been compared to one another.
Phenomenological approaches	This strategy's focal point is not data comparison, but rather the in-depth

	experiences of the lives of the research participants. This method of analysis attempts to generate information out of data to help the reader understand the lived experiences of the research participants.
Ethnographic methods	The focus of ethnographic studies lies on the aspects of human experiences and the interpretation of cultural behaviour. Ethnographic analysis is therefore a repeating process, where cultural-based ideas discovered during fieldwork are transformed, translated and presented in a document. This process involves digging through datasets to identify any inconsistencies and contradictions in order to finally generate conclusions about the reason for the occurrence of certain events.
Narrative analysis and discourse analysis	This type of analysis illustrates how narratives by the research participants shed light on the experiences they lived. The analytic processes enable the researcher to identify the main narrative themes in the stories derived from the participants. Discourse analysis, on the other hand, focuses on how social relations between participants influence their behaviour and thoughts.

Source: Thorne *et al.* (2000)

This study will make use of a phenomenological approach with elements of a constant comparative analysis, due to the following reasons:

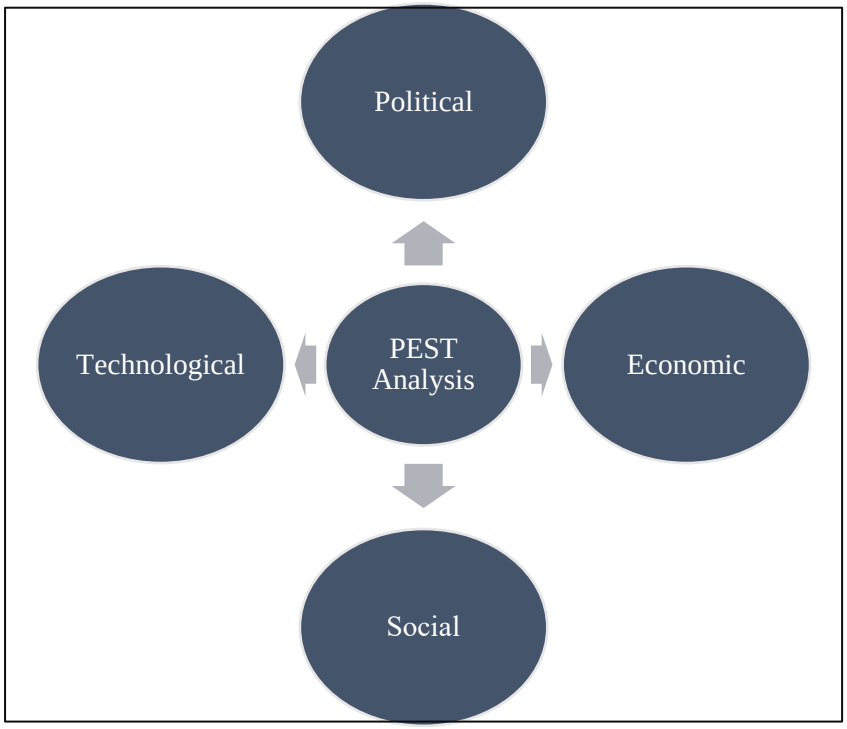
The constant comparative analysis will be used to compare the answers given by the different stakeholders of the Namibian beef supply chain during the interviews. However, the information will be mainly used to describe the experiences of the lives of the research participants. The researcher will attempt to generate information out of the interview data to help the reader understand the lived experiences of the research participants. The feedback from these interviews will be grouped in a Political-Economic-Social-Technological (PEST) analysis and a Strength-Weaknesses-Opportunities-Threats (SWOT) analysis. The suggestions made in these two analyses will be supported by quotations from the interviews in order to put the reader on a reading journey of the stakeholders' experiences. The PEST analysis is done to analyse the current external environment Namibia's beef supply chain finds itself in. The PEST analysis will be used to determine whether blockchain implementation can be adopted in Namibia's beef supply chain. The adoption criteria that are used were addressed in Chapter 2 (refer section 2.7, page 56).

Furthermore, the SWOT analysis of the current beef industry and supply chain will serve as a system description of Namibia's beef supply chain. This can be done because a study done by Diaconu and Alpopi (2014) also consisted of a SWOT analysis of a supply chain in general to analyse the system. Following this, by using the use-cases – from a Deloitte report (Dalton *et al.* 2018) of a blockchain-based supply chain system referred to in Chapter 2 (refer section 2.6, page 47), the researcher will attempt to capitalise on the mentioned strengths and opportunities, to address the weaknesses and threats, and finally to address the deficiencies mentioned in the PEST analysis. Performance measures addressed in a study conducted by Shukla et al. (2011) will be used to determine and conclude the improvement in Namibia's beef SCM due to a blockchain-based SCM system (refer Table 2-2, page 27).

3.5.3.1 PEST analysis

A PEST analysis is a tool that assists in analysing external factors affecting a business – or in the case of this study a supply chain (Alanzi, 2017). In a similar study by Vogel (2019), a PEST analysis was done to describe the external environment that an industry operates within. Figure 3-2 will illustrate a PEST analysis.

Figure 3-2: PEST analysis visual illustration



Source: Frue (2017)

The range of factors for each category will depend on the answers given by the research participants. These factors may include, but are not limited to the following:

- Political
    - Such as the tax policy of Namibia;
    - Government and political stability, and
    - Trading agreements between countries.
- Economic
    - Interest rates;
    - Exchange rates;
    - Inflation rates, and
    - Economic growth.
- Social
    - Living standards in Namibia, and
    - Namibia's beef consumers' taste preferences

- Technological
    - Current Namibian beef farming technological infrastructure;
    - Namibian beef supply chain technological innovations, and
    - The willingness of technological adoption of Namibian beef supply chain participants.

3.5.3.2 SWOT analysis

The SWOT analysis is a framework and analytical tool that can be used to identify an organisation's internal strengths and weaknesses or, as according to Diaconu and Alpopi (2014) that of a system, as well as the external opportunities it has and the threats it faces (Dyson, 2002; Pickton & Wright, 1998). Due to the qualitative nature of the data derived from the interviews, Brooks *et al.* (2014) motivate that a SWOT analysis is a popular tool for presenting qualitative data in a structured manner.

*3.5.4 **Methodological Rigour***

Methodological rigour is the responsibility of the researcher to guarantee that the relevant procedures have been followed to deliver dependable research results (Ćwiklicki & Urbaniak, 2018). For the purposes of qualitative studies, Golafshani (2003) articulates that the concepts for authentic data are trustworthiness, rigour and quality.

According to Bechoffer and Paterson (2000), validity has two types – namely internal and external validity. Internal validity is attributable to conclusions made from the research and is thus based on high-quality results. The more reliable the results are, the greater the chance is of identifying any differences in the collected data. In conclusion, internal validity is the accurate representation of the phenomena that are being studied (Ritchie & Lewis, 2003).

On the other hand, external validity is derived from the researcher's ability to generalise the findings from the data gathered in the study (Vogel, 2019). Tobin and Begley (2004) state that external validity aims to enable the researcher to conclude valid comparisons from the samples where data was gathered, as well as the population which supplied these samples.

In this study, all the interviewees were encouraged to share information on Namibia's beef supply chain and transparency, even if the interview questions did not necessarily attend to all

the information shared. This was done to ensure the requirements of methodological rigour as discussed above. Furthermore, all the interviews were audio-recorded to ensure that all the answers were recorded correctly. Interviews that were conducted with similar stakeholders consisted of the same questions – this was done to gain a different understanding of the same questions from the same type of stakeholders.

3.6 Ethics

Ethical norms and guidelines play an imperative role in conducting research. Firstly, these guidelines emphasise the ultimate goals of research – which is knowledge, truth and the prevention of errors. Additionally, research usually results in working with different individuals from different environments. The ethical guidelines stress the values that should be present when working with other people. These values include trust, accountability, fairness and respect for one another. Lastly, the ethical norms should ensure that the researcher can be held accountable in the unlikely event of conducting unethical research (Resnik, 2015).

To conclude, this study was approved by the North-West University's Ethics in Commerce Research Committee. The allocated ethical number is NWU-00791-20-A4 and the ethical clearance certificate can be found in Appendix 3. The ethical norms were upheld throughout the duration of this study. This was done by honouring the confidentiality agreements with all the research participants, by treating all the participants with the utmost respect, and lastly by complying with all relevant laws and regulations throughout the research process. One of the top priorities during the interviews was to ensure the safety and health of all participants concerning the COVID-19 pandemic. Chapter 1 (refer page 15) stated that all the health and safety considerations which the interviews had to adhere to, were stipulated and maintained.

3.7 Summary

This chapter attempted to find and present an appropriate research methodology to achieve the primary objective of this study, as set out in section 1.8.2 in Chapter 1 (refer page 10).1.8.2 Secondary objectives

Firstly, this chapter discussed the applicable research paradigm fundamental to this study, as well as the associated ontological and epistemological assumptions. The chosen paradigm is

interpretivism. Following this, the three main research approaches were discussed and resulted in this study following a qualitative research approach.

Purposive sampling was determined to be utilised to identify the stakeholders in the Namibian beef industry and supply chain. Furthermore, the data collection method was chosen, namely to consist of the conducting of semi-structured interviews with elements of open-ended questions.

The data analysis consisted of constant comparative analyses in which the feedback of the interviews was compared, grouped and composed in a PEST and SWOT analysis. The study adhered to standards of methodological rigour to assure the reliability and validity of the research.

In conclusion, ethical norms and guidelines have been addressed and followed to ensure that the objectives of this study are reached while maintaining sustainable relations with all research participants.

The following chapter will present the empirical findings of the research.

CHAPTER 4

4 Empirical research findings on Namibian beef supply chain

4.1 Introduction

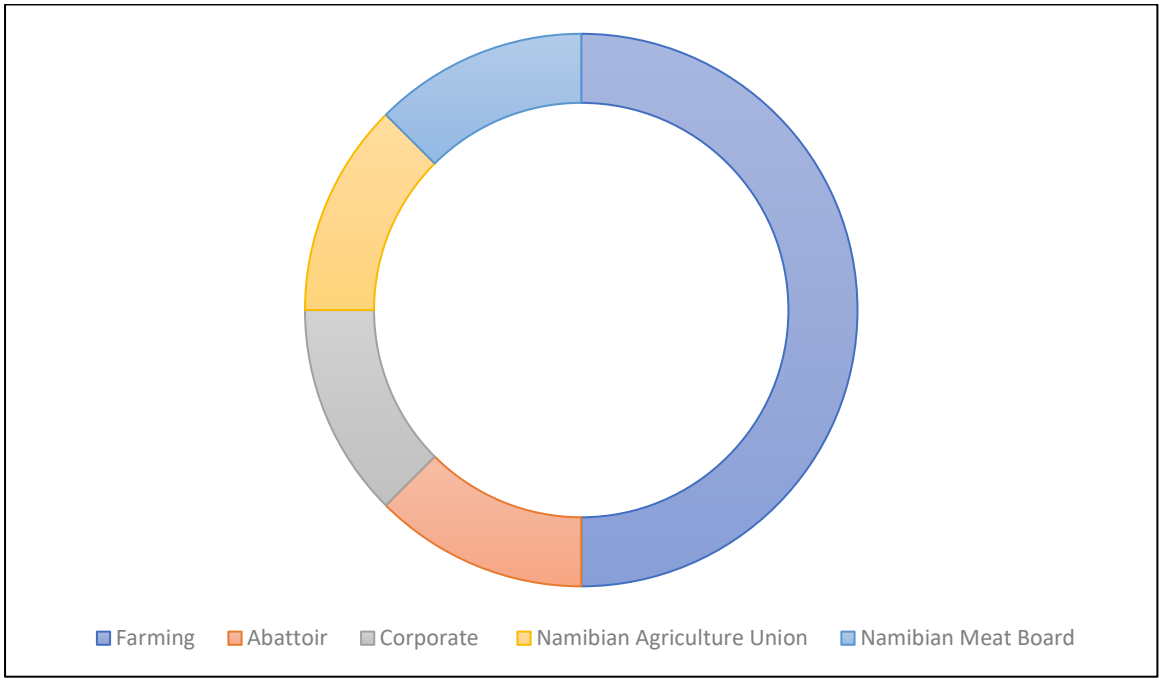
This chapter's objective is to address the third secondary objective, as stated in Chapter 1 (refer section 1.8.2., page 10). This secondary objective was to gather qualitative data from interviewees to explore the possible use of blockchain technology in Namibia's beef supply chain to enhance traceability and transparency. This chapter relates to the primary objective of the study which, as described in Chapter 1 (refer section 1.8.1, page 10), is to explore the possible use of blockchain in Namibia's beef supply chain to enhance traceability and transparency. This objective is divided into four separate components in this chapter. The first section after the introduction will give the reader general information about the participants and how they perceived the current transparency of the Namibian beef supply chain.

Firstly, the feedback of the empirical study will be grouped in a PEST analysis in order to describe the external environment that Namibia's beef supply chain finds itself in. In the succeeding part of this chapter, the results of the empirical study will be presented in a SWOT analysis in order to describe the internal strengths and weaknesses, and the external opportunities and threats that the Namibian beef supply chain faces. In the third part, the criteria stipulated in Chapter 2 (refer Table 2-6, page 56) will be applied to the interviewees' feedback in order to determine the need and possibility for the implementation of blockchain. Finally, the fourth part of Chapter 4 will make use of the use-cases, as described in Chapter 2 (refer section 2.6, page 47), in order to capitalise on the mentioned strengths and opportunities, to address the weaknesses and threats, and finally to address the deficiencies mentioned in the PEST analysis. This will in turn represent the effect that the possible use of blockchain will have on the Namibian beef supply chain. The chapter will eventually conclude by addressing the performance measures regarding Namibia's beef supply chain as stipulated in Table 2-2, Chapter 2 (refer page 27).

For the purpose of this study, similar interviews with open-ended questions were developed and utilised to gain insight into the Namibian beef supply chain. The interviews were developed and directed after the literature review in Chapter 2 had been performed. These interviews were directed in a semi-structured fashion to eight stakeholders in the Namibian beef supply chain.

The members were four farmers, of whom one is a chartered accountant, one abattoir representative, one corporate member, one Namibian Agricultural Union (NAU) representative and one Namibian Meat Board representative. As indicated in Figure 4-1, these eight stakeholders provided a wide representation of the Namibian beef industry and supply chain.

Figure 4-1: Namibian beef supply chain members interviewed



Source: Own research

The interviews directed to these participants, as presented in Figure 4-1, consisted of three separate sections. The first section was very particular to the type of stakeholder – whether it was the farmers (who were often referred to as the producer), the corporate members, or the NAU representative. The first section aimed to establish whether these stakeholders had an idea of what transparency in a supply chain means, and whether a transparent supply chain would be beneficial or not. Furthermore, in this section each stakeholder was asked what their role was in the Namibian beef supply chain to allow the researcher to determine whether they would be able to increase supply chain transparency.

The second section of the interview focused on the strengths, weaknesses, opportunities, and threats that the Namibian beef supply chain finds itself in. The objective of this section was to gain a first-hand understanding of Namibia's beef industry's strengths and weaknesses, but also the opportunities that exist and the threats that limit a prospering beef supply chain.

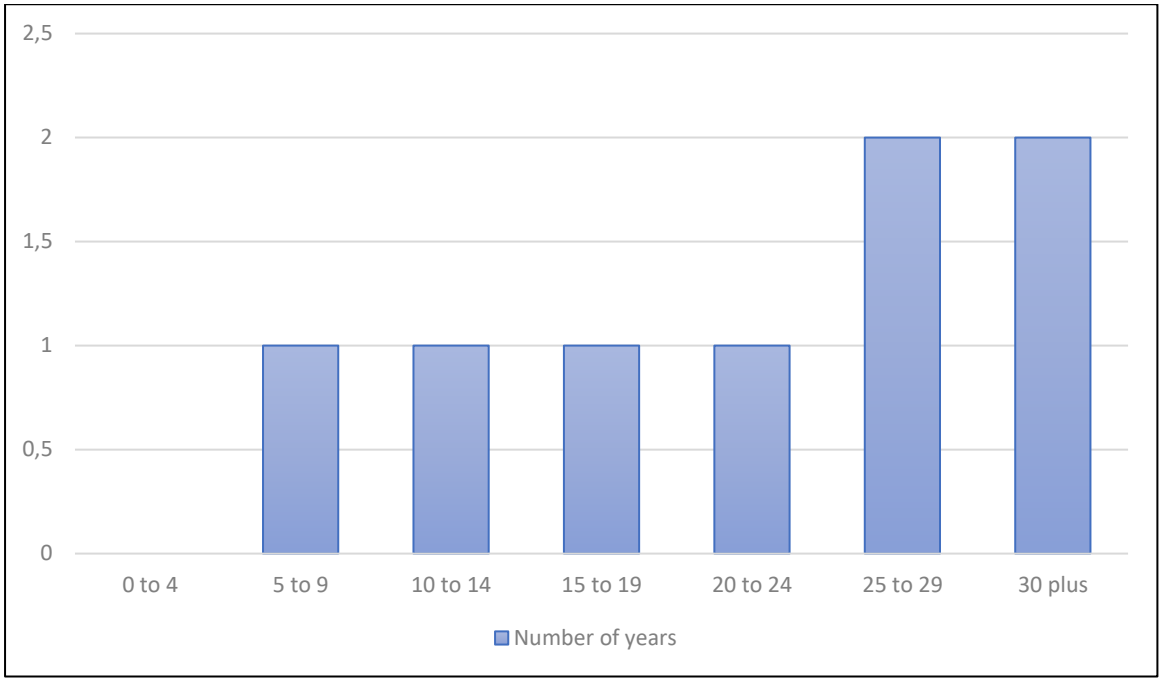
The third section of the interview required interviewees to give their opinions about the external factors that influence the prosperity of the Namibian beef industry and supply chain. These factors were categorised into political, economic, social and technological factors. The feedback of this section is discussed in the PEST analysis later in the chapter.

In the succeeding sections of this chapter, the findings obtained from the interviews will be discussed.

4.2 General information on the participants

As stated in the introduction of this chapter, the first section of the interview aimed to determine the experience of the stakeholders' engagement in the Namibian beef industry, as well as whether these stakeholders had an idea of what transparency in a supply chain means, and whether a transparent supply chain would be beneficial or not. Whether these stakeholders had sufficient experience, was determined by asking them how long they have been part of the Namibian beef industry – either how long they have been farming, or how long they have served as a corporate or board member. All of the participants resided in Namibia, and the chosen participants were also culturally diversified. It was reassuring to find that the average number of years of industry experience reported was 21 years, with the most years being 32 years of experience and the least being 9 years. Figure 4-2 illustrates the number of years of experience of the participants in the Namibian beef industry.

Figure 4-2: Years of industry experience



Source: Own research

From Figure 4-2, it can be regarded that the number of years of experience in the Namibian beef industry can be regarded as adequate, seeing that the average years of experience exceeds 20 years. The second part of this section of the interviews focussed on the participants' perception of supply chain transparency and traceability.

4.3 Transparency and traceability

The second part of the first section requested the participants to give their idea about the phenomenon of supply chain transparency and traceability. When listening to their answers, it seemed as if they had a general idea of what transparency in a supply chain means. They tended to combine the terms transparency and traceability. It was stated by a representative of the Namibian Meat Board that traceability is actually Namibia's international trademark. Three of the participants' answers on what transparency comprises, were the following:

> *"Good traceability will give you good transparency. In my opinion, good traceability in the meat industry is like the following. If something goes wrong with the final product, you want to be able to trace backward until the point of the fault's origin."*

"… basically, the supply chain begins with me at the farm when my cattle are loaded to Company A's abattoirs. A transparent supply chain will allow a farmer to have access to the quality-assessment of their beef. We as farmers sometimes receive a B-grade meat for what we regard as A-grade. Thus, for me, supply chain transparency will be enhanced if we have access to how Company A value our beef's quality to determine whether it is A-grade, B-grade, or C-grade."

"The first part of transparency is that the producers should be able to know and verify what price Company A receives on an international level when exporting a carcass. For instance, say the high-grade meat goes to Norway, the bones go to China, and the front-quart meat-cuts go the South-Africa. This total income that Company A receives per carcass, should be shared and communicated to all the producers continuously and regularly…The third part is to communicate a benchmark to the producers. For instance, the international benchmark to process a carcass is N$ 20, whereas Company A's cost is N$ 50 – then Company A should communicate this to the producers as well the plans are taken to bring down the N$ 50 to the N$ 20."

Taking these answers into account, the participants' answers linked well to the definition of transparency discussed in Chapter 2 (refer section 2.4.2, page 30) – emphasising the sharing and communication of vital information. Especially from the farmers and the NAU representative, it could be heard from the excitement in their voices that a potential increase in transparency could be beneficial to the producers' side of the supply chain. The researcher also determined that there was a need for transparency in the local beef supply chain – especially downwards to the producers. The participants made it clear that increased transparency would build the trust that the farmers put into the abattoirs and the state. This statement is supported by the following quote from the NAU representative.

"This transparency should, and will, create trust between the producers and Company A, which will motivate the producers to rather keep their cattle 2 years longer and deliver it to Company A than to sell it as a weaner-calf to South-Africa or another supply chain."

However, when asked about the supply chain relationships and trustworthiness thereof, the researcher got mixed responses. Four participants stated that the relationships lacked complete

trust and described it as “fragmented” or “worsening” – as explained by the following responses:

> *“In the past, Company A cared so much for the producers as if they were Company A’s employees, however, fast forward to now – all the loyalty and trust have been thrown out of the window. The trust relationship has crumbled down.”*

> *“Between 2012 and 2019 there has been a breach of trust between producers and Company A, when the directors appointed did not reflect the democratic will of the members.”*

One response, however, claimed that despite the diverse range of supply chain role-players, there are some positivity in it. This participant said that all of these role-players are all coordinated under one roof called the Namibian Meat Board. Given its legal mandate, it aims to help all kinds of stakeholders within the industry to build proper relationships. Supporting this, three participants described the relationships as “sustainable” and “open”, which is in total contradiction to the statements above. The answers regarding good relationships were as follows:

> *“Really good, because we work from the same system and it is a national system.”*

> *“… in the past years the service of Company A took a turn in a positive direction and I believe we have very sustainable relationships with them.”*

As mentioned in Chapter 2 (refer section 2.3.3, page 24), the mission of aligning incentives and objectives along a supply chain is considered very difficult, particularly when the supply chain is made up of different members. This “theory” was supported by one of the respondents who claimed that the complexity and the high number of supply chain players cause obstacles to obtaining supply chain efficiency and trust. However, different respondents from various levels of the supply chain agreed that the whole Namibian beef supply chain has a shared vision and strategy. The Namibian Agricultural Union deems it to be their responsibility to represent all the producers over Namibia and to implement strategies to improve the environment and welfare of Namibian producers. These strategies include sustainable farming, life- and leadership-coaching, and a realisation of synergy between the various beef supply chain players.

When asked about whether the Namibian beef industry has a shared objective, a corporate representative responded with the following answer:

> "*Yes, we do, all the different supply chain players deem it important to practice regenerative agricultural practices that lead in increased sustainability of farming which in turn allows us, as the exporter, to penetrate niche markets overseas."*

In another part of the first section, the researcher asked the interviewees whether a transparent and traceable supply chain would be beneficial to the Namibian supply chain as a whole, but also to each participant's specific role. Furthermore, the current transparency was queried. These responses are grouped in two parts – 1) the manufacturing and exportation of beef (Company A), and 2) the farming with cattle (the producers).

4.3.1 ***Company A***

It seems that the corporate representative of Company A deemed a traceable and transparent system to be equally important. It is possible that with a completely traceable and transparent system, the efficiency of the whole processing and exporting process will be increased. The participant was of the opinion that if something goes wrong with the end product, the consumer, as well as Company A, would be able to track the origin and all the processes of the particular cut.

> *"For instance, in the market, somebody determines that the meat contains a certain hormone. You should then be able to track via the batch's carton's ID number back to the production batch, then from the batch to the manufacturer who processed this batch."*

A corporate representative also stated that 99% of international consumers deem 100% certainty about Namibian beef's provenance. Therefore, the branding and certification of beef should be verifiable and trusted. If a supply chain as a system that conducts a brand's journey from a certified farm up to the consumer, Namibia will be able, according to the participants, to penetrate overseas niche markets which will be very beneficial for Namibia as a country, but also for the producers, because they will be able to receive a premium price. This concept is supported by the following two quotations of different participants:

"Yes, it will be very promising. If you look out of the point of brand naming beef, you'll need to be able to verify and support all the claims made in the brand description of the beef. And that will be promising. It will be even more promising if the consumer can trace the particular cut to the cow and the cow's story."

"If we can create a certification model or system that certifies that beef is produced under regenerative agriculture or on an organic basis, we will be able to penetrate niche markets. The certified producers and farmers, will then be able to receive a premium price for their cattle. This opportunity has the potential to build on our current strengths."

It seemed that the possibility of introducing a transparent and traceability system on consumer-level excited the corporate representatives – due to their usage of words such as "promising", "excellent", and "market-penetration". The researcher also felt an urge of excitement when engaging in conversation and hearing the tones of their responses.

However, when a question about the current upward and downward transparency and traceability was asked, it was understood by the researcher that there was a type of centralised national traceability system – which will be explained in section 4.4.4, but which could not be accessed by a consumer. This particular representative did not comment on downward transparency.

4.3.2 ***Producers (the farmers)***

The farmers expressed the need for transparency especially from the side of Company A and that of the government. The farmers felt that they did not have unlimited access to vital information that could benefit their farming practices. They felt, for instance, that if Company A could let them access the meat quality assessment criteria, it would allow farmers to adjust their farming practices in order to deliver higher-quality beef and in turn to receive a better price for it. This is explained by the following response of one of the interviewees:

"*It will be very beneficial. For instance, if I know that my cattle are degraded from an A to a B due to reasons "XYZ" that is under my control – such as body fat percentage, I can adjust these factors in my farming process to farm more efficient. Thus, if I am certain that I am selling A-grade cattle, and I receive an A-grade assessment, I can*

budget more accurately because of the 8-10 dollar per kilogram difference between A grade and B grade beef."

"Yes certainly. The information flow in a supply chain will help the farmer to do more calculated decisions in order to sell his or her cattle."

Furthermore, the participants explained in this part of the interview that increased downward transparency will not only benefit the cattle producers, but it will also be beneficial for Company A, hence the export market. One respondent claimed that if Company A communicated in a transparent and verifiable manner with the farmers, the farmers will perceive this communication as a "commitment" from Company A's side. The respondent further articulated that this commitment would build trust in Company A and the export market from the producer's side, which would result in the different supply chain actors collaborating in synergy. However, the respondent used the word "saddening" when revealing that the current lack of transparency is causing more farmers to move away from the export supply chain and moving towards the weaner-calf supply chain which is, in fact, damaging to the Namibian economy on a smaller scale.

Another participant said that in terms of information-flow, the producers felt "left in the dark". When the researcher requested this participant to elaborate on this, the participant responded as follows:

"*Yes, this refers back to the transparency. For instance, I sell my cattle to Company A for say about N$40 per kg. We are totally unaware of the profit margins added to the beef in the supply chain. Although me as a charted accountant are aware of the manufacturing costs and overheads allocated to the beef, my big problem is that we sell the whole ox for N$40 per kg, but the for example the T-bone in sold to the retailer by Company A for N$100 per kilogram. Thus, we have zero visibility where the value is added. And a major part for me is the waste-products of cattle like tongue and oxtail being sold for over N$110 per kg, but we are not compensated for that.*

A lot of us farmers feel like this. We really want to know how does the value-adding in the supply chain work. I remember a during an auction, a representative responded to this and only said that the farmers should be happy with the prices. To summarise it, we just want clarity on Company A's value-adding and profit margins."

The researcher got a similar response from the NAU representative. However, this participant acknowledged that some of this information is communicated yearly in an annual report, but that it is usually unclear and difficult to understand.

Another participant responded in a quite furious manner when the topic of information sharing came forward. This participant used the words "fighting with Company A" when he/she expressed his/her feelings. This participant explained his/anger by emphasising how the ever-changing demands from Company A towards the producers were disarranging the planning of their farming operations. This participant explained it as follows:

> *"Sometimes they want 'store' for the feedlot and motivates all producers to produce 'store', and then when this demand is met, they suddenly close the feedlot and demand heavy-oxen. Then they chop and change again by demanding A-grade meat, and then they change it to B-grade meat. So then everything is one big mess – because we as producers cannot plan our production lines. Due to this chopping and changing and unstable policies, the whole national herd structure have changed. If we could know what they want!"*

A "stoor" (plural "store") is an ox or a cow that is younger than an ox that can be slaughtered, but older than a weaner-calf. Normally, "store" is kept in a feedlot until it becomes eligible to be slaughtered. This participant said that the unpredictability of the policies and demands up in the supply chain is motivating more producers to move away from the slaughter beef supply chain and moving towards the weaner-calf supply chain.

The next section will dive deeper into the participants' experience on how different external factors influence the Namibian beef industry and the environment in which it operates.

4.4 PEST Analysis

The second part of the interview focused on how the different participants perceived the external factors that influence a macro-environment. These factors are grouped in political, economic, social and technological environments. The reason for including a PEST analysis was to analyse the macro environment in which the Namibian beef supply chain operates, and in turn, to determine how high the need is for chain transparency and meat traceability. The

responses of the participants are grouped in different themes that are supported by a discussion and quotations.

4.4.1 ***Political environment***

All the research participants were in strong agreement that the Namibian political environment affects and has the potential to affect the beef supply chain drastically. However, some of the participants (3 out of 8) argued that the peaceful political environment allows good relationships between the government and the stakeholders.

- Political interference:

This factor was brought in mainly because the only Namibian exporter is a state-owned enterprise. Therefore, this enterprise, according to some of the respondents, is used as a vehicle for political interference in the Namibian beef supply chain and industry.

> *"There is a lot of political interference that breaks the trust in the supply chain. The interference is done in such a fashion where certain ministers are appointing directors of Company A which does not reflect the democratic will of the members."*

> *"Another effect of the political environment is the fact that Company A is a SOE, which in turn creates its own political interference and sometimes straining the chain-transparency that can be achieved."*

- Land ownership:

Three out of eight participants referred to the uncertainty of land-ownership-policies which demotivate farmers to invest in their farms' infrastructure - mainly so because once a farmer wants to sell his/her farm, he/she first needs to present it and make an offer to the government, thus lowering the chances to get a reasonable price for the improved farm.

> ***"****On the one hand, it hinders the growth of farms because farmers are sceptic to expand their infrastructure or invest into their farm because of the fear that they are going to have to give up the farm to the government. This also hinders foreign investment into Namibian farms."*

"The government should give producers policy-certainty about economic growth and land-ownership. If producers have this certainty, they will commit further to investing in their own farms' infrastructure and expanding their own capacity. But if they have any doubt in the future, they are hesitant to invest in their own land."

- Peaceful political environment:

According to some respondents, the Namibian political environment and the beef industry work hand-in-hand in a way that constitutes effective dialogue. This also includes that the international trade agreements are made for the benefit of all private-sector and public sector producers.

> ***"****The fact that we live in a peaceful environment and not in fear as in our neighbouring country. As well as the fact that industry members can communicate with political leaders, even if they don't sit around the same table."*
>
> *"When it comes to international trade-agreements, we are really satisfied in a sense that the ministry of trade has opened the door to international trading to private sectors. Given our other trade agreements, we have preferential market access to all of these countries of not paying any levies and so-on. This really helps us to put us into a better decision."*

- The Namibian beef industry is at the mercy of political decisions:

During the interviews, the researcher noted that a majority of the participants said that the government either makes the meat industry, or breaks it. Some participants referred to an example where political decisions had led to the sheep industry's downfall, while others used words such as "bringing an industry down to its knees".

> *"I feel that because Company A is an SOE, the political interference can threaten the bargaining power of us farmers. We should only feel happy with the prices they offer us. Due to them negotiating on our behalf in the EU markets, we have no bargaining power of whatsoever."*

"If I can use a classical example of how the political environment can impact the agricultural industry, is the sheep scheme that we were having that brought the sheep industry down to their knees, that lead to the sheep industry slowly dying. Thus, it can be said that all the stakeholders are at the mercy of political decisions – they can make or break the industry."

Another participant added that a huge concern could be that the success of the beef export's supply chain is heavily dependent on the government's veterinarian department. This is because they are the competent authority who should sign off all beef export approvals. Their critical responsibilities also include inspecting the farms, abattoirs and borders for export-standard compliance. If the quality of these inspections is decreasing, the export countries increase the quality requirements, and that leads to Namibia not maintaining a certain degree of compliance. This, in turn, jeopardises Namibia's international marketing-status. Another participant mentioned this in an interview and concluded with the word "sadly" when he/she acknowledged the fact that the competent authority's competence was under huge doubt.

*4.4.2 **Economic environment***

The economic environment has a tremendous impact on the Namibian beef industry – but it also goes deeper than just the industry. Conventionally, the economic environment does not only impact the exporter and the producer, but rather goes beyond this to the livelihoods of the farmers, their workers and the economic environment of the countryside. The different themes and the discussions of the effect of the economic environment are presented below.

- Dependency on international economies:

Namibia, being a net exporter of beef, is heavily dependent on the prosperity of the export markets' economies. The participants who addressed this (five out of eight), used the words "at their mercy" when asked about the effect of the international markets. The explanation for this statement goes down to the fact that beef is a sought-after product in Namibia's export markets. Therefore, if the export markets' economies take a blow, this affects the quantity of beef being exported, as well as the prices that Namibia receives for these products.

"You know, Namibia is a net exporter of beef. As a result, we are at the mercy of international markets, so anything that is going on in the international markets has a direct effect on the Namibian meat industry. Let's say the economy in the EU countries are not well performing due to the pandemic, this will have its toll on us because it affects the price of the products."

"The issue with the economy is that Namibia's economy is so small to such an extent that when something happens towards the South African economy, then Namibia's economy is influenced – and we see that in the input costs of the abattoir, but as well as the prices we pay to the farmers."

- Foreign exchange rates:

Currency exchange rates, however, only impact the exporter - which is Company A. Due to the weak Namibian Dollar (NAD), which is 1:1 to the South-African Rand (ZAR), the corporate participants see it as an opportunity for exchange gains. This reflects the attitude of the Namibians in general where they make the most of a disadvantaged situation.

"Due to Namibia being an exporter of beef, the exchange rates are a positive affecting-factor for us because of our weak currency. We tend to invoice the importers in their currency, and we use hedging contracts to our favour."

The farmers, on the other hand, have other currency exchange rate experiences. They feel because the NAD is directly linked to the ZAR, they as importers from South-Africa absorb all the political drama when the ZAR weakens.

"We are not affected that much by exchange rates because we do not export and only imports from South-Africa (1:1 currency). However, South-Africa's economy affects us when the Rand weakens, our products are getting more expensive because we absorb all the costs on our side."

- The beef industry also affects the local economy:

Currently there is a concern in Namibia about the survival of the economic development, and the survival of the countryside towns due to the migration of younger people to the bigger cities

such as Windhoek. One participant claimed that a bigger cattle farming industry will employ increased spending in a farmer's own economy, either by paying Namibian labourers or by buying Namibian products.

> *"… in turn, this will strengthen the countryside's economy that will in turn decrease the migration of young farmers or labours from the countryside to the cities."*

- Financing:

When focussing on the producers, it is important to note that the revenue system is periodic in nature, which results in them not having a consistent monthly income. In turn, this has an effect on the working capital of farmers who do not necessarily plan and budget effectively. As a result, farmers mostly use overdraft facilities to facilitate their operational activities.

> *"The effect of interest rates on debt has an effect on farming financing in order to carry out all operations and input costs."*

It is important to note that two of the eight participants placed emphasis on the job creation effect of the agriculture sector in Namibia, but also emphasised the potential effect that a weakened economy can have on decreasing job security in the sectors. Based on these responses of the interviewees, it can be concluded that the economic environment can have a tremendous effect on the Namibian beef industry, but in turn that the Namibian beef export supply chain and industry can have tremendous effects on the growth of the Namibian economy.

4.4.3 ***Social environment***

In the context of this study, the social environment refers to the external factors presented by the consumers' preferences in the export markets, as well as to the demographic trends and welfare of the local population. Although numerous social factors are affecting all industries, the participants struggled to grasp this section of the interview. The majority of the participants (six out of eight) addressed the fact that the consumers' preferences impact and shape the beef industry, whilst three participants addressed the demographic trends and relationships. This will respectively be discussed in the succeeding paragraphs.

It is evident from the responses (five out of eight) that the way the consumers in the international markets view and prefer Namibian beef, is shaping the way in which the producers are farming. Some of the responses were as follows:

> *"In regards to consumer preferences, the export beef's consumers have different standards that the beef should adhere to, thus we as farmers should adjust and form our farming practices to align with these preferences."*

> *"The consumer preferences have a huge effect on us. If we do not adhere to these preferences, we cannot engage into that market. The market is currently being affected by different brands and niche markets."*

> *"… we should adapt in the same manner as our consumers evolve."*

Two participants said that they need to comply with these international standards, causing the farming costs to increase extensively, and if a farmer does not get a premium price for his/her beef, the adherence to these standards is not worth it.

Despite being the only African country to export beef to the EU, Norway and the USA, it can be regarded as a challenge. One participant said that the fact that the preferences overseas are very specific, it is increasing the difficulty-factor to farm inside the allowed regulations in an environmentally challenging country. This specific participant used the words "jealous" and "envy" when he/she compared the drought years in Namibia with those in South-Africa, especially in terms of what is allowed in South-Africa versus what is prohibited in Namibia. Quotations that support this is presented below:

> *"We have strict regulations we should adhere to in order to be able to sell cattle to an export-abattoir. This makes it sometimes challenging to farm – especially in drought years."*

> *"The farming practices we need to employ, causes our beef to be expensive compared to beef from South-Africa who do not have to comply to these standards. Thus, it is difficult to compete in South-Africa because they can have a cost leadership competitive advantage."*

When the participants addressed the demographic trends and welfare of the country, the researcher got the following responses:

> *"The Namibian beef social environment is very stable. In most cases, farmers and their labourers are living together in harmony."*

> *"There are different cultures in Namibia who farm. This stretches from Germans to Afrikaners to Hereros and Damaras. All these cultures are traditionally Namibian cattle farmers and are very experienced."*

One participant, however, sketched a different picture. He/she referred to the red-line in Namibia representing a figurative dividing line that creates political sensitivity between those who farm north of the line versus those who farm south of it.

Lastly, one of the participants integrated the welfare of all the stakeholders with the consumers' preferences. This binds well with the need of chain-wide transparency in order to penetrate international markets. This participant said that he/she believed everything evolves around the social element of human (and animal) welfare and the verifiability of it. The response further stated that the beef supply chain should not solely be just about putting a product on the consumer-plate. It needs to be made clear that each product has ethical and social dynamics attached to it, which actually boils down to how that product came down to where it is at the end. The following quotation is an example that this participant used to explain the above-mentioned statement:

> *"Examples include to how that particular product was raised on a particular farm as well as to how was the environment at that farm in terms of labour-welfare and fair-trade. It is important to note and to remember that the people who buy this product is interested in all of this information."*

These responses suggest that the main impact of the social environment is how consumers' preferences have the ability to shape the farming industry in terms of unique selling propositions (USPs) such as organic, free-range, hormone-free and fair-trade verifiability. All of these USPs refer to the need for chain-wide transparency and traceability.

*4.4.4 **Technology environment***

Technology plays a revolutionary role in the cattle farming industry as well as in the export beef supply chain. With the adoption of innovative technology, innovation can be realised which in turn allows an industry, or a supply chain, to grow, to operate more efficiently and to gain a competitive advantage. Kim-Keung Ho (2014) explains that the technological environment includes factors such as technological activities, infrastructure, incentives to use technology and technological changes.

Given that this study explores the usage of blockchain in Namibia's beef supply chain, it is critical to determine the level of the current technological activities, the current technological infrastructure, and the willingness of stakeholders to use and adopt technology. These three factors will be discussed hereafter, supported by the participants' feedback.

- *Current technological activities:*

Namibia's beef industry praises itself for its national traceability ear-tag system. This centralised system is owned by the Minister of Agriculture, whilst implemented and maintained by the Namibian Meat Board and state veterinary. Each calf born should receive an ear-tag with an RFID-chip that stores the identity of each particular calf. The calf's identity is in turn stored on the centralised database. This database can be used by registered farms (called FAMNEAT registered) to manage their cattle electronically by applying for transport permits online instead of travelling all the way to Windhoek to do the process manually.

This system is used by Company A and the relevant authorities to verify that certain criteria have been met before a certain cow or ox is received and slaughtered by an abattoir. The following quotation is that of a representative from an abattoir to explain it:

> *"Each cow has two ear-tags – one is an RFID chip and the other one is just a scannable code. They control this system up until the point when the cattle arrive at Company A…Take this for instance. The producer has certain standards to which it should adhere to which includes that the cattle should be FANMEAT registered and should be 40 days on a farm before advertising it to an export-abattoir. Typically, a calf gets born and the calf should get an ear-tag before six months. This calf and cattle can only be advertised*

to an export abattoir when the cattle have an ear-tag as well as it was 40 days on a farm before advertisement. Thus, the veterinarians verify on the system whether the cattle were 40 days on the same farm before sell-date. If the cattle are sold, the ownership also changes to the system…When the cattle arrive at Company A/export abattoir, the authority then verifies again the standards of the cattle by reading their ear tags manually into the system… When the cattle arrive at Company A, the cattle walk through a scanner that identifies the RFID and verifies it to the system. Discrepancies are flagged then. This report is printed out and then compared to the report the farmer has brought. After the comparison, the farmer and veterinarian both sign the document."

All of the other participants mentioned the national traceability when asked about the technological environment. The representatives praised the efficiency of the system, as quoted below:

"*Currently the ear-tag system which is driven by the minister of agriculture is really beneficial. We have the ability to apply and receive a permit for your cattle online to transport the cattle."*

"Well, we are not bragging, but we are the only country in Africa that uses this ear-tag traceability system. Of course, I cannot sit here and brag to say the system 100% percent. No system is. Every system has its own challenges. But of course, we are at the point where we can say we can confidently present our traceability system to the rest of the world."

"I think some of the producers are considerably more progressed than we think, given their use of the database and traceability system."

- *Current technological infrastructure:*

The installation of the national ear-tag system has set the playing ground for numerous technological uses. The current infrastructure includes the usage of RFID-tags, scanners and databases.

Although the infrastructure sounds promising, there are limitations. One farmer representative said that the usage of the national databases is restricted by cellular network coverage on large farms. However, contrary to this, another participant said that the farming community is pleased by the fact that large telecommunication companies invest heavily in cellular network infrastructure to expand network coverage on farms.

On the downside, the survival of the infrastructure that the national traceability system is built on, is under doubt. When the researcher asked the participant who made this suggestion to elaborate, the participant responded as follows:

> *"However due the national ear-tag system belonging to the government, uncertainty remains on the sustainability and innovation due to decreased governmental spending."*

Therefore, it is difficult to implement new technological infrastructure without the assistance or the collaboration of all stakeholders. The Namibian Meat Board invests in and attempts the maintenance of the technological infrastructures with the proceeds of meat-levies.

- *Willingness to use and adopt technology*

As mentioned in Chapter 2 (refer Figure 2-9, page 55), barriers with regard to blockchain implementation can be applied to technological adoption. These barriers include the difficulty to change organisational cultures, cultural differences between supply chain partners, and generation gaps between role-players.

The participants mentioned some of these barriers when they addressed the adoption of new technology. The general idea that the researcher got was that the cattle farming industry does not accept technological change in the farming sector. This suggestion is supported by the following quotations:

> *"Currently, farmers can get a scanner which can be used to scan beef when they transport the beef. This automatically updates the farmers' registry of cattle, but most farmers still do this by hand and is a very manual process. A lot of farmers are not willing to adopt technology and are trapped in their past-ways."*

"I have to say, there are two generations of farmers. The older generation and the younger generations. The young generations are really willing to use and experiments with technology, while the older generation do not want to use it although it helps."

"Wow, it is shocking to see how many farmers are willing to adopt and adapt to new technology. I am a specialist in the feeding of cattle, and when I propose new technology to cattle farmers that minimises their feeding costs, they are not willing to adopt it – maybe 10% will be interested."

However, a representative from the Meat Board acknowledged the fact that, in order to move forward, one needs to adopt and utilise new and innovative technology. This representative said:

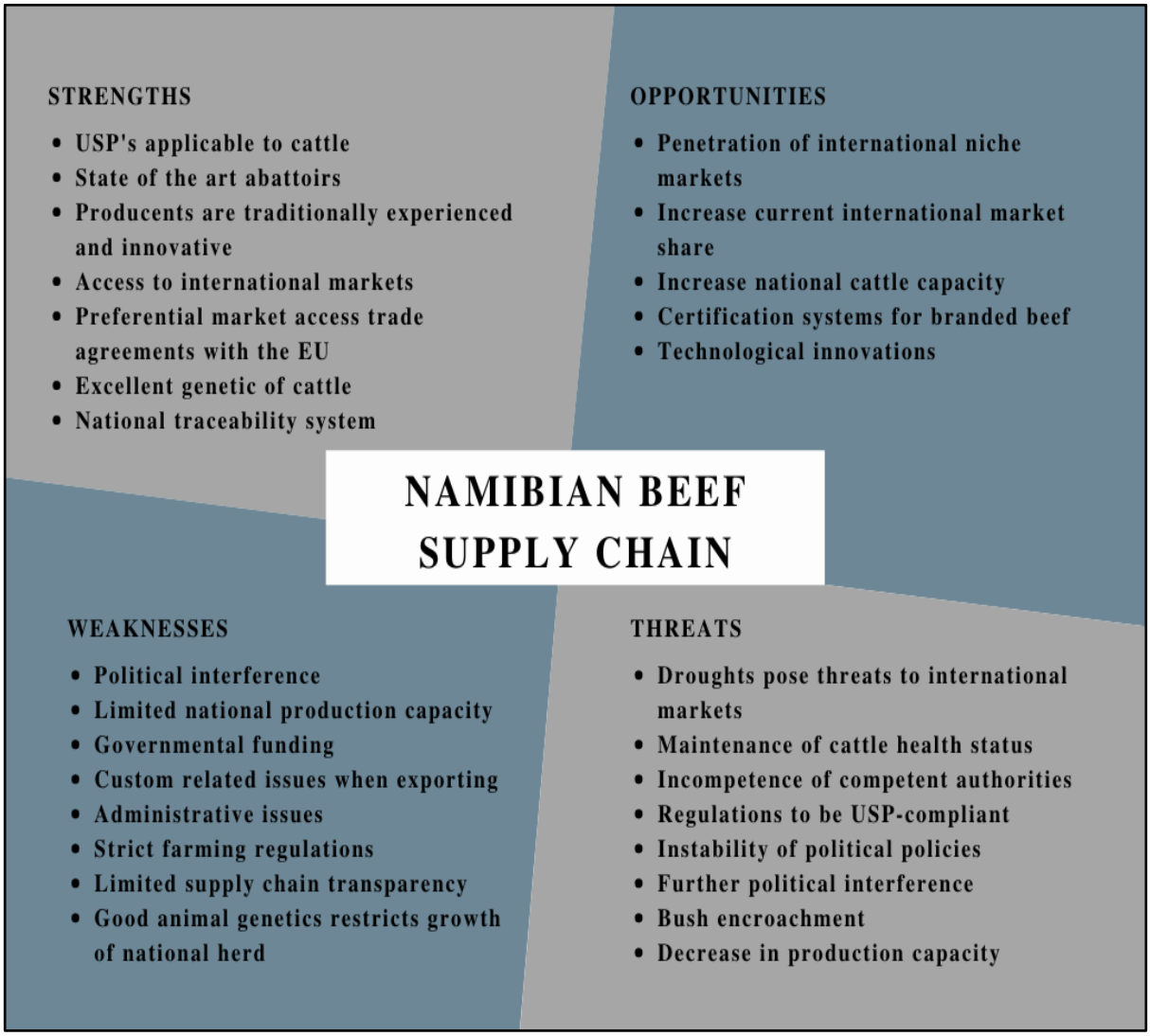
"The use of technology is always a challenge to the old-school farmers or the older generation. The current world we are living in now requires to adopt new technology in order to move forward."

As stipulated in the introduction of this chapter, the following section will describe the internal strengths and weaknesses as well as the external opportunities and threats of the Namibian beef supply chain as perceived by the participants.

4.5 SWOT analysis

The last part of the interview focussed on the participants' perceptions of the internal strengths and weaknesses, and the external opportunities and threats of the Namibian beef industry and supply chain. Figure 4-3 will present a summary of the strengths, weaknesses, opportunities and threats as mentioned by the participants. This will be followed by a discussion of each component of the SWOT analysis.

Figure 4-3: Summary of SWOT analysis



Source: Own research

As posed in Figure 4-3, the participants mentioned a wide range of elements in each matrix of the SWOT analyses. It is important to note that the responses received from the participants concerning the SWOT analysis of the Namibian beef supply chain are diverse and broad, due

to the fact that these participants represent different stages in the supply chain. All four of these matrixes will be discussed respectively in the succeeding paragraphs.

4.5.1 ***Strengths***

In the context of a SWOT analysis, strengths refer to a specific competence, resource or attribute an industry can utilise to make the best of opportunities that exist within an external environment (Capon & Disbury, 2003).

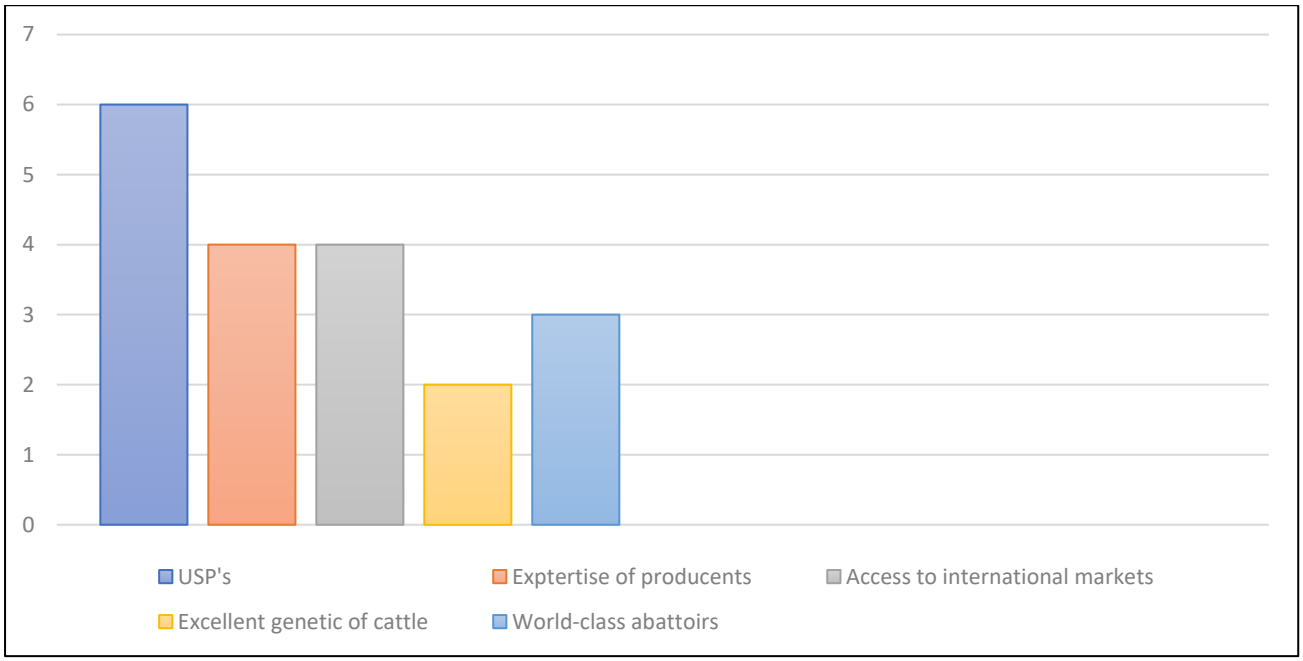
This study's research participants were asked to comment on the Namibian beef supply chain's strengths. Six out of eight responses agreed with one another by claiming that a huge strength which the Namibian beef industry and supply chain holds, is the fact that all of the Namibian beef has several unique selling propositions (USPs). These USPs refer to the beef being organic and free-range, which refers to cattle which roam in open pastures, which are not treated with any antibiotics or growth-hormones, and do not receive any animal by-products such as bone-meal. Four of these participants said that this strength goes hand-in-hand with the fact that Namibia is the only African country that has (preferential) access to international meat markets such as the EU, USA, Norway and China. Preferential market access refers to Namibia not required to pay foreign duties and levies while enjoying quota-free access to these markets. These attributes can be marketed to these markets in order to receive a premium price.

> *"I think the most important strength is that we deliver organically produced beef. Complimentary to this, another strength is that we have access to large global markets in the world – for instance, we have a quota from Norway who is a country that pays one of the highest prices in the world for beef. We also have duty free and quota-free access to the whole European Union. And recently, we gained access to the Chinese and American markets."*

Other strengths which were outlined by the participants included expertise and knowledge of the Namibian producers and abattoirs (four out of eight); high-quality and sought-after cattle genetics (two out of eight), and Namibia having state of the art abattoirs (three out of eight). One of the participants alluded to the culturally diverse range of cattle farmers in Namibia (Afrikaners, Germans, Englishmen, Damaras, Herero's and Namas) who are traditionally good livestock farmers. This is regarded as a strength because the expertise in the different cultures

results in mutual respect, which in turn opens the door for synergy. Figure 4-4 illustrates how much several strengths were in agreement with one another considering the participants' responses.

Figure 4-4: Strengths of the Namibian beef supply chain



Source: Own research

It should be noted that Figure 4-4 does not represent all the strengths. One of the participants made an ironic statement by saying:

> *"Funny enough, the export to Europe can be considered as a strength and a weakness. The weakness is due to all the regulations and requirements, it limits our capacity of farming. The farming practices we need to employ, cause our beef to be expensive compared to beef from South-Africa who does not have to comply with these standards."*

This alludes to an inherent weakness that the cattle farming in Namibia has – the compulsory compliance to standards that drastically increase operating expenses. Farmers feel that it is unfair when they do not receive premium prices compared to the local prices South-African farmers receive when selling their cattle locally. They feel that their prices should have a premium compared to the other countries' farmers who do not need to comply to these standards.

This brings the reader to the next section – the weaknesses of the Namibian beef industry and supply chain.

*4.5.2 **Weaknesses***

In contrary to strengths, Capon and Disbury (2003) explain that the term weakness refers to the absence of a certain competence, resource or attribute within an industry that is needed for a good performance in an external environment. The participants of the study tended to mix the weaknesses with threats and vice-versa – therefore the researcher found it fit to organise the responses into weaknesses and threats. The criteria that were used to distinguish weaknesses and threats from one another, was the degree of control a supply chain member has over it. Weaknesses include factors that are within some control, while threats include factors that are not within the industry's control. Figure 4-5 illustrates how much the participants addressed the same weaknesses.

When asked about weaknesses in the Namibian beef industry and its supply chain, five out of the eight participants said that the restriction to increase the national cattle production is a weakness. This relates to the difficulty Namibia faces to increase the cattle production capacity which is built on three factors.

The first factor is that all cattle north of the veterinary cordon-line (also known as the red-line) are, by law, not allowed to be commercialised. This is due to foot-and-mouth disease which is active north of the red-line. This area is known as the Namibian Communal Area (NCA). If cattle from the NCA enter the marketing stream, it poses a risk for the foot-and-mouth disease to spread to the rest of Namibia. If this happens, all international trade of beef will be suspended for twelve months, which will be catastrophic. One of the participants put this inherent weakness into perspective by saying:

> *"To put it into perspective, Namibia has 60-million-hectare agricultural land. 30 Million of this are attributable to communal farmers of which 50% is above the red-line, and the other 30 Million is attributable to commercial farming."*

This restricts Namibia – being a net exporter of beef – to export its full capacity of cattle farming, therefore it is crucial to penetrate the correct international markets in order to receive a premium price that reflects the standards of Namibian beef.

The second factor that limits the Namibian production capacity is the bush encroachment that Namibia is facing. Bush encroachment is a natural phenomenon that is characterised by the dramatic increase in the density of woody plants, such as bushes and shrubs, at the expense of grasslands used for grazing by cattle (De-bushing Advisory Service, 2016). Two out of eight participants considered this as a weakness that affects Namibia's cattle production capacity. However, these two participants had different outlooks on the bush encroachment. The first participant saw the glass half empty, focusing only on the negative impact of the bush encroachment. This participant's response was:

> *"Due to forest encroachment, we had a decrease in grazing fields in the last couple of years. In turn, this led to a decrease in stocking per hectare which directly affects production per hectare."*

The other participant chose to rather see the glass half full – responding as follows:

> *"We are very threatened by bush encroachment in Namibia. This leads to a decrease in the carrying capacity for livestock in terms of grazing. But at least we can find ways on how to deal with it and come up with new innovations."*

When asked about the innovations, the participant mentioned that the farmers cut down the encroached bushes and trees and then either sell it as fire-wood or convert it into commercial-charcoal, in turn creating open lands for pastures to grow again. This binds with the arising of opportunities, which will be discussed in the next section.

Lastly, one of the eight participants addressed the third factor - being the fact that Namibia's cattle are known for good genetics. This, therefore, impedes the growth of Namibia's national cattle herd by restricting the import of cattle from certain countries where foot-and-mouth diseases occur and where cattle do not comply with Namibia's USP regulations.

Two out of the eight participants alluded to two weaknesses that can be grouped as administrative weaknesses. The first weakness is regarding the exportation of the meat. It is understood from this participant that whenever beef is exported via South-Africa, once a year the South-African customs require some kind of verification and certainty that the beef that was brought into South-Africa, was the same beef that was exported. The participant said that

the verification is an administrative nightmare due to the storage nature of beef being different from other products.

The second administrative weakness, as told by a participant, is when Company A cancels slaughtering appointments with producers. When the researcher asked this participant to elaborate, the researcher could hear the anger and disappointment in the participant's voice. The answer was as follows:

> *"Because for instance, prior to the slaughtering I feed my cattle for 30 days in a feedlot for the cattle to gain mass. But if the slaughter appointment is cancelled by Company A, it has a ripple effect on the farmer. Say they cancelled it a week before, the farmer then fed the cattle for 23-25 days, but now it cannot be slaughtered anymore. This results in losing the feeding I fed the cattle for 25 days because now I have to send the cattle back to the veld. And in the veld, I lose all the weight I added to the cattle in the feedlot."*

As discussed in section 4.3 (refer page 83), participants portrayed that the lack of information transparency downward from Company A to the producers is causing the farmers not to farm efficiently. Therefore, if this weakness can be improved into a strength, it can be possible for all stakeholders to work in better synergy.

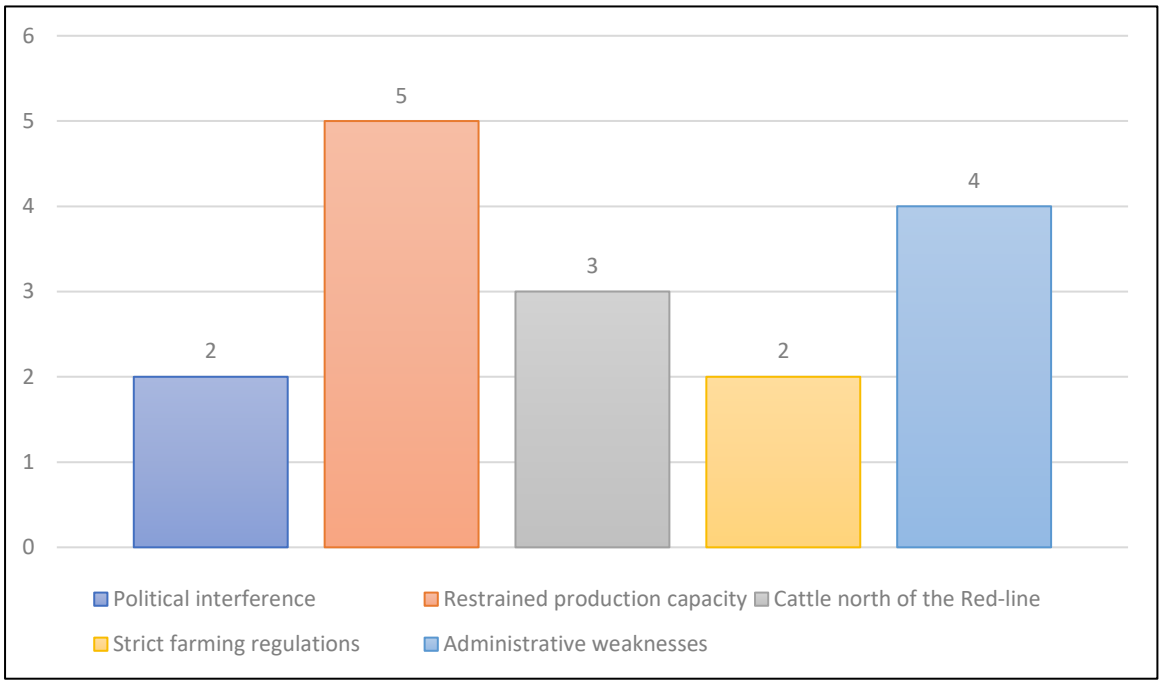
Lastly, the representative from the abattoir responded by referring to two weaknesses. The first one being that during the processing of the meat in the abattoir, the deboning and cutting of the cow/ox is restraining the ability to track each cut back to a specific cow/ox. The other weakness, according to this participant, quotes as follows:

> ***"****Well, to be quite frank and honest. Our cost control is not what it should be. For instance, there are studies going around that the international benchmark to process a cow or ox, is about N$19 per kilogram, while we operate at N$39 per kilogram. There are a lot of hidden costs we should control."*

Another participant's response supported this weakness. This participant said that the poor management of costs is allowing the expenses to devour the income generated from exports.

Figure 4-5 illustrates how much some weaknesses were in agreement with one another when considering the participants' responses.

Figure 4-5: Weaknesses of the Namibian beef supply chain



Source: Own research

The next section will address the opportunities in the Namibian beef supply chain and the industry as perceived by the different participants.

*4.5.3 **Opportunities***

Opportunities are possibilities that exist in an external environment for an organisation – or a supply chain – to pursue in order to acquire benefits (Capon & Disbury, 2003). During the interviews, feedback regarding the opportunities went hand-in-hand with the strengths of the Namibian beef industry and supply chain.

The most common opportunity that the researcher was made aware of, was the opportunity that the Namibian beef industry and supply chain has to increase their international market share. Five out of the eight participants commended the fact that, due to the existing access to

international markets the Namibian beef supply chain has, Namibia has the opportunity to increase their market share in these markets. One participant stated that during the past years Namibia has opened vast markets, given their meat-status and beef USPs, while positioning themselves into beneficial market positions. This participant furthermore concluded on this by saying in a prideful manner that it poses an opportunity to capitalise on these markets. The following response can be regarded as an average answer when the researcher asked about any perceived opportunities.

> *"Well, the fact that we can produce certain qualities of beef with certain USP's while enjoying the access to international markets, there is always an opportunity to utilise these markets at full capacity."*

Another participant commented on the opportunity that the accessibility to these international markets poses. The participant said that it would be of great value if there can be a kind of certification model or system in the Namibian beef supply chain that certifies that beef are produced under regenerative agriculture or on an organic basis. He/she stated that this would allow certain farmers to be "brand-certified" and, in turn, they would be able to receive a premium price for their cattle. This will in turn motivate more farmers to shift to the slaughter beef supply chain which can ultimately increase Namibia's beef production capacity. Another participant whose response included this principle said the following:

> *"If you look out of the point of brand-naming beef, you'll need to be able to verify and support all the claims made in the brand description of the beef. And that will be promising."*

However, two participants had dissenting thoughts on the international markets. These participants said that it is wonderful that Namibia has access to these markets, but they asked what is the use if Namibia has all this access, but no capacity to fulfil these markets.

This alludes to another opportunity that three of the eight participants mentioned. They said that, although there is a threat and a weakness that they are restrained to grow their national beef production capacity, there is an opportunity to increase it. These participants often referred to the NCA when addressing this opportunity. For instance, a producer's view on the opportunity was as follows:

"If we can somehow commercialise the area above the red-line, we will be able to increase and streamline our whole beef value chain. There are so many potentials above the red line, but due to incompetence the potential is not being used. For instance, corn fields can be planted along the Okavango river and this can be used to feed the whole Namibian beef supply chain. And this will cause that we won't have to import all the necessary corn from South-Africa."

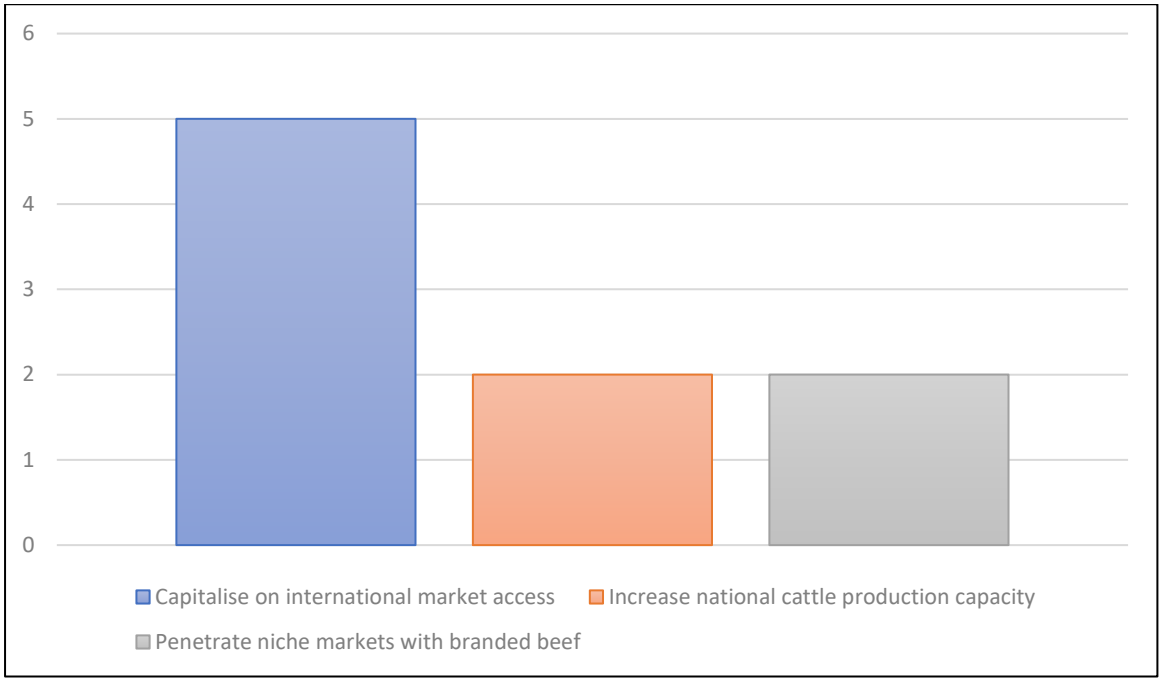
On the other hand, the viewpoint of corporate members on the opportunity that the NCA holds, was as follows:

"A big opportunity is if we can take the NCA which is the land above the red-line, into the regional and international marketing stream, I think we will be able to address the supply constraint issues we are currently facing."

When keeping in mind the adoptability of technology, which was discussed in the PEST analysis, it was interesting to note that one participant regarded the implementation of technology as an opportunity. This participant – a young farmer – said that the implementation of innovative technologies can result in efficient farming and "a more effective and streamlined" beef supply chain.

Figure 4-6 gives an indication of which opportunities weighed the most, considering the participants' feedback.

Figure 4-6: Opportunities in the Namibian beef supply chain



Source: Own research

The following section will discuss how the participants perceived different threats in the external environment of the Namibian beef industry and supply chain.

*4.5.4 **Threats***

Capon and Disbury (2003) defined threats more than a decade ago as an external factor that impacts the performance of an organisation – or a supply chain – negatively. When the participants responded to the last question of this section, namely the threats, their responses corresponded with one another to a certain degree. This can be seen in Figure 4-7.

Three of the eight participants immediately referred to periodic droughts affecting the production capacity of Namibian beef production. These participants said that about every seven to ten years Namibia experiences serious droughts that normally affect the supply chain. This effect is in the sense that Namibia exports a lot of live cattle to neighbouring countries during these droughts, leaving the Namibian national herd in a decline mode and essentially lowering the beef production capacity. With regard to this threat, one participant made the following comment:

"Due to the cattle that are grass-fed and free-range, severe droughts and climate changes in Namibia affects the farming sustainability."

It is interesting to note that in years of drought there is limited grass for the cattle to graze on, while the main USP of Namibian beef is the free-range and grass-fed USP. Ironically, two of the participants considered the different USPs and farming practices as threats, due to the high input costs needed to comply with these standards. It is difficult to sustain these practices in years of drought without using practices that are contradictory to the USPs, such as growth-hormones or cheaper animal feeding.

Another threat that the researcher regarded as rather concerning, was the threat to the national traceability system as well as the maintenance of Namibia's international marketing status. Three out of the eight participants addressed the concern of how the survival of Namibia's international market access and the EU-approved status are threatened by the incompetence of the national competence authority - which is the Directorate Veterinary Services (DVS) - in other words, the state veterinary. The DVS's responsibilities include the maintenance of the national cordon-line, the inspection and signing-off of farming practices in order to comply with EU-requirements, the testing of cattle for hormones, and the maintenance of the national traceability ear-tag system. All of these responsibilities are to ensure the survival of Namibia's international marketing status on which all the strengths, opportunities and current profitability are built on. Three participants made it clear that the DVS's competence is in a steep downward trend. One of these participants went as far as to use foul language when he/she expressed his/her frustration:

"If I can just highlight one, is the decrease in the competence of the national veterinary. I mean, they do not maintain the cordon-fence that protects the commercial areas from foot-and-mouth disease… I mean, they can't even do the required inspections on the farms nowadays!"

To put the seriousness of this into perspective – if one single case of foot-and-mouth disease is found south of the red-line, Namibia's beef exportation will be suspended for a minimum of twelve months. Another participant added that the weaker quality of the DVS's inspections becomes, the stricter the requirements posed by the international market regulations become – thus making it so strict over time that Namibia would eventually not be able to comply with

the regulations. These participants suggested that the reason behind this decline of competence is the lack of funding that the DVS receives from the government.

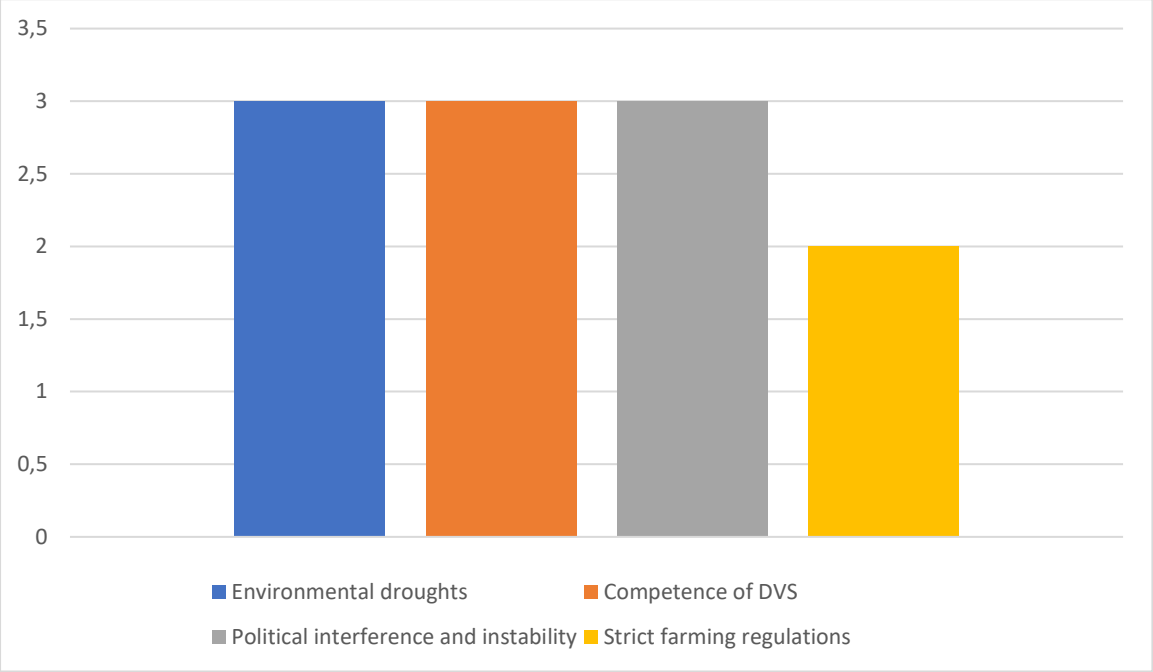
Three of the eight participants also noted that continuous political instability and interference can pose additional threats to the Namibian beef industry and supply chain. In this regard, two participants shared their opinions:

> ***"****I feel that because Company A is an SOE, the political interference can threaten the bargaining power of us farmers. We should only feel happy with the prices they offer us. Due to them negotiating on our behalf in the EU markets, we have no bargaining power whatsoever."*

> *"The political interference also poses numerous threats. I mean, the biggest threat is that we as farmers are fearful of the possibility that the government is closing down the private feedlots as they have done with the sheep industry that totally destroyed this industry. It is sad that they threaten us that they will do it."*

Other threats mentioned by the participants included the dramatic increase of the average farmer's age (one out of eight), and the limitation of the production capacity of the Namibian beef supply chain (two out of eight). The threats that weighed the heaviest considering the participants' feedback are illustrated in Figure 4-7.

Figure 4-7: Threats in the Namibian beef supply chain



Source: Own research

The previous two sections of this chapter described the external environment in which the Namibian beef supply chain operates, as well as the strengths, opportunities, weaknesses and threats it faces. The next section will apply the criteria, as stipulated in Table 2-6 (refer page 56), in order to determine whether the implementation of blockchain into the Namibian beef supply chain is practical.

4.6 The possible implementation of blockchain

As discussed in Table 2-6 in Chapter 2, a criterion framework was established in order to determine whether it is possible and necessary to adopt blockchain into a beef supply chain. This criteria consist of different categories which then again contain questions asked. The framework, however, does not give the user a definite answer, but it certainly leads the user to whether the use of blockchain is necessary or not. The researcher used the information gathered from the empirical study to form a basis of understanding in order to apply these criteria to the Namibian beef supply chain. The different categories that the framework comprise of are discussed and applied to the information gathered from the empirical study in the succeeding sections.

4.6.1 ***The need for traceability***

Questions regarding this category often refer to what the total need for traceability and transparency is in the supply chain and which parties need access to different kinds of information. An aspect such as which parties should have access to enter data into the blockchain is also addressed in this category.

The answers concerning this category were relatively easy. Eight out of the eight participants knew exactly what transparency and traceability means, and they also incorporated it into the Namibian beef supply chain. Furthermore, due to the USPs that the participants viewed as a strength, it is critical for end consumers to verify the source of the meat as well as the compliance to the USP-standards, hence increasing the need for product traceability and information transparency. Taking the branding of meat mentioned by two participants into account, they deemed it important for that meat's "promises" to be verified and traced back by the consumer.

> *"... look out of the point of brand naming beef, you'll need to be able to verify and support all the claims made in the brand description of the beef... It will be even more promising if the consumer can trace the particular cut to the cow and the cow's story."*

As referred to in the previous section concerning information transparency (refer section 4.3.2, page 83), the producers urged for information transparency downwards from Company A. This need that they have is regarded as essential because, as stated by these participants, increased information transparency will allow them to farm more efficiently and will improve their farming planning.

> *"...I can adjust these factors in my farming process to farm more efficiently. Thus, if I am certain that I am selling A-grade cattle, and I receive an A-grade assessment, I can budget more accurately..."*

Therefore, the perceived need for information transparency and traceability is regarded as high, with all the players in the supply chain being able to add information onto the blockchain. However, access to the data should be expanded to more parties, while the type of data able to be viewed should be limited.

*4.6.2 **Material characteristics***

It is evident that blockchain is digital in nature – therefore other technologies are required to link the physical assets to a digital identity. The different variables should therefore be determined, like what physical transformations are applied to the products, what technologies are currently in use, as well as the size of the product being tracked.

When considering the physical transformations of a product, it is important to take note that the nature of beef varies from other commercial products whereas a beef product starts as a living animal in the form of an ox, and ends in the form of a steak, a brisket, or a by-product such as beef-tongue. Therefore, it is important to keep track of which ox is cut into which pieces of meat – as this is a difficult task considered by one participant who said that the deboning of cattle is an obstacle standing in the way of meat traceability. It can be suggested to allocate an identity to each cut of the carcass before the deboning commences – this can thus allow different cuts to be traced back to each respective cow or ox.

As stated in the previous paragraph, the beef goes through cutting and deboning, which in turn affects the size of the product being tracked. Although the raw material, being a cow or an ox, is big in structure, it is fairly easy to track and identify. This can be done by the use of ear-tags and RFID chips, as it is done currently. The meat, on the other hand, is fairly small and is shipped in batches with its own barcode or identity number.

Currently, the supply chain does have elements of traceability given the national ear-tag traceability system and the barcode tracking of batches of meat being done by Company A. Therefore, it is evident that there are numerous IoT devices already in place – such as RFID-chips, barcodes and QR-codes. These existing usages of technologies will in effect ease the integration and use of blockchain technology.

*4.6.3 **Supply chain layers and partners***

To realise consensus to implement blockchain in a supply chain with various participants involves a lot of stakeholder engagement. Therefore, it is imperative to determine how many players in the supply chain are part of the creation of the end product, and whether these players are willing to adopt new technology.

With regard to the complexity of Namibia's beef supply chain, one participant stated that due to the processing nature of an ox to beef, together with the exportation thereof, it can be regarded that there are a lot of players in the supply chain making it complex. However, to be specific, the players are the producers, the veterinarian services, the abattoir (Company A), the transportation services, and the consumer in the international market. When considering adoption and collaboration, it is only the producers, the veterinarian services and the abattoir who should drastically adopt the usage of blockchain. The transportation services will adopt in minimally, whilst all the other stakeholders will only use the viewing function of blockchain.

However, when considering the willingness of the supply chain partners to adopt blockchain, it can be a dissenting thought when keeping in mind what was said in the PEST analysis when technological adoptability was addressed (refer section 4.4.4, page 95).

*4.6.4 **Technological environment***

The effort needed to connect all the current systems and data structures depends on how these systems are currently being set up. As to the understanding of the researcher, the participants said the meat traceability system is developed internally by Company A, with only them having access to it, whilst the national ear-tag traceability system is centralised and state-owned and with all FANMEAT registered users having access to it. Therefore, not much effort will be needed in order to connect the current systems to each other – the greatest effort will be statute in nature when the different parties of the systems are in engagement.

The transition from the current data structure to the blockchain will be made by a certified blockchain development company whose expertise is blockchain integration. The current technological infrastructure of the Namibian beef industry and supply chain will assist this transition, due to the current IoT technologies which are already in use – such as RFID-chips, barcode-scanners, tracking systems and QR-codes. However, one constraint to add blockchain interfaces to all supply chain environments can be the limited cellular network coverage on large farms, as stated by one participant. On the contrary, another participant said that telecommunication companies are currently working on expanding cellular network coverage on all farms.

4.6.5 ***Regulation***

The regulation category needs to determine to which countries the supply chain spans, and whether the product should adhere to certain prerequisites in order to be able to be exported to these countries. The corporate participant from Company A stated that the Namibian beef supply chain originates in Namibia on the farm, and spans to different international markets. Thus, the end of the supply chain is in these markets, including the USA, the European Union, Norway, South-Africa and China.

The majority of these countries, however, have put strict regulations and standards in place to which the beef products should adhere to in order to be eligible for trade. These prerequisites include all the USPs of Namibian beef meat, which are free-range, organic, non-hormonal and antibiotic-free. Currently, the DVS's responsibility is to ensure that Namibian farming practices adhere to these standards, but due to the decline of their competence, their trustworthiness and authority can be under doubt – therefore it is imperative that a trusted system should be implemented in order to verify all of these standards.

In conclusion, the researcher has determined the following:

1. The need for traceability and transparency in the Namibian beef supply chain is regarded as high.
2. The size of cattle and beef cuts is considered as practical in order to track and tag with an identity.
3. The Namibian beef supply chain consists of numerous stakeholders – each being able to contribute data to a blockchain.
4. Due to the availability of a national traceability system, and the use of IoT devices in Namibia's beef industry, the implementation of blockchain will be made easier. It should be noted that blockchain will not serve as a replacement for these systems, but rather as a tool to increase transparency and traceability in the supply chain.
5. Namibia's beef is exported to international markets and has different USPs applicable to it. Therefore, it is imperative for these countries to be able to verify and trust these USPs.

Considering points one to five, it is suggested that the implementation of blockchain can be possible in Namibia's beef supply chain. The next section will make use of the use-cases

discussed in Chapter 2 (refer section 2.6, page 47) in order to determine whether the strengths and opportunities in the SWOT analysis can be capitalised, while the weaknesses and threats in the SWOT- and PEST analyses can be addressed.

4.7 Effect of blockchain on Namibia's beef supply chain

This section will consist of four subsections. The first subsection will address whether the participants' demand for increased information transparency can be achieved by the use of the use-cases as discussed in section 2.6, Chapter 2 (refer page 47). The next subsection will determine whether the strengths and opportunities highlighted in the SWOT analysis can be capitalised by the usage and implementation of blockchain, considering applicable use-cases as referred to in section 2.6, Chapter 2. Thirdly, the use-cases from section 2.6 in Chapter 2 will be considered to explore whether some of the weaknesses and threats mentioned in the SWOT analysis can be mitigated. This section and chapter will eventually conclude by addressing the performance measures regarding Namibia's beef supply chain, as stipulated in Table 2-2, Chapter 2 (refer page 27). All in all, this will comprise the exploration of blockchain in Namibia's beef supply chain.

*4.7.1 **Transparency and traceability***

Issues regarding transparency and traceability comprised the lack of information communication from Company A to the farmers, and certainty of governmental policies. Furthermore, opportunities relating to brand-naming of beef were addressed by the participants - that bind with transparency and traceability. However, this will be discussed in more detail in section 4.7.2 (refer page 115).

The issue relating to information asymmetry can be summarised, as in section 4.3 (refer page 79), as follows. The producers deem access to three types of information, to which they currently struggle to obtain, as follows:

1. The producers deem that Company A gives increased transparency to the assessment criteria of their cattle – in turn, they can align their farming practices to it.
2. The farmers deem to have visibility to the revenue that Company A derives per exported carcass, as well as how they add value to a respective carcass.
3. Certainty about the needs of Company A – such as what type of cattle they need.

For this section, two of the use-cases will be used to address these asymmetries. Firstly, *Use-case 1: End-to-end traceability* (hereafter referred to as Use-case 1) can allow Company A's abattoir to add the assessment criteria to the blockchain per farmer's cattle. This will in turn allow the producer to have access to the criteria on how his/her cattle were assessed. The farmers will consequently be able to determine why their cattle were, for instance, graded as a B-grade and not an A-grade. In turn, a farmer will be enabled to structure his/her farming practices according to these criteria which, in effect, will result in more accurate budgeting and efficient farming.

Secondly, *Use-case 3: Blockchain's assistance in trade finance* (hereafter referred to as Use-case 3) can be implemented to address the second and third information asymmetries. When considering Use-case 3, the posting of a retailer's purchase order on the blockchain can eliminate both asymmetries because – 1) the farmers, having access to the blockchain, can see what the revenue per purchase order is, and 2) by posting the purchase order on the blockchain, farmers have trusted information about the cattle needed by Company A. Thus, they can structure their cattle accordingly, which in turn can result in more efficient farming.

Furthermore, in relation to the political interference regarding political appointments which does not represent the farmers' democratic will, the following suggestion is made: when directors are chosen by the farmers – as stipulated in the legislation of Company A – these elections can be done on the blockchain which can eliminate the opportunity for political interference; hence, the will of the farmers' vote will be represented democratically.

Blockchain offers the opportunity for all stakeholders to communicate on one, decentralised system which has the potential to get miscommunications out of the way.

4.7.2 ***Strengths and opportunities***

The core strengths from Figure 4-4 (refer page 99) are the USPs that Namibian beef has and the access to international markets, while the opportunities can be observed from Figure 4-6, namely to use these USPs and international markets to increase the Namibian market share. Two participants addressed the need for a certification system that can be used to certify these USPs to the consumers. Therefore, three use-cases can assist in this manner.

Firstly, *Use-case 2: Labelling-assurance* (hereafter referred to as Use-case 2, refer page 51) can be used to ensure that all information on the blockchain regarding these meat batches is unaltered and objective. Due to Namibia's existing IoT-device usage and veterinary-attestation, Use-case 2 can be a reality. The posted information on the blockchain provides a rigid audit trail of the cattle's free-range grazing (geo-tag and RFID-chips), grass-feeding (smart-feeding machinery), and antibiotic-free conditions (veterinarian's attestation to the blockchain). Use-case 2 can therefore provide assurance regarding any USPs made to market-regulators, retailers and consumers.

Secondly – regarding the brand-naming of beef – *Use-case 4: Certification* (hereafter referred to as Use-case 4, refer page 53) alludes that blockchain can deliver a secured certificate issuance process. This process will be strictly applicable to selected producers whose practices are authorised by the "brand". All relevant up-to-date information regarding these practices will be stored and shared on the decentralised blockchain platform to selected parties. Therefore, this certification system can be suggested as a solution for retailers, consumers and market regulators who rely on quality and practice accreditations when approving the exportation of meat.

In conclusion, when considering Use-case 2 and Use-case 4 in nexus with Use-case 1's end-to-end traceability feature, a stakeholder can be ensured that the USPs on the meat label in trusted, verifiable and accredited by a certification process. Therefore, the wish of these participants can be fulfilled in the sense that they wish for the consumers to be able to instantly verify the product's provenance and story – as can be done with the features of Use-case 1 (refer page 47).

In the analysis of the social environment, one participant said that it is imperative to communicate to the consumer that Namibian beef tells a story – that the *"meat on your plate is not only food but food for somebody else."* The participant meant this in the sense that Namibian production of beef adheres to fair-trade principles where all parties applicable to the delivery of a piece of beef are benefitting from the selling thereof. Therefore, Use-case 1 in its simplest form can serve as a pathway for Namibia to communicate each piece of beef's story to the consumer.

The opportunities that these use-cases can realise, build on the strengths of the Namibian beef supply chain, which is to deliver locally produced organic beef by experimented Namibian farmers.

The next section will apply the use-cases to the weaknesses and threats, as discussed in section 4.5.

*4.7.3 **Weaknesses and threats***

The applicable weaknesses and threats that received the most attention from the participants, as presented in Figures 4-5 and 4-7 (refer pages 103 and 109), were the production capacity restraints in Namibia, the administrative weaknesses on the customs-end when exporting, and the declining competence of the DVS. These factors will be discussed respectively. Other weaknesses and threats included, amongst others, environmental droughts - which cannot be influenced by human interference.

Regarding the production capacity restraint that Namibia faces in relation to the unutilised cattle farming north of the red-line, Use-case 4 (refer page 53) together with smart contracts can be suggested as a possible solution. Namibian authorities can select applicable farmers above the red-line who are regulated by certain practices that mitigate foot-and-mouth disease. These practices include fencing of farmlands and the quarantine of cattle when moving the cattle to a different location. Use-case 4 (refer page 53) will certify these farmers as accredited to commercialise their cattle into the export supply chain. Given prerequisites set by smart contracts on the blockchain - for instance the smart contract - will only allow a farmer's certificate to be accredited if an IoT device (such as an RFID-chip or Geo-tag) communicates to the blockchain that the particular cow or ox was in isolation and quarantine for an applicable length of days, as well as that veterinarian attestation was given that the cattle are free from foot-and-mouth disease. This can in effect result in the situation where more cattle from north of the red-line are commercialised - eventually increasing Namibia's cattle production capacity.

Secondly, with regard to the customs issue, Use-case 1 (refer page 47) can allow custom officials in South-Africa – who receive read-access to the blockchain – to confirm the different batches' identity numbers as well as the arrival dates, departure dates and whether it is still in transit or not.

Concerning the DVS, the following suggestion can be made. If the maintenance of the national traceability system can be privatised in synergy with the blockchain system, DVS can solely focus on the testing of cattle and attesting these results to the blockchain. The confirmation of permits and signing-off of batches can be automated by the blockchain system through certification functions and smart contracts, as stipulated by Use-case 4. Use-case 1 will allow third parties to confirm whether the cattle comply with certain requirements in order to be signed-off as approved.

Taking the current Namibian beef supply chain together with the use of these blockchain use-cases into account, the measures discussed in section 2.3.4 in Chapter 2 (refer page 26) will be used to assess the performance and conclude on the improvement in the (new) Namibian beef supply chain.

4.8 Performance of the Namibian beef supply chain

Khan (2013) states that a measuring model should integrate all the functions of a supply chain and should measure the overall performance of the supply chain. If these functions' improvement can be summarised per stakeholder group, it can be summarised as follows:

1. **The producer/farmer:** The producers will have access to transparent information that allows them to farm more efficiently and profitable. This will in turn affect the livelihoods of the labourers on the farm – thus increasing the standard of living on a farm overall. Furthermore, if a farm gets brand-certified, this particular producer will be able to receive a premium price for his/her cattle.
2. **Company A:** Company A will be able to explore international markets with a verifiable USP "backed" product. This can in turn allow them to receive premium prices and increase their current market share. Furthermore, blockchain can allow Company A to communicate transparently with its producers, which can recreate trust and eventually create a sustainable supply of quality cattle for Company A.
3. **Consumers:** Environmentally-aware consumers will be able to enjoy the convenience of instantly verifying a USP on a label. They will be able to trust the information due to the immutability of blockchain giving trusted information. Furthermore, they will be able to see the story behind their product and how they help to put food on someone else's table.

Coyle *et al.* (2003) address another performance measurement which indicates that a supply chain should have an overall strategic objective that tends to strategic alignment. In the new and current beef supply chain in Namibia, the strategic objective will include communicating transparent information to all stakeholders – this will and can be realised by the usage of blockchain. Each stakeholder's access to relevant information will be limited to his/her own demand for the information – which allows all players in the Namibian beef supply chain to work in collaboration, which in turn results in synergy. As stated by the representative of the Namibian Agricultural Union:

> *"We should be able to find synergy between these role-players so that we can make suggestions to the government as one united force."*

In conclusion, Uddin (2011) suggested nine years ago that the key success factors in the beef industry's supply chain could be considered to be interdependent relationships with strong elements of transparency, traceability and knowledge flow. As stated in this study, blockchain aims to 1) decentralise all information between supply chain parties – making relationships interdependent; 2) increasing the visibility and accessibility to trusted information between the different supply chain partners – thus increasing transparency and traceability; and 3) creating a decentralised and accessible platform for all relevant information to be viewed by selective parties in order to increase the efficient information-flow in a supply chain.

Therefore, as stated by the stakeholder theory, when the supply chain adds value to each stakeholder, each stakeholder will in turn add value to the supply chain, resulting in prosperity for the Namibian beef supply chain and its stakeholders.

4.9 Summary

This chapter's objective was to address the third secondary objective as stated in Chapter 1 (refer section 1.8.2, page 10). This secondary objective was to gather qualitative data from interviewees to explore the possible use of blockchain technology in Namibia's beef supply chain to enhance traceability and transparency. In this chapter, eight members from the Namibian beef industry and supply chain were interviewed. These members comprised four farmers of whom one was a chartered accountant, one abattoir representative, one corporate member, one Namibian Agricultural Union representative, and one Namibian Meat Board

representative. As stated in Chapter 4, these participants' average years of experience in the Namibian beef industry is 21 years.

The first part of the interview required the participants to address what transparency and traceability in a supply chain means, from their perspective. Eight of the participants had a good comprehension of what it means, however they tended to mix the terms transparency and traceability. Furthermore, this part of the interview required the participants to elaborate on whether and how increased transparency and traceability will benefit their specific role in the supply chain. The majority of the feedback alluded that increased information transparency will either assist farmers in making better and more calculated farming decisions, while on the corporate end of the supply chain, it was suggested that increased transparency and traceability could be used as a competitive advantage tool to increase Namibian beef market share in international markets. These benefits and effects were grouped into two groups (refer sections 4.3.1 and 4.3.2, pages 82 and 83). The final question of this part asked the participants how they viewed the integration of relationships in the Namibian beef supply chain. The researcher noted that four of the eight participants deemed the relationships as "bad" and "worsening", whilst three participants claimed the relationships to be "open" and "sustainable".

The second section of the interviews formed part of the PEST analysis that was performed in this study. In this section, participants were required to give their perceptions of the effects of each of the external environments on the Namibian beef industry and the beef supply chain in particular – if possible.

Although three participants claimed that Namibia has a stable political environment, all of the participants alluded to the fact that the political interference was becoming unbearable, or that the beef industry is at the mercy of political decisions.

Concerning the economic environment, five participants agreed that the Namibian beef supply chain is influenced by the prosperity and economies of the countries to where Namibia exports its beef . This is because Namibia is a net exporter of beef – 80% of locally produced beef is exported, whilst only 20% is consumed in Namibia. Two participants also noted that the beef supply chain, in turn, has an effect on the countryside's economies.

The participants struggled in general to address the social environment aspect. Five participants suggested that the most common impact of the social environment is how the consumers prefer their beef. They stated that these preferences shape the way in which they operate their farming practices, while two participants said that these farming practices restrain their profitability if they do not receive a premium price for their cattle.

Lastly, eight of the participants mentioned the current national traceability system that is used in the Namibian beef industry. However, it was noted by the responses of the participants that the survival of this system is under doubt, due to the lack of governmental funding. Four of the eight participants, however, were of the opinion that the majority of farmers were not in favour of adopting new technology.

The final section of the interview consisted of the participants giving their opinions about the internal strengths and weaknesses of the Namibian beef supply chain, as well as the external opportunities and threats.

It was evident from the interviews that the most common strength (six out of eight), perceived by the participants, was the ability for Namibia to market beef that has different USPs such as free-range, organic and antibiotic-free. Overall, four participants regarded the fact that Namibia has international market access as a strength to export Namibian quality beef. Other strengths included world-class abattoirs, the expertise of farmers and the good genetics of Namibian cattle. The most common weakness addressed by the participants was the restraining of the increase in the production capacity of Namibia. This was elaborated on in section 4.5.2 (refer page 100).

There were only three opportunities that were addressed by multiple participants – the most common was to use the Namibian beef USPs to increase the Namibian market share in existing international markets. However, four threats enjoyed agreement from multiple participants where – as perceived by the participants – the declining competence of the DVS was regarded as the highest threat.

Following the SWOT analysis, a framework, as discussed in Chapter 2 (refer Table 2-6, page 56), was used to determine whether blockchain implementation will be possible and needed in the Namibian beef supply chain. With regard to the need for traceability, it was established that

the nature of the supply chain deems traceability important. The characteristics of the materials and products in the supply chain also proved to be suitable to integrate with IoT devices in order to form part of the blockchain integration. However, the supply chain partners posed some barriers to the adoption of new technology, which could become an area of concern. In contrast to these barriers, the current technological environment proved as welcoming for new technology that can be used in nexus with the current usage of IoT devices such as RFID-chips and geo-tags. Finally, concerning the regulation requirements, Namibia's beef is exported to international markets that have different USPs applicable to it. Therefore, it is imperative for these countries to be able to verify and trust these USPs. It was concluded that blockchain implementation will be possible.

In the penultimate part of this chapter, different use-cases that were discussed in section 2.6 (refer page 47) in Chapter 2 were applied to the feedback from the participants. The attempt was to use these use-cases to offer solutions for the current information asymmetry as perceived by the respective participants. The use-cases were further used to determine whether, with blockchain, Namibia would be able to capitalise on the perceived strengths and opportunities and to mitigate the respective weaknesses and threats.

It was suggested that Use-case 1 and Use-case 3 could be used to align information-flow in a supply chain between the applicable supply chain partners. This section also suggested that the use of blockchain can decrease the amount and effect of political interference in the form of decentralised voting polls when electing directors.

With regard to the strengths and weaknesses, the researcher identified the most common factors to be the Namibian beef with its USPs, while these products can enjoy international market access. It was suggested that, in nexus with the branding of beef, Use-cases 1, 2, and 4 could be used to capitalise on these strengths and to realise any potential opportunities.

The researcher identified the production capacity restraint and administrative issues as weaknesses and threats that can be attempted to be mitigated by the use of the blockchain use-cases. A suggestion on how Use-case 4 can be used in nexus with blockchain's smart contract feature was made with the aim of increasing Namibian cattle production capacity in a sustainable way. Furthermore, Use-case 1 was suggested to address the customs-issue that Company A currently experiences with the export of beef going in-transit through South-Africa.

The last section of this chapter used performance measures - as discussed in section 2.3.4 in Chapter 2 (refer page 26). It was concluded that the implementation of blockchain would be able to add value to each stakeholder in the supply chain, which could result in an aligned strategic objective across the supply chain – and finally where the supply chain creates its own value within each layer.

The following chapter will summarise the study, make recommendations, highlight the limitations applicable to this study and will suggest areas for future research as well.

CHAPTER 5

5 Conclusions and recommendations

5.1 Introduction

The objective of this chapter, as stated in Chapter 1 (refer section 1.8.2, page 10), is to address the last secondary objective. This objective is to conclude and make recommendations on the gathered qualitative data and literature concerning the usage of blockchain in Namibia's current beef supply chain.

The primary objective of this study was to explore the possible use of blockchain technology to enhance traceability and transparency in Namibia's beef supply chain. This objective was supported by the following secondary objectives set out in Chapter 1 (refer section 1.8.2, page 10):

- Reviewing literature around (blockchain-based) SCM, and the beef supply chain both globally and in Namibia, while considering the concepts of transparency and traceability (Chapter 2).
- Presenting the chosen research methodology appropriate for this study (Chapter 3).
- Gathering qualitative data from interviewees to explore the possible use of blockchain technology in Namibia's beef supply chain to enhance traceability and transparency (Chapter 4).
- Concluding and making recommendations on the gathered qualitative data and literature (Chapter 5).

The study encompassed a literature review as well as an empirical study. This chapter will briefly summarise both the literature review (Chapter 2) and the empirical study (Chapter 4). This will be followed by recommendations based on the findings of this study.

The final part of this chapter will comprise of sections presenting the limitations of the study as well as areas for future research.

5.2 Literature review

The literature review was conducted by reviewing literature around (blockchain-based) SCM, and the beef supply chain both globally and in Namibia, while considering the concepts of transparency and traceability. This, in essence, was to address the first secondary objective (refer Chapter 1, section 1.8.2, page 10). The literature review considered three topics, namely supply chain management and integration, transparency and traceability, and the implementation of blockchain into supply chains. Concerning SCM, extant literature attested that supply chains as a whole are competing against each other, and not as individual organisations. It was further found that there is a requirement that organisations in a supply chain should build sustainable relationships that synergise efficient information-flow in the supply chains. Different schools of thought regarding supply chain performance measurement were summarised to demonstrate whether a supply chain is operating efficiently or not. Table 2-2 concluded that a supply chain should be measured to establish whether the overall strategy is aligned to form one consortium.

Section 2.4 (refer page 28) of the literature review determined that increased transparency and traceability in a supply chain form part of the CSR of organisations. It was further determined in the literature review (refer Table 2-3, page 29) that scholars found a parallel correlation between enhanced CSR and firm-performance. This was linked to Freeman's stakeholder theory that enhances the idea that organisations that care for a wide range of groups or individuals who can influence or are influenced by the organisations, will tend to operate more effectively and create more value. In this study's case, a supply chain can be regarded as "the organisation". The literature review suggested that an increase in the elements of supply chain transparency and traceability will improve the supply chain's performance as a whole. In the succeeding part of this section, the concepts and necessity of transparency and traceability in a beef supply chain were addressed. Blockchain was finally introduced as a possible tool to improve transparency and traceability in beef supply chains.

Blockchain was explained in section 2.5 (refer page 35) of the literature review, where it was determined that blockchain technology has the ability to revolutionise the management of supply chains. Table 2-5 compared three types of blockchain networks and suggested an applicable network for SCM. Two figures (Figures 2-1 and 2-2, refer pages 38 and 44) were presented to illustrate the process of how blockchain adds information to the network, as well

as how the visibility of this information can improve operations such as working capital financing. Following this, four use-cases (Figure 2-4 to Figure 2-8, refer page 47) were presented to illustrate the use of blockchain in a beef supply chain. These use-cases were used as a reference in Chapter 4.

The literature review concluded with the different obstacles a supply chain faces concerning the implementation and adoption of blockchain. These barriers were presented in Figure 2-9 (refer page 55). Finally, suggested criteria were extracted from the literature to determine whether an organisation – or a supply chain – should and can adopt blockchain (Table 2-6, refer page 56).

5.3 Empirical study

The researcher collected qualitative data by performing individual semi-structured interviews with eight members of the Namibian beef supply chain. These interviews were done either face-to-face or telephonically. All face-to-face interviews strictly adhered to the health and safety considerations as set out in section 1.12, Chapter 1 (refer page 15). The interview questions – which were designed by the researcher – were directed to four Namibian beef farmers, one abattoir representative, one corporate representative of Company A, one representative of the Namibian Agricultural Union and one representative from the Namibian Meat Board.

The interviews comprised three sections where every section had a separate objective. These sections addressed the following:

- The general information of the research participants such as their years of experience and their role in the Namibian beef supply chain.
- The participants' perception of supply chain transparency and traceability, and how these elements affect the Namibian beef supply chain.
- A SWOT analysis of the Namibian beef industry and supply chain.
- A PEST analysis of the external environment of the Namibian beef industry and the supply chain.

The first section of the interview was composed to establish the quality and reliability of the collected data. It was established that the quality and reliability of the data could be regarded as sufficient, given that the average number of industry years concluded on 21 years. It was also concluded from this section that the participants had a general idea of what supply chain transparency and traceability mean – and that the potential of increased transparency and traceability in a supply chain could be beneficial. This was explained in section 4.3 (refer page 79).

The PEST analysis was aimed at gaining an understanding of the participants' views on the political-, economic-, social- and technological environments' effects on the Namibian beef industry and supply chain. It was concluded that the environments that the participants agreed on the most, was on how the political environment poses numerous threats to the industry in the form of political influence and land ownership uncertainties. It was further determined that the industry is heavily reliant on the economies of the countries who import Namibian beef, due to the luxury nature of imported beef. The participants struggled to give clear answers on the social environment and its impact – generally referring to the consumers' meat preferences and how it influences the farming practices. The PEST analysis concluded that Namibia's technology environment is above-par in comparison to other African countries, but that the current generation of farmers struggles to adopt new technology.

Concerning the SWOT analysis, the participants found it easy to answer most of the questions. Several factors in each matrix of the SWOT analysis were repeated and in agreement among multiple participants. The participants gave rather equal responses regarding strengths versus weaknesses and opportunities versus threats. The principal strength was regarded as the fact that Namibia has free-range and organic beef that is marketed through different USPs in international markets. The weakness that drew the most attention was the fact that the national beef production is restrained by different factors, as discussed in section 4.5.2 (refer page 100). The addressed opportunities seemed to build on the strengths that the participants regarded Namibia's beef industry to have. The most common opportunity was that the international market access should be used to further employ Namibian beef – and specifically, branded beef. The threat that enjoyed the most attention was the suggestion that the declining competence of the DVS threatens the international marketing status that Namibia possesses.

The feedback from the interviews was further used in collaboration with information from the literature review to determine whether blockchain could be implemented and used in the Namibian beef supply chain. It was suggested that this was possible, given the criteria set out by Laaper *et al*. (2017).

The penultimate part of the empirical study's chapter suggested different use-cases that attempted to address the information asymmetry posed by the lack of transparency. It was determined that the efficient use of Use-cases 1 and 3 can improve information sharing that could mitigate the transparency issues. The use-cases were also suggested to capitalise on the SWOT analysis's applicable strengths and opportunities, and to address the analysis's weaknesses and threats. Concerning the strengths and opportunities, it was established that Use-cases 1, 2 and 4 could be used to capitalise on the strengths and realise any potential opportunities. Finally, Use-case 4, together with the use of smart contracts, was suggested as a sustainable solution to increase the national beef production capacity. It was also found that other weaknesses such as the product verification issue by customs in the exportation process could be solved by the implementation of Use-case 1.

Finally, the empirical study concluded with the performance measures addressed in section 2.3.4 of the literature review (refer page 26). It was determined that the implementation of blockchain would be able to add value to each stakeholder in the supply chain, resulting in an aligned strategic objective across the supply chain – and finally where the supply chain creates its own value within each layer.

5.4 Recommendations

The results from the semi-structured interviews with the diverse range of supply chain members clearly indicated that there is currently a lack of information transparency and a need for a certification system to employ consumer traceability of a product. It is recommended that all the stakeholders and parties in the Namibian beef supply chain should strive to achieve transparent, trusted and sustainable relationships. Given the personal level of Namibian relationships, this can be achieved.

Further recommendations include the implementation of a blockchain system to be integrated with current supply chain systems in the Namibian beef industry. As stated in Chapter 4, the

potential to revolutionise the production and marketability of Namibian beef can be deemed as prosperous. It is recommended for a regulative body such as the Namibian Meat Board to drive such an implementation and to embark on market research concerning the technicalities of blockchain implementation. As stated in section 1.2.4 of Chapter 1 (refer page 4), consumers are willing to pay premium prices for products whose story can be traced and verified - such as the Namibian branded beef - as suggested by two participants.

The political interference in the beef industry as well as policy uncertainties were regarded as the highest threats. The participants felt that the mixing of politics and commercial industries tend to result in havoc – deeming that they as members prefer to privatise all the functions. It is therefore recommended that the beef industry should form trusted coalitions with the Namibian Ministry of Agriculture in order to negotiate certain terms that will be beneficial to both parties. Rebuilding possible lost trust between the government and the private sector will require a joint effort from both parties to act in the best interest of the Namibian beef industry and its people, rather than in only party's self-interest.

It is important to draw a final conclusion based on the primary objective of the study – which is to explore the use of blockchain to enhance transparency and traceability in the Namibian beef supply chain. It is thus recommended that the use of blockchain should seriously be considered due to the profound effects it has on the transparency and traceability in a supply chain. It was also found in this study that the use of blockchain has the potential to capitalise on particular strengths in the Namibian beef industry, whilst it can realise opportunities as well.

5.5 Limitations of the study

The sample population of this study was small and did not represent all the stakeholders in the beef supply chain in particular – such as the transporters and the consumers. It was fairly impractical to include consumers into the sample population, given that the beef industry's end-consumer is situated in several countries across the world. Due to the small sample, the perceptions of the research participants cannot be generalised as a stereotype that exists in the Namibian beef industry and supply chain. It is further important to note that this study focussed solely on the Namibian beef industry whereas the export of beef's supply chain was researched – therefore, this study's result cannot be made applicable to other industries in Namibia, or to similar industries in different countries.

Another core limitation of this study is the phenomenon of blockchain technology. Given it is in its early stages of adoption, there is limited trusted literature about it and limited blockchain specialists to be included in the sample population. Therefore, the technical implementation of blockchain into a supply chain was not addressed in depth.

Finally, the last limitation was the fact that the world was struck by a pandemic this year, 2020. This resulted in a delay in interviews due to people being in self-isolation, and as well as research techniques such as doing site observations and taking field notes that could not be done.

5.6 Areas for further research

The areas for further research are guided by the limitations as set out in section 5.5. Further research opportunities include, but are not limited to:

- Researching the feasibility of branded beef in the international markets where engagements are made with the consumers;
- Designing a blockchain system specific for the Namibian beef industry which can be tested in a scenario case-study; and
- Comparing the different supply chains in the Namibian beef industry to determine which supply chain should be followed by the industry.

This chapter and the study will conclude with a brief summary.

5.7 Summary

The problem statement summarised the idea that the Namibian beef industry's export supply chain is heavily dependent on the foreign consumption of Namibian beef. Therefore it was suggested that the Namibian supply chain should innovate in order to gain a competitive advantage in order to increase the Namibian market share in these markets. It was also found in the empirical study that a need exists for information transparency in the supply chain, as well as for certification systems whereby the consumer can verify and trace branded beef.

This study made recommendations that addressed the problems stated in the problem statement, and will in turn allow each stakeholder to add value and to derive value from the supply chain.

The addition of value to each stakeholder will not stop there, but it will dive deeper into the lives of the ordinary Namibian.

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APPENDIX 1: Interview questions

Interviews with corporate-, NAU-, abattoir- and Namibian Meat Board representatives

General

1. How long have you been part of Namibia's beef supply chain/ beef industry?
2. What is the role of the Namibian Meat Board?
3. What, in your opinion, does transparency and traceability in a supply chain mean?
4. What is your opinion on the transparency and traceability of Namibia's beef supply chain?
5. In your opinion, are the current systems employed in Namibia's beef supply chain focused on achieving transparency and traceability?
6. In your opinion, will it benefit Namibia's beef industry if consumers had instant 100% certainty of Namibian products' provenance?
7. How do you perceive the supply chain relationships and integration in Namibia's beef supply chain?
8. Does the Namibian beef supply chain have an overall and shared objective and strategy?

SWOT analysis

1. Which strengths do you perceive Namibia's beef industry and value chain have?
2. In your opinion, are there any weaknesses or deficiencies in Namibia's beef industry and SCM?
3. Which opportunities do you believe exist for Namibia's beef supply chain?
4. Are there any threats you believe to Namibia's exportation of beef?

PEST analysis

1. What effect does the Political environment have on the Namibian beef industry and supply chain?
2. What is the effect of the Namibian Economy on the Namibian beef industry and supply chain?
3. What is the effect of the Social environment on the Namibian beef industry and supply chain?

4. What effect does the use of Technology have on the Namibian beef industry and supply chain?

Interviews with farmers

General

1. How long have you been part of Namibia's beef supply/value chain?
2. What, in your opinion, does a transparent farm to fork beef supply chain mean?
3. Will a complete transparent and traceable supply chain be beneficial to farmers?
4. In your opinion, do farmers feel left out or "in the dark" in Namibia's beef supply chain – is there elements of information asymmetry?
5. How do you perceive the supply chain relationships and integration in Namibia's beef supply chain?

SWOT analysis

6. Which strengths do you think Namibia's beef meat industry and value chain have?
7. In your opinion, are there any weaknesses or deficiencies in Namibia's beef industry and SCM?
8. Which opportunities do you believe exist for Namibia's meat value chain?
9. What threats stand in the way of Namibia's supply chain?

PEST analysis

10. What effect does the Political environment have on the Namibian beef industry and supply chain?
11. What is the effect of the Namibian Economy on the Namibian beef industry and supply chain?
12. What is the effect of the Social environment on the Namibian beef industry and supply chain?
13. What effect does the use of Technology have on the Namibian beef industry and supply chain?

APPENDIX 2: Letters of consent to all research participants

Dear Participant,

Invitation to partake in master's degree research project

Title of research study: Exploring the use of blockchain technology to enhance traceability and transparency in Namibia's beef supply chain

You are herewith invited to participate in an interview as partial fulfilment of a master's degree in management accountancy at the North-West University (NWU). In this research, I am interested in your experiences and opinions about the possible use of blockchain to enhance traceability and transparency in Namibia's beef supply chain. The interview will consist of structured and open-ended questions. Please note that the responses from each individual will not be associated with your identity, but rather as an opinion of a stakeholder in the Namibia beef supply chain.

Please answer all questions as accurately and honestly as possible. Once the interview is conducted, the researcher will analyse the data, and a summary of the findings will be presented in the study. In this way, your contribution to the research could be beneficial to improve traceability and transparency Namibia's beef supply chain.

You must understand that it will not be to your disadvantage if you choose not to participate. Participating is completely voluntary and you can withdraw from the interview at any time. If you are comfortable to partake in the research – meaning that you have no objections – please complete and sign the attached consent form. **By participating in the interview, you give consent that this information may be used for research purposes**.

If you have any queries that have not been addressed and would like to discuss these, please do not hesitate to contact us.

Yours faithfully

Mr PJ van der Walt

Primary researcher

North-West University
(081) 696 5992
vanderwaltj11@gmail.com

Prof Danie Schutte

Empirical research study supervisor
North-West University
(018) 299 1436
Danie.Schutte@nwu.ac.za

I _____(Name of employee or representative), hereby give my permission to be interviewed for the above-mentioned study. I hereby also give you permission to audio record the interview.

_____	_____	_____
Signature	**Place**	**Date**

APPENDIX 3: Ethical clearance certificate

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

Private Bag X6001, Potchefstroom
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Economic and Management Sciences Research
Ethics Committee (EMS-REC)

15 September 2020

Prof Danie Schutte and Prof S Middelberg
Per e-mail
Dear Prof Schutte and Prof Middelberg

EMS-REC FEEDBACK: 31072020
Student: van der Walt (27079783)(NWU-00791-20-A4)
Applicant: Prof Danie Schutte / Prof Sanlie Middelberg – MCom in Management Accountancy

Your ethics application on, *Exploring the use of blockchain technology to enhance traceability and transparency,* which served on the EMS-REC meeting of 31 July 2020, refers.

Outcome:

Approved as a minimal risk study. A number **NWU-00791-20-A4** is given for one year of ethics clearance.

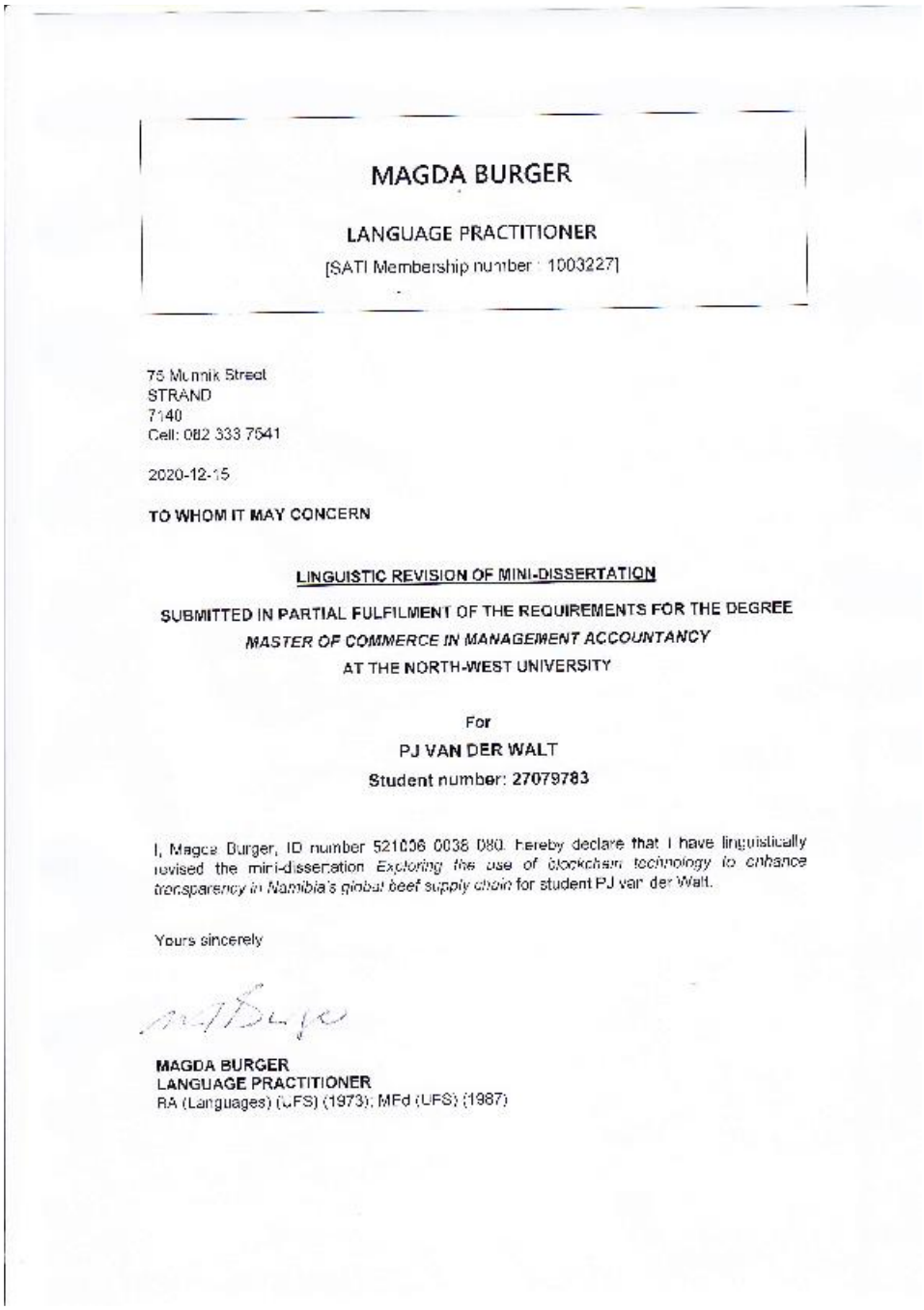
Due to the Covid-19 lock down ethics clearance for applications that involve data collection or any form of contact with participants are subject to the restrictions imposed by the South African government.

Kind regards,

Prof Mark Rathbone
Chairperson: Economic and Management Sciences Research Ethics Committee (EMS-REC)

1

APPENDIX 4: Language editor certificate



MAGDA BURGER

LANGUAGE PRACTITIONER

[SATI Membership number : 1003227]

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2020-12-15

TO WHOM IT MAY CONCERN

LINGUISTIC REVISION OF MINI-DISSERTATION

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
MASTER OF COMMERCE IN MANAGEMENT ACCOUNTANCY
AT THE NORTH-WEST UNIVERSITY

For
PJ VAN DER WALT
Student number: 27079783

I, Magda Burger, ID number 521006 0036 080, hereby declare that I have linguistically revised the mini-dissertation *Exploring the use of blockchain technology to enhance transparency in Namibia's global beef supply chain* for student PJ van der Walt.

Yours sincerely

MAGDA BURGER
LANGUAGE PRACTITIONER
BA (Languages) (UFS) (1973); MEd (UFS) (1987)