



**Conceptualising trust as a data-driven attribute  
in a study of supply chain relationships**

by

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### **ABSTRACT**

This research considers the trust dynamics that occur within the supply chain of the beef industry. The project uses qualitative research methods, primarily case study facilitated through the semi-structured interview of key personnel in BeefLedger, an innovative supply chain support system based on blockchain technology. A key issue faced in this industry are counterfeit products and so maintaining accurate data provenance throughout the supply chain goes to some way in addressing this issue, particularly when Australian beef is exported to the Chinese marketplace. Using contemporary trust theories, the research was able to identify some extension to these theories that being data-based trust, where trust is built through the exchange of accurate information between supply chain participants.



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## STATEMENT OF ORIGINAL AUTHORSHIP

*The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.*

QUT Verified Signature

*Signature*

27<sup>th</sup> March 2020

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## CHAPTER ONE – INTRODUCTION AND OVERVIEW OF THE RESEARCH

### 1.0 Introduction

This Master's thesis aims to conceptualise how data can be considered a base of trust in the increasingly complex, decentralised and cross-cultural beef supply chain. To study this phenomenon, the research setting will be BeefLedger, an Australian-based blockchain platform who provide data services to the Australian beef industry and their international supply chains. BeefLedger adopt a financial perspective and deal primarily with China, who are one of Australia's largest beef export markets.

The research approach will be an explanatory and exploratory single case study. Single case studies are used to test well-formulated theory or conceptual frameworks, or to explore a previously unresearched domain or organisation. BeefLedger emerged in 2017, and while some research has been conducted on their company, this research will be the earliest in-depth, rigorous and comprehensive qualitative study about how their processes reconceptualise trust in the beef supply chain. The primary sources of data will be interviews with senior BeefLedger executives and secondary data will comprise field notes and documents gathered by the researcher, who has industry experience with the supply chain network and spent some time with the BeefLedger organisation in exploring the Internet of Things (IoT) space. The unit of analysis will be *how BeefLedger's data provenance supports trust in the supply chain trust process*.

This introduction chapter will briefly provide the background of the thesis including the limitations in research and the motivations for this study; the study context, being BeefLedger; followed by the scope of the study and then the research questions. The final section, which sets out the structure of the thesis, will discuss the purpose and integration of the chapters that comprise this Master's thesis.

## 1.1 Background

The AgriFood (food that is produced agriculturally) industry is a sector that is continually improving its use of technology in the supply chain process, specifically focusing on the flow from the field to the consumer (Serazetdinova et al., 2019). In the Australian vernacular, field to the consumer is usually termed ‘paddock to plate’, which will be used throughout this thesis. The sector utilises technology including artificial intelligence, wireless and remote sensors and asset tracking among many others, as part of its Internet of Things (IoT) ecology to collect, manage and transfer data across the supply chain to maintain relationships and enhance decisions. Decision-making can be considered from both directions in the supplier-consumer relationship, with the provision of data influencing collaboration, communication, efficiency, risk management, recommendations and purchasing patterns.

Trust is a critical component in the supply chain (Handfield & Bechtel, 2004; Matapoulis et al., 2007; Groth, 2013). It is especially important in the AgriFood sector, as the number of entities can vary within different supply chain context and exchanges and transactions are becoming increasingly complex and cross-cultural. The meat supply chain in particular has the added complexity of food safety, food fraud and meat counterfeiting, and external factors such as uncertainty and risk, conflict and hidden motives, all of which have impacted trust in the industry (Yee & Yeung, 2010). Critical incidents such as the Mad Cow Virus and the 2013 European horsemeat scandal, in which products advertised as meat were in fact illegal horsemeat, have created controversial and impactful problems for the industry (Falkheimer & Heide, 2015). In a study on the European sector, Wezemaal et al. (2012) discuss how inconsistency in beef quality and tenderness is a major concern for the beef sector, as consumers have a clear preference for tender beef and are willing to pay a higher price for guaranteed tenderness. Similarly, the Australian-Chinese beef trade context experiences the same increasing concerns from the perspective of consumers, who are willing to pay high prices for Wagyu but are aware of risks such as the advertised or promised meat not being what they purchased (BeefLedger, 2018; Foth & McQueenie, 2019).

These problems have been traditionally embedded in the meat supply chain, where past bad practices, in which entities would act in their own interests, has created a need for

mechanisms that would improve trust relationships. Kwon and Suh (2004) and Wu, Chuang and Hsu (2014) identify information sharing as the most critical aspect of establishing trust in the livestock supply chain. Similarly, Cai, Jun and Zhang (2010) and Yee and Yeung (2010) state that provision of information is a powerful determinant of trust and has an effect in building relationships between entities who may not even know the identities of the supply chain participants. In a study of the sharing economy, Ter Huurne et al. (2017) found that perceived information quality was an antecedent toward trusting relationships and necessary for trusting behaviour.

Supply chain researchers are currently exploring how data can provide trust in the movement of products end-to-end, with particular focus on how data captures critical information that fulfils the trust needs of everyone from graziers to the consumer within the network (Laequiddin et al., 2012; Van Wezemeeal et al., 2012; Serazetdinova et al., 2019). This idea of data as trust has arisen through the emergence of blockchain, a decentralised electronic ledger that has been used predominantly in the cryptocurrency domain (Greiner & Weng, 2015). Blockchain is being used within the beef supply chain to assist in establishing the origins of meat products and preserving the information across the lifecycle of the product from paddock to plate (Malik et al., 2019). The importance of this data is that it enables decisions, increases efficiency, provides accurate recommendations, helps to manage external factors like uncertainty and risk and enables everyone on the supply chain to understanding purchasing patterns (Serazetdinova et al., 2019). Consumers have increasingly high expectations for beef products and the challenge faced by the industry is reconceptualising how data can be used to establish trust not simply for the end consumer, but for each entity involved in the lifecycle of the beef.

In an assessment of the modern supply chain, Handfield (2017) conceives the new era of a 'digitalised' supply chain as transparent and real-time, specifically stating:

*This is the era of the transparent, real-time supply chain, which is being enabled by the rapid digitization of the communication infrastructure, cloud-based computing, mobile technology, and the rise of the digital ecosystem. (p. 1)*

To date, there have been several studies cited in this section that have explored how data is developed and deployed in the beef supply chain but research on how data can develop trust in the supply chain remains in its infancy. As discussed by Chen et al. (2014), for data to be trustworthy it needs to include reliable, factual and accurate information. However, there is a lack of research about what this kind of information encompasses in the beef supply chain, in particular, what kind of data can establish trustworthiness among all parties. The data in this context is provided by platforms, who establish data provenance (i.e. origins of the product) and maintain and manage the information ascribed to the product through its lifecycle (Zhang et al., 2016). This creates an additional need for researchers to understand how platforms can add to the trust dynamic and what conceptual models explain the best trust practices in this emerging domain.

Trust in the AgriFood supply chain has received attention in the past, with a meta-analysis by Delbufalo (2012) on inter-organisational trust in supply chains revealing that 76% of supply chain trust studies used quantitative research approaches. Allemang and Teegarden (2017) believe that the sector needs more systematic and qualitative research about the inter-organisational relationships between entities. In an analysis of trust in customer-to-customer transactions, Ter Huurne et al. (2017) identified several modes of trust, including trust in institutions, trust in sellers and trust in platforms. As such, there is a need for more study on how trust is operationalised in the beef supply chain, accounting for factors such as data, platforms and human behaviour. Handfield (2017) perceives the modern supply chain as a complex adaptive system, and so research studies should incorporate needs such as the data produced by the system itself, how the information aligns with the perspectives of the human agents involved at both the system and individual level, and how high-risk situations impact on the trust humans have toward machines. Additionally, studies in supply chain trust have normally viewed trust from one party toward another; failing to account for both sides of the dyad will limit the predictive power of trust models (Korsgaard, Brower and Lester, 2015).

Studies on trust have traditionally utilised frameworks based on trust antecedents (Viriyasitavat & Martin, 2011; Zarvandi & Zarvandi, 2012). These antecedents will be further identified in Chapter 2, but in the context of the supply chain, can be distinguished between

system-level trust antecedents and individual-level trust antecedents (Grandison & Sloman, 2003). In the digitised supply chain context, Li et al. (2012) believe that several features will also need to be considered in the development of trust models, namely trust being subjective, dynamic, bi-directional, asymmetric, non-transitive and context dependent. Chapter 2 will describe these in further depth.

Following from this background, the motivations for this study include:

- To understand how data, human agents and institutions of the supply chain interact in the production of trust within the network
- To understand how data provides / supports trust and what factors need to be considered in the trustworthiness of data
- To develop insights into how provenance data and blockchain are used to develop trustworthy data in the beef supply chain
- To add the Australian context to the body of research, a need motivated by the lack of Australian studies in the literature review by Delbufalo (2012)

Following on from the last motivation, the study context will be BeefLedger, an Australian data provenance organisation.

## 1.2 Study Context

BeefLedger are an Australian-based digital platform that provides data provenance for the Australian livestock industry. Using blockchain technology, they offer a decentralised ledger that retains a digital record of the movement of a product through the supply chain from paddock to plate. BeefLedger provide provenance information, certifications and smart contracts to establish the origins, credentials and payment mechanisms that are recognised through a system of multi-signatories as the product moves from one entity to the next. The figure below is adapted from Foth (2017) and demonstrates the context of the BeefLedger supply chain.



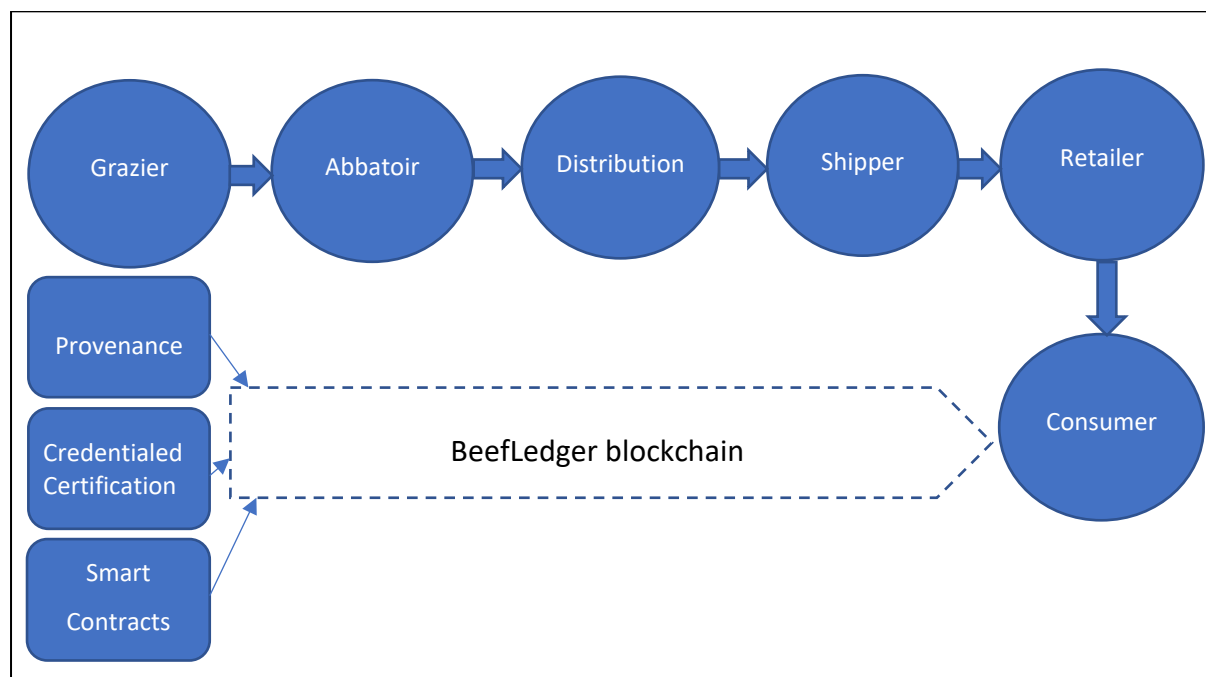


Figure 1.1: BeefLedger Supply Chain (Adapted from Foth, 2017)

Part of their system layers include a blockchain layer. A user interface can enable supply chain entities and participants to follow the traceability of the product, while data sources including ‘Oracles’ (certificate providers) contribute to the data (BeefLedger, 2018). Therefore, the end consumer has, potentially, greater knowledge about the product that they are consuming.

BeefLedger’s motivations are based on the following:

- 1) Simplifying payments for all parties
- 2) Ensuring that the data for the product is managed and maintained through its lifecycle
- 3) Reducing uncertainty and risk, conflict and hidden motives in what they term the ‘sticky’ beef supply chain.

In Chapter 4, a detailed Case Description about BeefLedger is documented to provide further context. To date, several news articles and research reports have been written about them and historical information gathered through the semi-structured interview was necessary to develop further understanding about their processes. BeefLedger are a novel company who emerged in 2017 and to date, there has not been a systematic and rigorous study conducted on their operations or operations of a similar nature.

Briefly, BeefLedger perceive themselves as operating in a ‘zero trust’ environment, which is consistent with many companies utilising the blockchain space (Greigner & Wang, 2015). According to Hawlitchek et al. (2018) and Mehrwald et al. (2019), however, this interpretation is slowly shifting as more research is conducted about the phenomena. Of most need is to reconceptualise how institution-based trust is developed through these platforms. In the past, systems had overarching structural assurances and situational normality created by the rules, policies, regulations and governing frameworks created by institutions (Mehrwald et al., 2019), but electronic exchanges are streamlining transactions to bypass the involvement of institutional structures. In particular, new research is demonstrating that blockchain is not simply removing the need for trust but rather reconceptualising how organisations enable trust through the data that is developed through the blockchain process. There is a need for research on trust in platforms, in particular how the provision of information from these platforms enables trust between all supply chain participants.

Handfield (2017) goes on to suggest that further inquiry using new methods or modes of inquiry and research is needed to build conceptualisations of how the new digital supply chain can be considered:

*“Too many of our current academic journals are bogged down by statistical or methodological concerns that sacrifice content due to overemphasis on rigor...their contribution to conceptual development and new content is minimal, and in many cases, adds nothing at all. Worse yet are the lengthy pages devoted to mathematical optimization and modelling solutions to problems whose boundary conditions have been made so tight that they would never exist in the real world of living supply chains. These models provide little or no new insight and are established to meet the standards of the people who try to pass them off as being “academically rigorous”, but who have lost sight of the objective of bringing novel insight to management thinking and decision-making” (Handfield, 2017, p. 1-2)*

### 1.3 Scope

The unit of analysis in this study will be *how BeefLedger's data provenance supports trust in the supply chain trust process*. Therefore, this study will focus on the following main constructs:

- The beef supply chain and the participants and processes involved in the lifecycle of a product from 'paddock to plate'
- Supply chain trust using selected system-level and individual-level trust antecedents (see Chapter 2)
- Trust constructs and variables that are specific to the beef supply chain
- Provision of Information and how provenance data supports the way in which BeefLedger provide information to all their supply chain participants
- Trust in Platform concepts and the external environment issues that directly affect the beef supply chain

For this research, Supply Chain Management and Supply Chain Theory will be excluded from the Literature Review and discussions. Psychological trust concepts, interpersonal trust between individuals and trust antecedents, which have no relevance to the context, will similarly be excluded. Adoption studies using theories such as the Technology Acceptance Model (Venkatesh & Davis, 2000) have been used to frame trust studies in technology-oriented fields. These, however, are not appropriate to this particular context. Consequently, adoption and acceptance theories will not be discussed in this study.

### 1.4 Research Questions

As this study is using data-oriented exploratory and explanatory research to guide data collection and analysis, it will follow the suggestion of Yin (2003) in formulating "How" and "What" questions, which best suit these categories of research. The questions for this study are:

- 1) How does BeefLedger engage in the provision of information to create data-driven trust in the beef supply chain?

- 2) What are the processes that BeefLedger provide to manage and maintain data in the lifecycle of a product to create high levels of trust among all supply chain participants?

The explanation for the development of these questions will be presented in Section 2.9.

## 1.5 Structure of the Thesis

This thesis is divided into six chapters: Introduction and Overview of the Research; Literature Review; Method; Data Collection and Analysis; Logic Model and Conceptual Model; and, Conclusion.

- Chapter 1 – Introduction and Overview of the Research, establishes the background and motivations for the study, identifies the study context as BeefLedger and the scope of the study, and states the central research question.
- Chapter 2 is the Literature Review, which provides an overview of the Agrifood supply chain and identifies the trust antecedents and technology that will be the boundaries for this study. It also outlines the conceptual framework and the gaps in the theory that this study will be exploring and explaining throughout this research. A guiding conceptual model is produced that summarises the constructs of interest and the key gap in data-driven trust that this study is exploring.
- Chapter 3 describes the Method employed in this research project and provides a description of the objectives of the research such as the development of constructs, presents the research design and defines the data collection and analysis approaches.
- Chapter 4 is the Data Collection and Analysis. This presents the data collection and data analysis procedures conducted on the organisation and on the empirical and secondary data collected, discussing how the major constructs and variables for this study were determined. It offers an explanation on the theoretical interrelationships between the constructs and variables. Extant literature from Chapter 2 will be interwoven into the explanation-building to connect the emerging concepts of this study with existing research gaps.
- Chapter 5 presents the Logic Model and Conceptual Model derived from the analysis, each of which combine the guiding conceptual model from Chapter 2 with the

constructs and variables that emerged from analysis in Chapter 4. Chapter 5 will present a series of propositions based on the theoretical interrelationships established between the constructs and variables.

- Chapter 6 is the Conclusion and will summarise the thesis. It will also discuss the study limitations, future research implications and implications for practice.

## CHAPTER TWO – LITERATURE REVIEW

### 2.0 Introduction

This chapter reviews and analyses the literature that will inform the conceptual framework for this study. The literature draws on supply chain research primarily in the AgriFood sector. Consistent with the scope outlined in the Introduction, themes such as supply chain theory, supply chain management and similar generic topics associated with the terms in the topic title will not be considered for this project. The main concern is trust and the impact this construct has on the information associated with the products that move from ‘paddock to plate’. Trust, itself, is also a broad concept that broaches many fields of research, but within Information Systems the concept is explored alongside organisational structures, business-to-business studies and in transactions and e-commerce. The trust literature that informs this study will draw from psychological, social and institutional research about trust.

In this literature review, trust antecedents will be discussed under the categories of *system-level trust and individual-level trust*. Authors such as Li et al. (2012) and Grandison and Sloman (2003) adopt these categories primarily for online transactions, as trust between trustors and trustees is dependent upon both their trust in the technology and the way this technology mediates their engagement. These broad, overarching categories of trust encompass a number of constructs and provide a general framework for trust in the supply chain setting, which has relationships and interactions similar to online transactions that past researchers described previously have explored. They deal with the organisations, participants and end-to-end providers and consumers in the network. A third broad category of trust that appears in research is dispositional trust, which is also known as personality-based trust (Gefen et al., 2003; Li et al., 2012). Dispositional trust is personal, stemming from psychological beliefs, independent of contexts and is based on someone’s own faith in humanity. Because supply chains deal with organisations and, at times, individuals acting on behalf of companies, certain dispositional facets of trust can be considered out of scope. For example, most individuals in the supply chain do not encounter each other face-to-face and dispositional elements such as how they feel toward the visual features of another person are not possible

in this context. While it could be argued that the end consumer may have dispositional trust toward meat, they are not intricately involved in the supply chain and can be considered an entity. As such, dispositional trust, and thus psychological-level trust concepts, will be excluded from this literature review. System-level trust and individual-level trust concepts, as pertinent to the research, however, will be discussed.

In some studies, trust is the underlying conceptual factor that influences adoption or acceptance of a technology (Schoorman, Mayer & Davis, 2007). These studies focus on trust as being comprised of theoretical attributes such as perceived risk, ease of use and intentions. These attributes come from the psychological studies of trust and consider trust in relation to some form of technology, whether a hardware, system, process or architecture (Canavari et al., 2010). As this research is exploring the supply chain process and the holistic integration of systems and people, there is no one singular technology that is the focus of research.

As described previously, systems-level trust within this research encompasses a range of different technologies such as blockchain, data provenance and ICT, all of which mediate participant interactions and functions in supply chain relationships. Users are not necessarily ‘adopting’ a particular instance of a technology in this context, rather, the study is exploring how the holistic integration of systems within this context facilitate trust. As such, this study is exploring the process of trust as it builds over time and through interactions rather than the motivation of a singular individual’s trust toward an object. Therefore, for the purpose of this study, adoption theories and discussion thereof will be considered out of scope.

To understand the context of this very interesting industry, meat production and its journey from ‘paddock to plate’, one must consider the mechanics of its associated supply chain.

## 2.1 AgriFood Supply Chain

The AgriFood industry supply chain can be conceptualised as the number of entities that are involved in the stream from ‘paddock to plate’. An industry may be complex and contain many entities, which creates a variety of possible interactions in the supply chain. Typically, the entities consist of farmers, suppliers, pack-houses or distributors, transporters, exporters, importers, wholesalers, retailers and consumers (Matapolous et al., 2004). As the number of

entities increases, depending on the AgriFood line, the more problematic the information exchanges become, and as a consequence hindering supply chain collaboration, as companies often do not have compatible systems for information exchanges (Matapoulis et al., 2007)

Both McLaren et al. (2002) and Becker et al. (2004) believe that collaboration between entities is the most important element of the supply chain for being able to fulfil and satisfy the end consumer. In the traditional view of collaboration, two or more chain members actively work together to coordinate activities that span the boundaries of their organisations. Matapoulis et al. (2007) identified collaboration barriers as being the result of increasing number of companies or entities involved along the chain. They state that power-trust relationships are identified as a significant precursor toward collaboration.

Some researchers such as Cox (2003) and Handfield and Bechtel (2004) view power as the greatest deterrent toward trust, reducing effectiveness and efficiency. The more the depth (from operational to tactical and strategic), the width (from simple supply chain activities to more complex undertakings such as new product development) and the number of entities (two or more entities, upstream or downstream) the more intense the collaboration is. Dependence of one company on another means that the company will have power over the other in the chain.

In the livestock supply chain, there is a possibility for companies or entities in the network to not knowing each other, not had previous experience or dealings with the other entity or may not even have communicated directly in the movement of a product from one node to another (Foth, 2017). The end consumer, for instance, may have little dealings with the logistics or distribution entity and is only concerned with the grazier or retailer, and perhaps not even them. In this context, power is of less interest, leading the researchers to the central construct of exploration i.e. trust. According to Handfield and Bechtel (2004), trust is the single most discussed element in making supply chains function and perform most effectively and efficiently. Trust can affect and determine the intensity of collaboration and communication, as well as influence the selection of the appropriate information-data sharing technologies and techniques.



Finally, another important element for the design and governing of supply chain activities includes the decision of selecting the appropriate technique and technology to facilitate information sharing. It is a very complicated decision, since not all potential collaborators are able to meet the requirements of collaboration in terms of technology and techniques (Matapoulos et al 2007).

The modern supply chain is defined by several factors, such as online transactions, wireless communication and e-commerce exchanges. While the product moves through the nodes physically, the accompanying data and the payments are often virtual or electronic (Malik et al., 2019). As such, this literature review will draw upon supply chain, organisational and e-commerce literature in using trust frameworks that have been developed in this virtual or electronic context. Communication, and by nature collaboration, is difficult to achieve in the traditional supply chain (Matapoulis et al., 2007). However, with new information technologies and e-business applications, the production and movement of efficient data and information exchanges between supply chain members warrants a new understanding into how data can be used to enhance the key needs of exchanges in this setting.

In a study of supply chain partnerships, Shore and Venkatachalam (2003) found that limited information-sharing was one of the key factors that led to supply chain fuzziness. This was caused by the limitations of information-sharing capabilities available at the time. Since this study, the introduction of technologies such as blockchain and smart contracts have changed the nature of information-sharing and new research is warranted into how these newer technologies have impacted information-sharing and what effect these have had on supply chain collaboration in particular.

### **2.1.1 External Environment**

Virtual transactions are subject to a potentially greater set of uncertainties due to factors such as the unfamiliarity of entities and participants in the network, the cultural, social and regulatory disparity of exchanges, particularly in cross-cultural transactions, and often the unreliable manner in which services are delivered (Li, van Moorsel & Smith, 2012). Given the differences between Business to Business (B2B) and Business to Consumer (B2C) e-

commerce, some previous research made distinctions between inter-personal and inter-organisational trust (Lane, Zaheer et al, 1998). However, it should be pointed out that even in B2B e-commerce, the inter-organisational trust is frequently maintained and executed via individuals acting on behalf of the organisations.

Trust in this context is concerned with two kinds of transactions: intra-organisational transactions and inter-organisational transactions. Intra-organisational transactions are concerned with coordination, control, exchange of information and logistics within an organisation, whilst inter-organisational transactions are concerned with purchasing, cooperation, exchange of information and customer relationship management. In most cases, the consistency between two organisations is lower than that between two actors within the same organisation, as the former is characterised by different interests and organisational cultures or structures. Moreover, inter-organisational transactions are generally more formal and are usually protected by contractual safeguards (Li et al., 2012)

Trust in an online transaction has been classified under the categories of (1) individual-level and (2) system-level trust (Grandison and Sloman, 2003; Josang et al. 2007; Ramchurn et al. 2004). The aspects of online services in which such trust can be placed has itself been classified as (1) resource-access trust; (2) service provision trust; (3) certification trust; (4) delegation trust; and, (5) infrastructure trust (Grandison and Sloman, 2003). In online transactions, trust depends not only on the relations between a trustor and a trustee mediated through technology, but also on the attitudes of the trustor towards technology as an object of trust (Bart et al., 2005; Corritore, 2003; Li, van Moorsel & Smith, 2012).

Though the supply chain partners develop risk-worthy characteristics and risk-worthy rationale related to economics, dynamic capabilities and technologies, there is always an element of risk present in the partner's relationship from the changing political, institutional and business environment (Laequddin, 2012).

In supply chain literature, factors such as opportunistic behaviour and uncertainty in the environment are common considerations in affecting trust within the network (Wu, Weng & Huang, 2012). Indeed, when even considering supply chain trust, it is evident that the industry

can affect the way trust forms through collaboration between entities. Wu, Chuang and Hu (2012) found that variables such as commitment, shared values and communication were important in the trust relationships in technology industries, with correlations with external environment like uncertainty.

The meat supply chain can be characterised by elements such as uncertainty and risk, conflict and hidden motives (Yee & Yeung, 2010).

### **2.1.2 Supply Chain Trust**

Trust is critical in the act of transactions that incur risk. The livestock supply chain, in particular, whether dealing with live animal products or boxed meats, has traditionally faced problems of trust across all entities in the network (Yee & Yeung, 2010). Communication is cited frequently in the literature as the most effective remediator for trust in this setting (Wu, Weng & Huang, 2012; Maestrini et al., 2018).

The introduction of sensor technology and the Internet of Things (IoT) into supply chains in recent years has produced a reconceptualization of how constructs like communication, collaboration and, in particular, trust, function as part of the process between entities (Serazetdinova et al., 2019). In their study of an Agrifood supply chain business, Matapoulis et al. (2004) identified information sharing as one of the most critical needs for producing seamless logistics, in particular the need to determine common business vocabularies across the supply chain and the sharing of common processes.

Most supply chain studies that used trust as a framing concept have been focused on technology industries, such as studies by Wu, Weng and Huang (2012) who studied trust in supply chain partnerships in the context of high-tech companies in Taiwan. In their study, Wu, Weng and Huang (2012) used commitment-trust theory to explore positive correlations between variables of the theory and continued partnerships in the supply chain.

In the Agrifood sector, particularly, the role of trust is of crucial importance as many aspects of food quality are process characteristics and may be difficult to scrutinize at the raw, intermediate or end product (Batt, 2003, Fischer et al., 2007). As a consequence,

procurement decisions of Agrifood companies require the presence of trust as decision variable (Hornibrook, Fearne, 2003). This is particularly relevant in a first transaction with a new supplier, where prior experience does not yet exist. For the Agrifood sector, the linkage between information and communication technology driven opportunities and the issue of trust is of particular importance due to the challenges in communicating food quality issues across the food supply chain.

In conceptualising a trust model from 808 articles on trust, Eber (2009) identified 8 clusters or themes that affected trust in transactional relationships: the person, satisfaction, reputation, security/risk, transaction cost, future intention, dependency and environment. Of interest, dependency is denoted by variables independence, autonomy, leadership and power. Trust in the supply chain relies, inter alia, on the data sent between participants.

### **2.1.3 Supply Chain Data**

In conceiving the ‘digitized supply chain’, Handfield (2017) states that:

*“The next competitive capability in the supply chain will be visibility, real-time response, and digitization as the ingredients for driving rapid growth in a flat economy. Visibility requires transparency, which in turn can be leveraged through the new technological capabilities of inexpensive cloud-based computing, distributed computing “at the edge”, and the growth of a digital ecosystem. Those who harness these technologies through collective innovation with their supply chain partners will win” (p. 4-5).*

Research in this context has begun to explore how data is used as both a visible asset and an underpinning form of trust in the supply chain. Serazetdinova et al. (2019) explored how digital data could be transformed into decision-making in the supply chain, focusing on areas such as improving efficiency in livestock production, food provenance, developing new operating models that shorten the supply chain network and how it could manage uncertainty and risk. The multi-disciplinary nature of the data in the AgriFood industry raises questions around standards, inter-operability and ownership, although Serazetdinova et al. come to the

finding that trust in the data needs to be considered in future research. This research project is attempting to do just that.

Malik et al. (2019) identified the data layer as an important component of the modern digitalised supply chain. This layer is comprised of data collected from sensor data streams, trade events and regulatory endorsements that capture real-time information and collate it with existing information about the commodity. In this layer, sensors installed with the commodity monitor changes such as temperature and record them through the IoT, while trade events are triggered at points of change of ownership of the commodity. Regulatory endorsements are provided by food safety authorities at checkpoints throughout the movement of the commodity, in the form of commodities and reports.

Viriyasitavat and Martin (2012) explored the potential of trust in data in workflows through supply chain networks. Supply chain creates data and there is a need to conduct research on how real-time data exchange influences the trust between entities. A consideration in this research is that of trust antecedents.

## 2.2 Trust Antecedents

In virtual and e-commerce transactions, Li et al. (2012) believe that trust requires various antecedents prior to engagement between parties. These antecedents provide the foundation for business relationships and can facilitate long-term relationships between entities in the network. There are many terms that are associated with trust, including collaboration, cooperation and communication (Gunasekaran et al., 2001). Trust underpins each of these terms and is central to cohesive and productive relationships where efficient operations become based on reliance between entities, specifically on words and deeds that have been fulfilled in the past (Tschahannen-Moran & Hoy, 2000). According to Baier et al. (1986), trust provides the foundations for effective cooperation and communication. The influence of trust on business relationships is that it allows for the continued exchanges that benefit all parties and reduces the complexities of transactions that are generated in supply chain networks. In the meat industry, these transactions occur at all times in the supply chain from paddock to plate and it is not only necessary to foster business relationships between

entities, as Garbarino and Johnson (1999) note, trust is critical in guiding consumers' decision-making toward the purchase and consumption of products.

Trust can be perceived as the generalised expectation that individuals, groups or artefacts such as technology can be relied on (Fasli, 2007). Mayer, Davis and Schoorman (1995) noted that trust is a subject of great interest among scholars but its study within the organizational context remains problematic. Reasons for this include lack of clarity between trust and associated constructs, confusion between trust and its antecedents, and a failure to consider both the trusting party and the party to be trusted. These reasons become particularly important in the supply chain setting, where entities can be diverse and even cross borders and countries. Developing their views on trust further, Mayer, Davis and Schoorman (2007) stated that cross-cultural and international dimensions would need to be considered in exploring trust within organisational research, particularly with a clear definition of variables.

In a meta-analysis of trust theory in organisational studies, Delbufalo et al. (2012) surveyed 182 research papers and derived a classification for the most used trust theories. The most commonly used trust theoretical approaches were Social Exchange Theory, Transaction Cost Economics and Trust-Commitment Theory. These meta-level theories consider what relationship factors affect trust in a business exchange but are lacking in how they apply specific variables about trust and how these variables can be affected in an organic, complex network of exchanges like a supply chain. The study found that the US, China and the Netherlands were the most used contexts, while cross-country studies were extremely popular. This correlates with the observation that Australia has been an underrepresented context in supply chain trust studies. Following the results of their study, Delbufalo et al. perceived that future research needs to focus on inter-firm trust as a reciprocal concept and more attention was needed on how cultural influences affect inter-organisational trust outcomes.

As a general view of high-level trust antecedents, Li et al. (2012) identify six antecedents: dispositional antecedents; cognition-based antecedents; institutional antecedents; knowledge-based antecedents; calculative antecedents; and, identification-based antecedents. In their model, they view these antecedents as intermediaries between a party

– whether a consumer or business - and the transactional context. Antecedents influence the party's perception: if each antecedent is present and at a high level, then trust in the transaction is high. Similarly, He (2011) used personal characteristics-based, knowledge-based, deterrence-based, social influence-based, technological attributes-based, vendor image-based and institution-based trust antecedents.

With a broad number of trust antecedents and a diverse collection of constructs, variables and conceptions of trust available in the literature, there is a need to provide a more refined and targeted list of trust concepts that will be of particular relevance to the supply chain setting under study in this research. Fasli (2007) more simply divides trust into personal and impersonal factors. This is useful in considering the context of supply chains; while entities operate and have transactions at the organisational level, there is a mix of organisations that are group-based such as abattoirs, distributors and logistics people who operate at the group level, and individuals who participate including farmers, safety check operators and consumers. The meat supply chain is diverse and therefore trust needs to be explored from the many possible perspectives. Personal and impersonal factors are the most effective way to group this diversity.

In the context of online transactions, Li et al. (2012) define trust as individual-level trust and system-level trust. Individual-level trust can be considered as the perspective of supply chain entities who operate individually, including the end consumer, who have different trust needs compared to organisations operating at the system-level. System level trust is the view of organisations who create the network and supply the rules, cross-cultural boundaries and institutional settings that operate in tandem with individual perspectives. The individual perspective is examined in more depth in this project.

### **2.2.1 Individual-level Trust Antecedents**

While meta-theories of trust are popular in supply chain research, there are few studies that have comprehensively assessed individual-trust antecedents and how they influence trust in data through the supply chain lifecycle. The individual-level trust antecedents are referred to as determinants (Yee & Yeung, 2010), paradigms (Handfield & Bechtel, 2004) or building blocks (Tschannen-Moran & Hoy, 2000) among many other conceptual terms. What is

common across studies is that these represent the trust from the individual level from psychological, emotional or personal perspectives and correlate with how individuals feel toward an agent or entity depending on their past experiences and perception. In supply chain research, individual-level trust models are usually concerned with the computational methods used to evaluate the trustworthiness and reputation of a node in the network, based on the observed past behaviour pattern. If an instance of undesirable behaviour of one node is observed by another node, the observer will decrease the trustworthiness, and thus reputation, of the node by adjusting the past evidence recorded (Han et al., 2010). Therefore, individual-level trust is organic, changing based on both past and present experiences between entities that will influence future transactions.

There are a number of variables that have been used as individual-level trust antecedents. Handfield and Bechtel (2014) asserted that trust could be grouped into six conceptual paradigms, which are reliability, competence, goodwill (openness and benevolence), vulnerability, loyalty, and multiple forms of trust (e.g. cognitive trust and affective faith trust). In the context of e-commerce, Wolski, Howard and Richardson (2017) identify necessary trust antecedents such as ability, benevolence and integrity. Yee and Yeung (2010) identified competence, reliability, integrity, credibility and benevolence. In the sharing economy, Kim, Yoon and Zo (2015) identified reputation, social presence and benevolence as antecedents and perceived risk as a variable toward trust. In supply chain partnerships Wu, Weng and Huang (2012) found that shared values, communication and opportunistic behaviour were antecedents for trust. Finally, Laeequddin et al. (2012) add honesty and transparency as other characteristics.

Further to this, Laeequddin et al. state that trust researchers focus overwhelmingly on the trustee's characteristics to build trustworthiness, identifying antecedents and consequences of trust in various contexts presuming trust as one-dimensional phenomenon. They state that trust is context-dependent, and researchers need to determine how their context affects how they design trust building models. Li et al. (2012) support this, saying that online transaction scenarios need to be appropriately classified and the types of actors and safeguards must be considered when researchers explore trust in a particular virtual setting.



While there is a broad number of trust antecedents, there needs to be careful selection of the types that will form the variables for studying trust in supply chain settings. In particular, the trust antecedents need to be selected in consideration of the transactional attributes that are involved in these exchanges, particularly around information and trustworthiness between entities that is created in the exchange of data. This study will use the Tschannen-Moran and Hoy (2000) ‘building blocks’ of trust that can be used to study relationships or collaborations based on trust: willingness to risk vulnerability, confidence, predictability, reliability, honesty and openness. These are individual-level trust antecedents that are the layer of trust in the supply chain lifecycle.

The table below classifies these individual-level trust antecedents and identifies associated determinants that these variables will attempt to capture for the purpose of this investigation. These will be discussed below.

<b>Individual-level Antecedent</b>	<b>Trust</b>	<b>Associated Antecedent</b>
<i>Willingness to Risk Vulnerability</i>	Vulnerability,	Interdependence, Opportunistic Behaviour, Perceived risk
<i>Confidence</i>	Faith	
<i>Predictability</i>	Cognition, Reputation,	
<i>Reliability</i>	Competence, Ability, Reliance	
<i>Honesty</i>	Credibility, Integrity, Loyalty	
<i>Openness</i>	Benevolence, Shared values, Goodwill	Communication,

Table 2.1 Trust Antecedents

### **2.2.2 Willingness to Risk Vulnerability**

In this antecedent, trust is perceived as a willingness to be vulnerable under conditions of risk and interdependence in which the perceived probability of loss is weighed against the potential benefits of an exchange (Rousseau et al., 1998). Vulnerability is considered one of the most important elements in understanding interpersonal or individual-level trust (Mayer et al., 1995). In traditional online transactions based on trust, users negotiate an online platform in the understanding that risk may be in other agents, humans or viruses can access, copy or even modify the data intentionally or by mistake. For example, purchasing goods for inflated prices or making false or faulty reservations could result. Risk in online platforms is created by information asymmetry that consequently generates identity and product uncertainty, information asymmetry, and fears of opportunistic behaviour, and these properties of risk reduces transaction intention (Kim, Yoon & Zo, 2015).

Especially in the meat industry, where there is the risk of the meat not being what the customer paid for or that conditions of uncertainty like animal diseases affecting risk, trust is diminished. As one of the more greatly associated components of trust in the literature (Mayer et al., 1995; Rousseau, 1998), vulnerability is assumed as a matter of importance by most definitions of trust. Risk is the perceived probability of loss (Coleman, 1993; Williamson, 1993); it creates an opportunity for trust that can lead to risk-taking. These two aspects are related by Rousseau et al. (1998) through the condition of *interdependence*, where the interests of one party cannot be achieved without reliance upon another. The degree of interdependence may alter the form trust takes, and hence brings certain vulnerability. Thus, trust can be seen as a willingness to be vulnerable under conditions of risk and interdependence.

### **2.2.3 Confidence**

Rousseau et al. (1998) discuss this antecedent as the degree of confidence one holds in the face of risk rather than in the choice or action that increases the risk. Luhmann (1988) explains that if one party does not consider alternatives in an exchange, then this is a situation of confidence whereby one action is chosen in preference to other in spite of the possibility of being disappointed. Both researchers borrow from Kee and Knox (1970), who previously

believed that a party can rest in uncertainty with a certain degree of confidence. In the meat supply chain, confidence is a common form of trust in which entities believe that a transaction will be authentic even when there is the possibility of being disappointed.

#### **2.2.4 Predictability**

Prediction and trust can both be understood as means of uncertainty reduction (Lewis & Weigert, 1985). Although some literature equates predictability with trust, Deuth (1958) suggests that, to be meaningful, trust must go beyond predictability; equating the two is to suggest that a party who can be expected consistently to ignore the needs of others and act in a self-interested fashion is therefore trusted because the party is predictable. What is missing from predictability is the willingness to take a risk in the relationship and therefore be vulnerable. Predictability might best be thought of as influencing cooperation. If one expects that a party will predictably behave positively, one will be disposed to cooperate with the party. However, the reason for that predictability may be external to the party, such as strong control mechanisms (Friedland, 1990). Without those mechanisms, a person may be unwilling to be vulnerable to the party. Thus, predictability alone is insufficient to form bonds of trust.

#### **2.2.5 Reliability**

According to Tschanne-Moran and Hoy (2000), reliability – also known as dependability – can be considered as predictability combined with benevolence. Benevolence is a common trust variable, described as being present when there is care and empathy in an exchange and a partner is seen to act in a manner that is not completely self-serving (Mayer et al., 1995; Yee & Yeung, 2010). In the context of service platforms, Kim, Yoon and Zo (2015) describe benevolence as the belief that the sharing service is genuinely interested in the consumer's welfare. Ebert (2009) uses "reliance" when referring to the reliability variable, which is a trustful and confident commitment between one party and another. In a situation of interdependence, when something is required from another person or group, the individual can be reliably counted on to supply it. And thus reliability is reflected in the predictability and consistency of the trustee's behavior (Moorman et al., 1993)

### **2.2.6 Honesty**

Honesty is what speaks to a person's character, integrity, and authenticity (Tschannen-Moran & Hoy, 2000). Correlation between a person's statements and deeds characterises integrity. An acceptance of responsibility for one's actions and avoiding distorting the truth characterises authenticity (Tschannen-Moran & Hoy, 1998). Honesty is seen as one of the most pivotal facets of trust and shares commonalities with antecedents such as integrity and benevolence (Baier et al, 1986). Ha et al. (2011) believe when supply chain relationships form mutual trust, this will lead to more open and honest exchanges of valuable data or information, thereby enabling strengthened cooperation with less risk of misuse of information.

### **2.2.7 Openness**

Openness is when one makes oneself vulnerable to another by sharing personal information (Mishra, 1996). Butler and Cantrell (1984) characterised openness as the extent to which relevant information is not withheld. It signals a reciprocal trust; a confidence that neither the information nor the individual will be exploited, and recipients can feel the same confidence in return. Ibrahim and Ribbers (2009) perceive openness as being influential on organisational relationships as it encompasses the willingness of partners to share sensitive information and generates empathy, resulting in modifying typical behaviour in response to partners' needs. Openness motivates information sharing even beyond contractual obligations, making it the highest form of individual-level trust in a supply chain.

To date, these facets have formed part of organisational studies that have explored them as concepts in reciprocal relationships. Trust is considered in one-to-one relationships or as reciprocal events or actions that are mutually beneficial.

In this prior research there is a lack of consideration of how trust can be developed through data. But before considering this we must look at broader systems of trust.

## 2.3 Systems of Trust

### 2.3.1 System-level trust

System-level trust is when reputation systems form a framework of trust in which good behaviour is rewarded and poor behaviour is punished. Trust in this framework is social capital, that is formed by protocols or rules of interaction that govern the behaviour of a group or system of people (Han et al., 2010). In system level trust, trustworthiness is institutional and based on roles, systems or reputation, and the trust shared by all participants is based on the formal structures in place (Puusa & Tolvanen, 2006).

Much trust literature dissects trust into a number of bases. Bases of trust are psychological expectations, generally focus on what basis the expectation is formed and on whom the expectation is focused – essentially, what is the basis for a relationship between a trustor and trustee (Rousseau et al., 1998; Ebert, 2009). There are many bases of trust and each are context-dependent, for instance, several bases of trust are directly applicable to business relationships. For the purposes of this research, the following bases of trust have the most relevance and will be discussed in this literature review:

- 1) Deterrence-based trust is generated through the presence of costly sanctions in a transaction
- 2) Knowledge-based trust is established through ongoing relationships and building a history of interactions
- 3) Rules-based Trust is shared among participants
- 4) Institution-based Trust is formed through overarching structures and norms that are created through
- 5) Identification-based trust based on shared interests

In conceptualising intra-organisational trust, Zarvandi and Zarvandi (2012) perceive trust as a continuum that moves across five bases: deterrence-based trust, calculus-based trust, knowledge-based trust, relational-based trust and identification-based trust. At the lowest level of deterrence, there is distrust or perhaps absence of trust as trust can only exist if there are costly sanctions in place. With the highest-level being identification-based trust, two

parties identify with each other through shared interests, resulting in complete confidence. The limitation is that this model explores trust in the intra-organisation context and based its development on the employer-employee relationship. As such, the bases of trust here reflect interactions between individuals who might have contact, face-to-face interactions or prolonged relationships and within the business-to-business context, particularly where two entities may have little or no contact, the development of trust will not proceed according to the continuum.

This continuum may not apply to inter-organisational transactions, particularly in the international setting where face-to-face interactions are rare, and deterrence-based trust may even be a desired agreement between both parties to sustain an ongoing relationship of exchanges and collaboration. We discuss the parts of this continuum below.

<b>System-level Trust Antecedent</b>	<b>Associated antecedent</b>
<i>Deterrence-based Trust</i>	Calculus-based trust
<i>Knowledge-based Trust</i>	History-based trust, Interaction-based trust, Relational-based trust, Identity trust, Affective trust
<i>Rules-based Trust</i>	Cognitive-based trust
<i>Institution-based Trust</i>	n/a
<i>Identification-based Trust</i>	n/a

Table 2.2: System Level Trust Antecedents

### 2.3.2 Deterrence-based Trust

In this form of trust, interactions are facilitated based on system protocols having costly sanctions, consequences or deterrents in place for any violations in the transaction. A number of researchers have stated that they do not consider this a form of trust at all, but rather a form of distrust (Sitkin & Roth, 1993; Zarvandi & Zarvandi, 2012). However, Rousseau et al.

(1998) feel that this trust emphasises utilitarian considerations that enable one party to believe that another will be trustworthy, provided deterrents are in place to prevent a breach of trust or prevent opportunistic behaviour, particularly in inter-firm situations where costs of breaching trust are high and the involvement between parties and the knowledge they have of one another is limited before and during the transaction.

Laequddin et al. (2012) perceive deterrence as trust being produced in environments of shallow dependence. The mechanisms of the institution deter unreliable behaviour through explicit sanctions, and a sense of obligation is created through the procedures and bureaucracy largely put in place by the institution. Shapiro et al. (1992) explored this as calculus-based trust in which relationships are formed from balancing potential costs against the benefits of cooperation; though some researchers have separated calculus-based trust and deterrence-based trust into different system-level antecedents, they are both based on cost-benefit psychological states in which participants engage in a transaction based on the knowledge that there could be substantial costs to a party who breaks the trust. In the supply chain setting they share many similarities and will be grouped together for the purpose of this research.

### **2.3.3 Knowledge-based Trust**

Knowledge-based trust emerges from the quality of social exchanges and recurring interactions or communication between a trustor and trustee over time (Shapiro et al., 1992; Rousseau et al., 1998). Through regular communication and repeated exchanges, parties will develop a reinforcing pattern of trust in which they can come to predict one another's behaviour. Many researchers collate this with history-based or personalised trust, particularly in the organisational context (Kramer, 1999). Actors begin to develop an understanding of one another, and the relationship or collaboration evolves to the extent where each is able to predict how the other is likely to behave in a situation.

As parties begin to have more points of contact, a self-reinforcing pattern of trust emerges in which their predictive behaviours can become more evident in the collaboration. Knowledge builds over the repeated interactions and when expectations associated with the predictions are fulfilled, this leads to trustworthiness in a wider social context. Repeated cycles of

exchange, risk-taking, and fulfilment of expectations are critical for this knowledge-based trust to form (Tschannen-Moran & Hoy, 2000).

Through knowledge-based trust, 'interactional histories' form based on understanding others' dispositions, intentions, and motives. Reliability and dependability from previous interactions develop positive expectations between parties. Therefore, an individual's willingness to engage in trusting behaviour during interactions are processes that are largely history-dependent (McAllister, 1995). Scholars sometimes refer to this form of trust as 'affective trust' or 'identity trust' (Rousseau et al., 1998).

In the supply chain context, knowledge-based trust can be difficult to conceptualise given that many exchanges are done online or through electronic transactions. Further, there is often the possibility that supply chain entities do not know who the other might be. In the livestock supply chain especially, the end consumer often may not be aware of who the distributor is. Equally, the grazier may never come to know their end consumers.

#### **2.3.4 Rules-based Trust**

Rules, both formal and informal, include the knowledge members of organizations have about the explicit and tacit understandings regarding transaction norms, interactional routines, and exchange practices that provide a basis for the inference that others within an organisation are likely to behave in a trustworthy fashion (Kramer, 1999; Puusa & Tolvanen, 2006). Rule-based trust is predicated on shared understandings regarding the system of rules regarding appropriate behaviour. It includes knowledge that members have about the tacit understandings relating to the system of rules and the appropriate behaviours that have been established or formed in the past. Rules are institutionalised through continued practices and exchanges and will eventually become internalised at the individual-level, coinciding with reliability.

Rules, both formal and informal, include the knowledge that members have about tacit understandings. Rule-based trust is predominantly shared understandings relating to the system of rules regarding appropriate behaviour. By institutionalizing trust through practices at the collective level, trust becomes internalized at the individual level. (Kramer, 1999.)



According to March and Olson (1989), rule-based trust is sustained through reciprocal confidence in the socialisation of members of a system and also through the adherence of each member toward normative practices. Rule-based trust is a form of institutionalising trust at the collective level; thus, it facilitates spontaneous coordination and cooperation among organisational members.

### **2.3.5 Institution-based Trust**

Institution-based trust, is based on the perceived reliability of a system or institution of rules, protocols and guidelines in place, described as structural assurances such as the contracts, regulations, procedures and laws of the system (Korsgaard et al., 2015) and situational normality of the environment in which there are shared transaction norms that at all times are a measure to how regular exchanges should be conducted (Li et al., 2012). As Cai, Jun and Yang (2010) note, institutional forces are the most critical determinants of trust in organisational and inter-firm studies, as strategic decisions are often made based on the institutional environment. Using China in particular, they note that legal protections, government support and situational normality attributes such as *guanxi* (business conducted through personal networks) influence the decisions to build trust between suppliers, providers and consumers. Typically, structural assurances and situational normality are created through third party endorsements, guarantees and reputation scores (Yakel et al., 2013). These are difficult to define in virtual or electronic exchanges in which individuals may conduct their transactions in lieu of recognisable institutions. According to Pavlou and Gefen (2004), in online transactions services such as feedback, reputation scores and intermediary trust could replicate electronic forms of institution-based trust.

### **2.3.6 Identification-Based Trust**

Identification-based trust is based on identification with others' "desires, intentions and empathy; it is the highest level of trust development through repeated interactions" (Lewicki & Bunker, 1996, p. 122). This form of trust is characterised by shared goals and values between actors (Li et al., 2012). This allows the actors to come to a deeper understanding of each other and become aware of shared values and goals, thereby enabling trust to grow to a higher and qualitatively different level. Identification-based trust is also enhanced by a

strong emotional bond between the actors, based on a sense of shared goals and values. It is grounded in perceptions of interpersonal care and concern, and mutual need satisfaction (Lewicki and Tomlinson, 2003).

Only a few relationships will attain the highest level of trust - identification-based trust, “based on identification with others’ “ desires and intentions” (Lewicki and Bunker, 1996: 122). While these established forms of trust have been examined by several researchers, there are emerging forms of trust concepts that are useful to this research project.

### **2.3.7 Trust in Platforms**

Trust in Platforms is an emerging research phenomenon that is primarily studied within the cryptocurrency and online exchange environment (Hawlitchek et al., 2019; Mehrwald et al, 2019). Trust in a platform or the corresponding (sharing economy) platform provider can be interpreted as the beliefs regarding the performance of an institution or organization rather than an individual.

Kim, Yoon and Zo (2015) conducted a study on service platforms as a mediator between peers in sharing economy transactions. The motivation for their study came from the notion that previous research perceives platforms as removing the necessity for institutions as they provide direct exchanges between individual users. However, the service platform itself assumes a form of system-level trust. Their study posits platforms as not only mediators of an exchange but as third-party institutions. These are however subject to geographic issues such as local government and legal issues based on countries.

In e-commerce environments, Fasli (2007, p.4) believe that for agent technology such as platforms to fulfil its true potential and for users to be willing to engage with and delegate tasks to agents, a number of challenges need to be overcome. In particular, users need to:

- (1) trust that agents do what they say they do;
- (2) be confident that their privacy is protected;

(3) be confident that the security risks involved in entrusting agents to perform transactions on their behalf are minimized; and,

(4) be assured that any legal issues relating to agents trading electronically are fully covered as they are in traditional trading practices.

Current research around platform trust is based around peer-to-peer transactions and exchanges conducted purely online (Mohlmann & Geissinger, 2018). Trust in this sense is developed by the platform provider, who offer substitutes for attributes such as structural assurance and situational normality within the institution-based trust level. These attributes can vary between settings and there is a need to understand how they can be substituted in the supply chain setting.

The aspects of online services in which such trust can be placed has itself been classified as (1) resource-access trust, (2) service provision trust, (3) certification trust, (4) delegation trust and (5) infrastructure trust (Grandison and Sloman, 2003).

Ter Huurne et al. (2017) analysed nine articles that explored the use of trust in platforms and most research focused on e-commerce, online transactions and customer-to-customer exchanges. In their meta-analysis of literature on the sharing economy, Ter Huurne et al. found that the five most influential dimensions of trust toward platforms were:

- Safety measures such as protection of privacy
- Guarantees
- Website quality
- The quality of the platform service
- Reputation of the platform

They also identified that, from a buyer's perspective, perceived risk and buyer characteristics play a role in forming trust. Some common themes across this literature review were how platforms provide guarantees and assurances, which provide trust to its users.

With the emergence of recent technologies such as blockchain, there is a need for further research into the concept of trust in platforms. Mehrwald et al. (2019) studied blockchain and

its potential to impact trusting relationships in online platforms, summarising two perspectives: (1) perceived trust in the platform described by the ability, benevolence and integrity of the platform, and (2) the integrity of the platform as defined by the dimensions of structural integrity and situation normality (p. 4588). Because institution-based trust has traditionally been considered in the presence of a literal institution, such as a bank, this institution provides users with external trust that, in the event of a negative transaction, that the institution will intervene and preserve the integrity of the exchange. Third-party vendors may be considered institutions in the exchange but may only be facilitating the movement of data, products or services between entities with little policies, regulations or implications for negative transactions. They are not facilitating collaboration between parties but providing data about the product within the exchange. This means an absence of structural assurances and situational normality if institution-based trust is invoked and an absence of shared values and shared understanding if identification-based trust is necessary.

Nine studies found that trust in the platform also influences trust in the seller (Chen, Huang, et al., 2014; Chen, Lai, et al., 2014; Chen, Huang, et al., 2015; Lee & Lee, 2004; Möhlmann, 2016; Thierer et al., 2015; Verhagen et al., 2006; Wei et al., 2014; Zhang et al., 2014). A platform, for example, can use guarantees and assurances to establish trust as mentioned above.

This section introduced major concepts associated with system-level trust. As will be seen in later toward the end of this Chapter, system-level trust is an important theoretical underpinning for this research. It is posited that system-level trust is comprised of deterrence-based trust, knowledge-based trust, rule-based trust, institution-based trust and identification-based trust in that specific ordered sequence. Deterrence-based trust is considered the lowest form of system-level trust, moving up through to identification-based at the highest form with each base between being influenced or affected by the way supply chain entities engage in transactions.

One emerging technology that underpins many transactional platforms is blockchain.

## 2.4 Blockchain

BeefLedger, the organisation under study, employs blockchain as the primary technology that underpins their operation. Blockchain technology has emerged in the last few years and has received much research attention in the cryptocurrency field where online and virtual transactions are dominant (Mehrwald et al., 2019). Tonissen and Teuteberg (2018) describe a blockchain as a stringing (concatenation) of data, which are combined into individual blocks and stored on all users' computers. This succession of data blocks produces a sequence that reflects the course of transactions, resembling a chain. The blocks are protected from changes, so that over time a gapless chain of linked data blocks is created, and the inclusion of a new record in the chain requires a consensus mechanism that all participants within the transaction network must agree in unison, preserving the correct state of data in the network.

Because of its tamper-proof characteristics, blockchain is considered a disruptive technology that is being explored in many fields of IT. In paraphrasing an article in the Economist, Mehrwald et al. (2019) refer to blockchain as the "trust machine" (p.4590). Furthermore, Greiner and Wang (2015) believe that blockchain has the propensity to create trust-free systems. This will have enormous impact on what Merhwald et al. (2019) see as the sharing economy. Some of the current uses of blockchain they identify include file transfer across peer-to-peer platforms, contract management systems and security transactions, which each have applications in banking and financial service industries.

Greiner and Wang's (2015) notion of trust-free systems proposes to utilize blockchain technology's capability to automatically create an immutable, consensually agreed, and publicly-available record of past transactions that is governed by the whole system to mitigate trust issues in peer-to-peer systems. In addition, smart contracts allow the implementation of contractual agreements and other applications to happen within this supposedly trust-free environment. This way, costly mechanisms to build trust in intermediaries or interpersonal trust are thought of to be rendered obsolete by design (Greiner and Wang, 2015).

Introducing the notion of trust-free systems, Greiner and Hui (2015) propose to address trust issues in peer-to-peer systems, such as Bitcoin, by eliminating the need for trust rather than

employing costly trust-building mechanisms and insurance measures. In such a system, governing institutions or interpersonal trust get replaced by cryptographic protocols and decentralized consensus algorithms (Notheisen, Hawlitschek & Weinhardt, 2017). The concept of being trust free, however remains unclear, since one could argue that trust will not be replaced but rather shift from central institutions or market authorities towards algorithms. These need to be formed by predefined rules that eventually govern the agents' interactions (Maurer et al., 2013). Thus, human users are required to trust in algorithms instead of traditional institutions

Auinger and Riedle (2018) see this as an opportunity for reconceptualising trust in this new system, stating that *“it is a massive exaggeration to claim that the blockchain is trust-free or that trust in intermediaries is not needed any more in the blockchain context...this does not mean that trust issues have changed fundamentally. Rather, traditional determinants of trustworthiness (i.e., ability, benevolence, integrity), along with known mechanisms to establish trust in online settings (e.g., third-party institutional mechanisms), will remain critical in blockchain settings”* (p. 7).

Storing information and data in a blockchain may create a more secure environment for data-based applications but it is the provision of information from such applications that helps to establish trusting relationships.

## 2.5 Provision of Information

Provision of accurate and reliable information is a strong determinant of trust (Anderson & Narus, 1990; Chen et al., 2014; ter Huun et al., 2017). Particularly in times of risk or uncertainty or conflict, sharing true and reliable information facilitates trusting relationships (Yee & Yeung, 2010). In their study of livestock supply chains, Yee and Yeung found that consumer trust was high when suppliers showed evidence that they had the capacity to fulfil obligations and meet expectations. In particular, provision of information mediated the trust determinants of their causal model and resulted in higher consumer trust in the supply chain entities.

Kwon and Suh (2004) identified information sharing as the most critical agent in the trust-building process of supply chain implementations. Provision of information is characterised by underlying elements: being true and reliable, being complete and being factual. An information exchange process between two parties can result in positive attitudes, predictability and openness. Sharing this information will remove suspicion, reduce hidden motives, particularly in times of uncertainty and risk or conflict. It has a positive effect on the perceived integrity and reliability of the trustee (Yee & Yeung, 2010). The figure below explores how provision of information is a key mediator between the external factors and the effect it has on entities through specific information or data inputs.

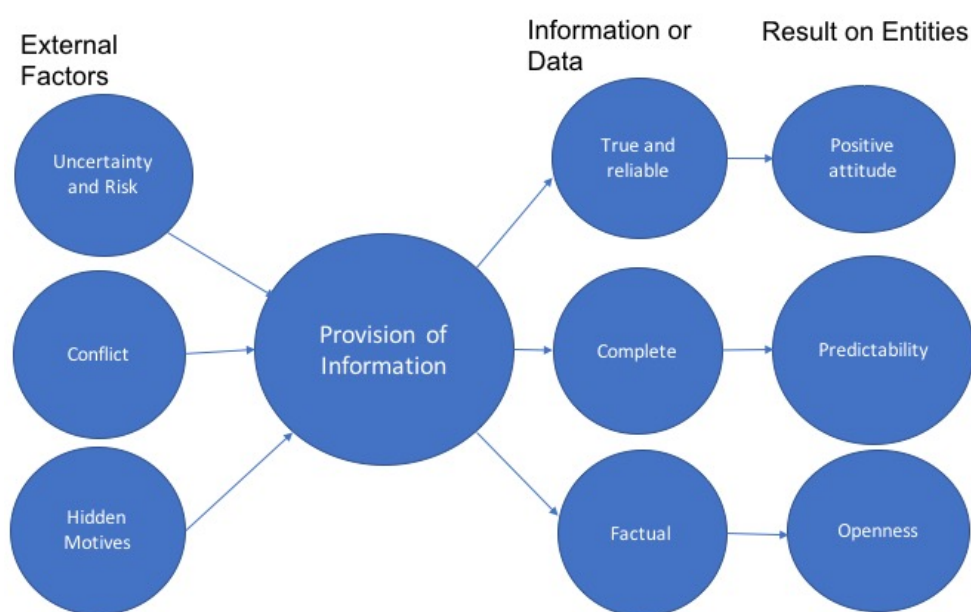


Figure 2.2: Provision of Information effect

Providing information enhances the prediction of the future intention of the exchange partner. By sharing true and reliable information, perceived trust could be built, and perceived risk could, in principle, be reduced. Uncertainty or conflict between the two parties can be reduced when information is provided in the form of completeness and openness (Yee & Yeung, 2010).

In the supply chain context, provision of information is an important determinant of trust. In supply chains, information sharing refers to knowledge interactions and information exchanges that enable better transactions (Lee & Ha, 2018). When the external environment is compromised by uncertainty or risk, conflict or hidden motives as it can be within beef industry, provision of information increases trust around concerns such as safety, meat quality and purchase choice or intentions (Grunnert, 2005). In his research, Verbeke (2005) found that in times of genetically modified food, irradiation or other health concerns, new information affected how consumers reacted to a product even without medical or scientific evidence. The beef supply chain in particular is driven by concerns for safety and fraud,

As trust level is not static in a relationship, it needs to be developed in systematic way. According to Van Wezemael et al. (2012), if the provision of information includes tangible benefits to all parties, then it can be considered a key factor in shaping consumer acceptance of food technologies. Further to this, Mazzocchi et al. (2004) add that if the knowledge base consists of reliable information from a trustworthy information source, then this will have positive effects on consumers. If there is understanding about the risk-benefit perceptions, knowledge, and trust consumers have in information, this will increase the success of technological solutions in the beef sector (Van Wezemael et al., 2012).

Li, van Moorsel and Smith (2012) view trust in terms of transactional attributes. A transaction is dependent upon two conditions: the attributes of the transaction and the context of the transaction. Attributes of a transaction include the value, volume, the frequency of the exchange and the costs involved. Each attribute is dependent upon the transaction context and the perception of the other party. For instance, the value of one exchange will be seen as low to one entity but be perceived as higher to the other. The differences in the value-perception can significantly affect trust in the exchange from one side or the other

While they identify some significant transactional attributes such as actor-specific and relationship-specific transactions, Li et al. (2012) believe that a significant attribute is the quality of information provided by a seller. The level of trust in an exchange can be affected by inconsistent information provided by different sellers or the same seller providing conflicting information. Technologies such as blockchain can potentially solve this.



The transactional attributes discussed above need to be assessed in a specific transactional context, or transactional environment, which provides different standard and optional measures to safeguard the interest of the parties and increase the trustworthiness of the online transaction for both actors.

Two considerations about the information are its content and its quality. In the traditional supply chain, the content of shared information are the market demands, production plans and inventories, while the quality of shared information are the accuracy, timeliness, adequacy and credibility of that information (Zhou & Benton, 2007; Lee & Ha, 2018). In a study of supply chain systems, Handfield (2017) notes that the system should ideally produce data itself and, in particular, data that is trustworthy. This leads to the concept of data provenance.

## 2.6 Data Provenance

Data provenance, sometimes called lineage or pedigree, is the description of the origins of a piece of data and the process by which it arrived in a database (Bunemann, Khanna & Tan, 2001). Provenance information is used to trace the origins of a product, establish its history and confirm its authenticity (Wolski, Howard & Richardson, 2017). Understanding the provenance of data along with establishing rigour in regard to its management all contribute to the ultimate goal of reproducibility. According to Groth (2013), knowing the provenance of data in a supply chain helps consumers trust the quality of a product.

Data provenance has emerged in IS research as a form of data validation, providing a means to trace and record the origins and movement of data (Buneman, Khanna & Tan, 2000). Simmhan, Plale and Gannon (2005) define data provenance as a kind of metadata that contains the history of a data product, beginning with its source and functions to provide an audit trail that is useful for regulatory implications. Previous studies have used provenance as a measure for the quality of information in web-sharing (e.g. Hartig, 2009) but there is growing attention on data provenance as a guarantor of trust for physical products. For instance, Zhang et al. (2016) perceived data provenance as having the potential to provide trustworthiness of a data product through the ease of which it can provide access to the

source and origins of the product. It must be noted that the difference between provenance of data and provenance of a product differs in that the data in this context is entirely a digital record of the product. Data provenance is not the product in of itself.

In a study on information sharing between users and online data repositories, Fear and Donaldson (2012) determined that provenance metadata was a significant factor in establishing the credibility of the supplier. Provenance metadata and disciplinary or industry norms were crucial in influencing how credibility of information was assessed. They however, stressed that there is a need to further understand user and stakeholder perspectives in more diverse industries, with their study on provenance credibility largely conducted on data within online repositories.

Jenkinson et al (2018) perceive that for trust in data provenance to become established, users will have the following questions: who created the data, is the creator of the data trustworthy, does the data depend on other propositions and as further propositions to the data become available, how do they change the conclusions?

This was consistent with the study by Yee and Yeung (2010), who developed a hypothesis about trusting relationships. In their study, they found that consumer trust is more likely to increase purchase likelihood and prediction of future intentions to deal with the supplier. This is particularly important in times of uncertainty or during risky scenarios; in the livestock industry for instance, this can include bovine flu and meat transference. Subsequent purchases from suppliers is positive if the expectation is continuous provision of information. They use the example of the horsemeat scandal of 2013, in which advertised beef products were found to contain undeclared horsemeat. Research by Falkheimer and Heide (2015) and Yamoah and Dawson (2014) both determined that the scandal had severe negative effects on brand perception and industry trust following the revelations in the context of Europe and the UK. If this concept can be applied to asset management, particularly in the AgriFood supply chain, the nature of trust can be reconceptualised in terms of its data-driven attributes, which would improve the efficiency of relationships by enhancing the provision of information, thus reducing the relational aspects of trust in cross-cultural and cross-border supply chain relationships.

Data could help to increase consumer trust and safety by helping to establish the provenance of products and the conditions under which they have been brought to market. Data can help to develop real-time prediction of emerging risks to food safety and fraud, e.g. the horsemeat scandal in 2013. Data on prices of commodities, consumer price index, exchange rates, extreme weather, pest and disease incidents, changes in regulation and standards, profit margins, production capacities, etc. can be used to develop early warning systems for food fraud.

Wolski, Howard and Richardson (2017) define key aspects which need to be addressed to ensure data veracity, with trust figuring quite prominently:

- integrity of data and linked data (e.g., for complex hierarchical data, distributed data)
- data authenticity and (trusted) origin
- identification of both data and source
- computer and storage platform trustworthiness
- availability and timeliness
- accountability and reputation

Understanding the provenance of data along with establishing rigour in regard to its management all contribute to the ultimate goal of reproducibility. The OECD (2012, p. 8) state that: “The credibility of data products refers to the confidence that users place in those products based simply on their image of the data producer, i.e., the brand image. Confidence by users is built over time. One important aspect is trust in the objectivity of the data”.

Blaze et al. (2009) and Malik et al. (2019) posit the concept of trust management, which would address challenges such as external certifications of quality, extracting trusted data from multiple sources, maintaining stewardship of data and creating mechanisms to ensure data integrity and security (Wolski, Howard & Richardson, 2017). These considerations are important to this research and will inform the theoretical understandings necessary to address the research gaps. These lead to the idea of data as trust.

## 2.7 Data as Trust

Upon reviewing the literature, there is a clear research gap about how data can be used to build trust in the supply chain setting. Existing research has explored this from the system-level and individual-level, but there is a missing element in how supply chain environment can use data to develop trust between organisations and individuals ranging from suppliers to consumers. Wolski, Howard and Richardson (2017) believe that not all tools or services are considered as requiring a high level of trust, but this can lead to risk for all participants if trust toward the platform is not considered as an element of the supply chain.

According to Viyasitavat and Martin (2012), provenance-based trust has been discussed as a technique for determining trustworthiness, but there is a lack of research into how human agents in a complex, moving system like a supply chain can contribute to and develop provenance. In particular, there are questions around what happens to that provenance information and whether it carries the same level of trustworthiness for all participants.

This research gap will be explored using a framework from Li et al. (2012). In virtual transactions the following considerations for understanding trust is adapted from Li et al. (2012):

- Trust is *subjective* depending upon the stage of the transaction it is within and who the entity under consideration is
- Trust is *dynamic* in that it changes across the supply chain lifecycle and develops through the transaction of the product
- Trust is *bi-directional* in that it needs to be considered both ways in the supply chain
- Trust is *asymmetric* in that one entity in the supply chain may require a different level of trust compared to another entity in the network
- Trust is *non-transitive* in that one level of trust felt by one entity does not necessarily translate or become shared by another
- Trust is *context dependent* in that the nature of the supply chain and the business, political and institutional can influence how trust should be considered within the network

These trust considerations are emerging concepts that are considered for the development of trust models within online, virtual and electronic transactions and exchanges (Blaze et al., 2009).

Subjective trust is defined by Sitkin and Roth (1993, p. 368) as “a belief, attitude, or expectation concerning the likelihood that the actions or outcomes of another individual, group or organization will be acceptable or will serve the actor’s interests”. Further to this, Das and Teng (2004) believe that subjective trust is based on the probability that the desired actions will be performed balanced against the perceived risk that non-desirable results will be an outcome of an exchange. In the supply chain, Delbufalo (2015) found that asset specificity, knowledge-sharing routines, and effective governance mechanisms were important variables in confirming the role of trust as an activator of enhancing trust processes in inter-firm economic exchanges. In a system with no central trusted authority to vouch for the users, the credibility of witnesses becomes a critical facilitator for allowing an agent who has had too few interactions with a subject to form a meaningful trust opinion (Li et al., 2012).

Chang et al. (2005) describe the dynamic nature of trust as its most challenging to measure in electronic transactions. They define dynamic trust as being when trust is not stable or always changing with the passing of time, two observable phenomena in the supply chain. Zhou and Benton (2007) indicate that dynamism changes in tandem with the changing pace of products and processes in supply chains, becoming a significant reason for the reluctance to share information.

Bi-directionality is the receiving and providing of information flows and is integral to supply chain cooperation and collaboration (Lee & Ha, 2018). From their research, Lee and Ha (2018) found that bi-directional trust was a significant factor in the inflow and outflow of information between supply chain entities as it assists in developing mutual trust. For a supply chain to function effectively, information sharing needs to be evaluated in terms of its directionality and balance back and forth through the supply chain, in particular, evidence of social capital within the supply chain as being used to facilitate the inflow and outflow of information in a trustworthy manner.

In conceiving trust as asymmetric, Chang et al. (2005) state that this is caused by the non-mutual nature of trust in the supply chain which is based on the different internal factors and expectations of individuals. Essentially, two agents in the supply chain may have different levels of trust. According to the findings of Korsgaard et al. (2015), this can even result in situations where some entities trust more than their partners, resulting in one-way transactions where high trust was not necessarily reciprocated. Such imbalances can lead to difficult systems in which cooperation and communication are not shared by all parties. Information sharing can potentially solve the problem of trust asymmetry across the supply chain (Zhou & Benton, 2007).

Finally, in conceiving supply chain trust as context-dependent, Fearne, Hornibrook and Dedman (2001) note that a transaction has many attributes, conducted in specific transactional contexts. These attributes and the context are perceived differently by the transactional parties through multiple lenses and assessed with the aid of trust antecedents. In perceiving the end-to-end nature of the supply chain as a dyad, Korsgaard et al. (2015) believe that aspects of social context such as rules, roles, institutions, culture and social identities comprise a uniform driver for trust within specific contexts. Further, Kramer (1999) believes that shared context that include social, relational and institutional factors will maintain the dyadic system of trust. Thus, trust being context-dependent refers to the context of the supply chain and how each agent both enacts and enforces the social contexts for exchanges to occur. These contexts can differ according to the entities involved, the product being transferred and the external environment factors that influence the need for information sharing.

To summarise the review of literature and compile a visual map of the key concepts that this study will explore, the follow section will present the Guiding Conceptual Model for the Case Protocol. This will be discussed further in Chapter 3.

## 2.8 Guiding Conceptual Model for the Case Protocol

To further understand the research gaps identified throughout the preceding sections in this chapter, a guiding conceptual model is developed to firstly collate the major concepts derived

from the research in preceding sections that will be of significance to this study, and secondly to demonstrate the major research gap that exists within current understanding. Figure 2.2 presents a diagram that compiles the major headings and sub-headings (i.e. concepts) of Sections 2.1 to 2.7 and the tentative relationships between them. The model identifies the major research concern of this study, which is understanding how provision of information can increase system-level and individual-level trust. These levels combined together are considered a “spectrum of trust” that moves from situations of low trust to high trust.

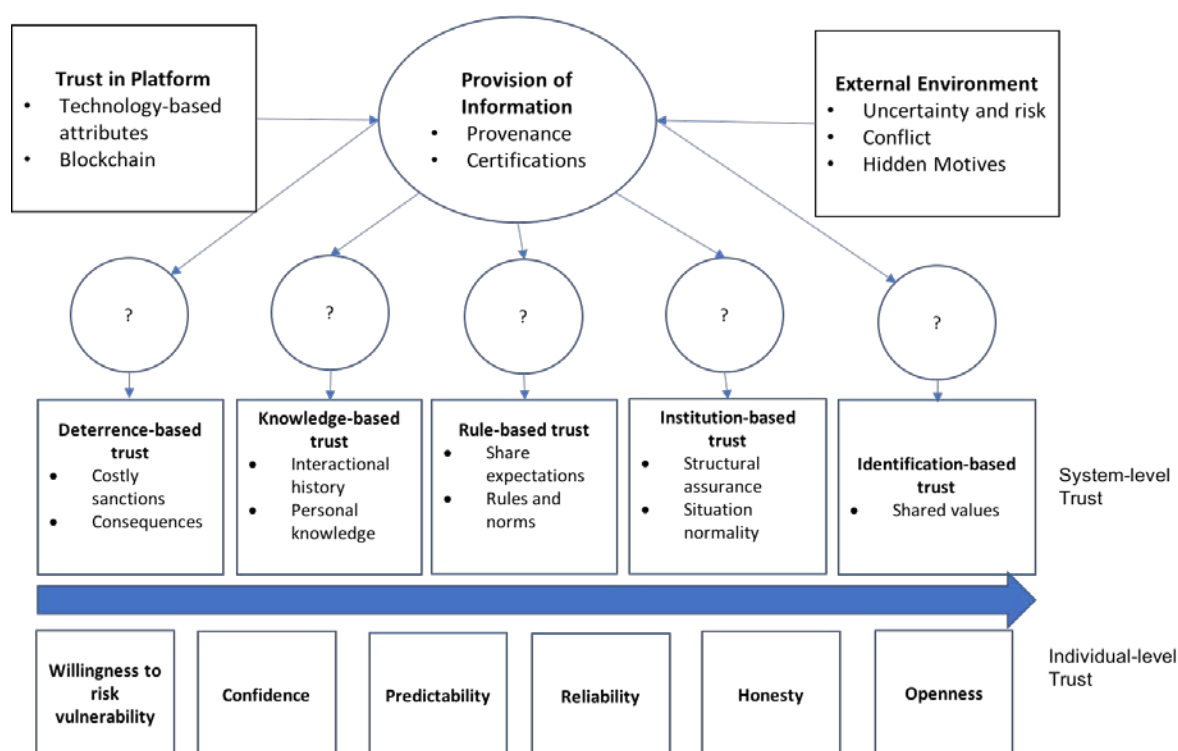


Figure 2.2: Guiding Conceptual Model

In Figure 2.2, the circles with The Guiding Conceptual Model makes several research assumptions that provide direction for this study:

- Trust in Platform and External Environment are necessary conditions before Provision of Information
- Trust in Platform is comprised of the major sub-variables of technology-based attributes and blockchain, the two technologies of most interest to this study

- External Environment is comprised of uncertainty and risk, conflict and hidden motives, negative variables that drive the need for Provision of Information by a mediating party such as BeefLedger in the supply chain
- The activities of Provision of Information are known to be provenance and certifications.
- Both system-level trust and individual-level trust are spectrums. This is an important assumption, as this study posits that trust can be increased over time and across the supply chain as the product moves through. We posit that on the lower ends of the spectrum are deterrence-based trust and willingness to risk vulnerability, which are standard bases of trust at the beginning of most business exchanges. As Provision of Information adds to the exchanges, the bases will increase to higher forms of trust, with identification-based trust and openness deemed to be the most significant psychological states. The study will aim to find insight into this speculation.

The major research gap this model identifies is that there is a possible third layer, which mediates how provision of information contributes to the existing spectrum of trust. This layer will explore how data, generated from provision of information, mediates the spectrum and whether it influences how trust can move from low to high ends across the supply chain. The circles with question marks indicate possible concepts that correlate with each of the concepts in the system-level and individual-level layers in the trust spectrum.

Few studies have used the trust antecedents in a comprehensive, systematic way. There is a need to perceive the antecedents as part of a trust spectrum, which should be used as a tool to explore how trust changes in the movement of data throughout the supply chain. Some researchers have briefly explored contexts using the framework of a trust continuum. In a study on e-commerce, He (2011) found that deterrence-based trust, institutional-based trust and technological attributes-based trust were the three most influential forces in the formation and development of trust in these environments. Similarly, researchers such as Zarvandi and Zarvandi (2012) see degrees of trust as dependent upon organisational contexts. These authors posit a useful way to conceptualise trust for dynamic supply chains, at the system-level believing that the trust layer can be considered as a movement between deterrence-based trust through to identification-based trust. This built on the idea by Lewicki



and Bunker (1996), who previously described trust development as a process from calculus-based trust through to identification-based trust. They believe that calculus-based trust characterises interactions at the first stage of business relationships; however, the relationships will develop further through knowledge-based trust. Only a few relationships will attain the highest level of trust - identification-based trust, “based on identification with others” desires and intentions” (p. 122).

In their trust continuum, Zarvandi and Zarvandi named deterrence-based trust, calculus-based trust, knowledge-based trust, relational-based trust (rules-based) and identification-based trust as the five determinants at the system-level. This research will adopt a similar conception of the system-level trust continuum but use the system-level trust antecedents identified in this Chapter.

While trust continuums have used the system-level approach, no studies in information systems or supply chain have explored the individual-layer. In this research, the conceptual framework will explore trust as a continuum that is defined by a system-level layer, an individual-level layer and a data layer, with the data layer containing the unknown variables that the study on BeefLedger will address.

Three things to note about the Guiding Conceptual Model:

1. The individual-level layer in this diagram is speculative and the concepts have been arranged for the purpose of this study. As indicated previously, previous research has not explored the individual-layer. The concepts arranged in this model have been suggested as part of a spectrum, in which lower levels of trust. The speculative nature of this conceptual framework is driving the data collection process. The aim is to explore this phenomenon.
2. Likewise, the system-level layer is a speculative arrangement.
3. We speculate that there is a third layer that contains an order of unknown concepts that will mediate the formation of trust concepts along the spectrum of trust.

These arrangements, groupings and orders of concepts across these multiple layers will form the basis for the formation of the questionnaire.

The gaps identified in the conceptual model presented in Figure 2.2 summarise the key points and main concepts identified in the literature review that are guiding the research in this study and lead to the formation of the research questions.

## 2.9 Derivation of Research Questions

Following the presentation of this suggested model, this leads to the two major research questions of this thesis.

- 1) How does BeefLedger engage in the provision of information to create data-driven trust in the beef supply chain?

In Figure 2.2, the order of empty circles represents a possible third layer. This question speculates that this might be a spectrum of data-driven trust initiated by the provision of information.

- 2) What are the processes that BeefLedger provide to manage and maintain data in the lifecycle of a product to create high levels of trust among all supply chain participants?

This study speculates that the data-driven trust layer represents a possible order of undiscovered concepts that mediate provision of information with the existing concepts in the spectrum of trust. With this question, the motivation is to discover the unknown concepts of the data-driven trust layer.

## 2.10 Chapter Summary

This chapter discussed the literature that will provide the basis for the theoretical underpinnings and research gap for the case study to be discussed in Chapter 3. It provided background about the Agrifood Supply Chain, which detailed the external environment faced by the beef supply chain and the supply chain trust and supply chain data within the sector. It then discussed Trust Antecedents, including system-level trust and individual-level trust antecedents that will inform the extant theory for the case study. Then, it presented the Trust in Platform concept which has emerged in recent years with the rise of blockchain. Provision of Information was discussed next as another major construct for the extant theory, including

data provenance and data as trust, two knowledge gaps within the beef supply chain literature. It concluded with a conceptual framework that summarised all the major research concepts of this review. This conceptual framework is the first phase of the methodology, to be presented in Chapter 3.

## CHAPTER THREE: METHOD

### 3.0 Introduction

This chapter will outline the research method used for this study. This study has adopted the case study approach of Yin (1994; 2003). As such, many of the sections and content of this chapter draws from his research design.

The study will be data-oriented qualitative research following a single case study design as developed by Yin (2003). This research will employ two distinct types of case study analytical approaches being *exploratory* and *explanatory*. In exploratory information systems research, the investigator seeks to understand the reasons or motivations behind the interactions between actors and factors that result from the user-technology relationship. Explanatory research builds on the qualitative variables, offering in-depth understanding about the relationship between constructs and providing an explanation for the observations extracted from empirical evidence.

In exploratory research there is no clear single set of outcomes so to be comprehensive, explanatory research is later used to describe a phenomenon and the real-life context in which it occurs (Yin, 2003). Firstly, through exploring an area of trust in supply chain relationships and its connection to data provenance, which is an area that has not previously been thoroughly explored, and by describing the activities of the organisations through pattern-matching and the development of a logic model, the researcher can make a valuable theoretical contribution to this domain by providing an understanding through the assertion of a cause-effect model. It is important to note that the researcher has experience in these organisational workflows and currently works in company management. To mitigate the influence of the researcher's worldview, the interpretation of the data will adhere to a well-defined case study method and adopt qualitative analytical procedures. Both inductive and deductive approaches will be used to derive concepts in the data analysis and the involvement of the principal supervisor in data analysis will remove any unintended biases.

This chapter will firstly introduce the rationale for the use of case study. The rationale for case study will discuss its employment in similar research and justify its appropriateness for this study. Following, it will discuss the Research Design, including a detailed research map of the processes and activities that will be followed by the investigator through the duration of this study. The most important processes in the Research design are the Data Collection strategies and the Data Analysis processes. The data collection will be a single case study of BeefLedger, with the unit of analysis being data provenance as a form of trust in supply chain. From the data analysis, the logic model will be developed.

### 3.1 Rationale for Case Study

According to Schell (1992), case study research is an effective approach when used to explore either single or complicated research questions within rich environments that have many contextual variables. Case study uses multiple sources of data during data collection, including both primary and secondary data, which can produce independent and dependent variables. Both Yin (1994) and Creswell (2013) state that inductive logic to case study enables a more descriptive study, allowing for rich insights into the unit of analysis. When inductive logic is used in conjunction with multiple sources of data, researchers can develop relevant and testable theories (Barratt, Choi & Lin, 2011). When the researcher uses multiple sources of data, for instance, the context under investigation can be explored in a systematic and comprehensive way.

While theory is a common output of case study research, the development of variables may also result in propositions, constructs and models (Benbasat et al., 1987). Yin (2003) identifies a logic model as a desirable outcome from a case study, as this visually summarises variables extracted from analysing the evidence and provides relationships and interdependencies that will either explain or describe the activities observed in the field under investigation. Logic models can summarise the actions of organisations and provide management with implications for practice. These variables can later form part of developing new or extending existing theory with future research or study. Given the researcher's long experience in building and managing organisations, deriving an actionable logic model that will assist other business owners to better understand their business context is a natural pursuit.

Case study is a widely used qualitative methodology in organisational research (Cavaye, 1996). In a meta-analysis of case study research papers, Barratt, Choi and Li (2011) found that organisational behaviour and supply chain collaboration were common fields in which a case study approach was used. As a qualitative method, case study provides the researcher with robust data collection and analysis procedures that can explain the processes or systems under study. In case study, the researcher has a personal interaction with the case (Stake, 1995). While it has an interpretivist paradigm, there are still measures of methodological rigour that enable the researcher to make research contributions to body of knowledge. The contributions to research will be described in the Conclusion of this thesis.

Case study research is being recognised as a progressively important type of research in the context of agri-business, since traditional research strategies such as quantitative approaches have been slightly limited in their applicability and scope (Sterns, et al. 1998). The output of this particular Case Study, a logic model explaining the role of provision of information in livestock supply chain trust, will provide a new contribution to research. There are several reasons why Case Study is the most appropriate method for this study of the AgriFood:

- 1) Case Study research involves careful and in-depth investigation of the nature of each case, including an exploration of the historical backgrounds, physical settings and institutional and political contextual factors (Stake, 1998). These are critical aspects for understanding the supply chain BeefLedger facilitates.
- 2) The outcomes of a Case Study analysis can explain the behaviour of the area under investigation and outcomes are not generalizable to all populations (Thomas, 2011).
- 3) Cases are developed through the relationship between the researcher and informants (Stake, 1995). The lead researcher has a strong relationship with the principals of Beef Ledger.
- 4) Case Studies are presented as stories which more actively engage the reader (Stake, 1995).

Case Study is increasingly being used in AgriFood research to gain greater insight into the business processes, with traditional research strategies often being limited in applicability and

scope (Sterns et al., 1998). Matapoulis et al (2007) used Case Study to understand processes and supply chain in the Hellenic Company in Greece, while Gorton et al. (2006) applied Case Study to understand the supply chain in Moldova.

### 3.2 Single Case Study

As this study is dealing with one organisation, the research design will be a single case study on BeefLedger. While Yin cautions against a single-case study design, the advantage of a single case is that there is a richer opportunity for data. A single case study is effective for either testing a well-formulated theory or conceptual framework and extending it through empirical data, or for exploring a previously unresearched or novel domain or organisation. As BeefLedger offers the opportunity for both, a single case study design is suitable for the aim of this research. Furthermore, the trade-off between a loss of usefulness of findings (Yin,2003) because of lesser induced generality, is offset by the greater depth of understanding that a single, potentially revelatory case study provides thereby offsetting the breadth of multiple case studies (Stevens, 2011). This study will be a holistic single-case with a context being the livestock supply chain and a single unit of analysis being how the provision of information influences trust within this context. There are several rationales for justifying a single case study as given below:

- 1) The critical case is testing a well-formulated theory. To date, most supply chain studies have applied organisational trust lenses on processes but there is little understanding of trust as a continuum. The extant theory developed in Chapter 2 presents a unique opportunity to test a new conception of trust as a multi-faceted process.
- 2) The single-case represents a unique case. BeefLedger has emerged only recently and there is little research about how they affect or influence trust in the livestock supply chain. Additionally, there is little theoretical research conducted on their processes. As they are empowered primarily through blockchain, itself an emerging technology, this is a unique research opportunity that could inform both the industry and the research community.
- 3) This could potentially be a revelatory case. The researchers have an opportunity to investigate a phenomenon that has previously not been studied through a theoretical

lens. Insights into the provision of information processes that inform the development of trust in the supply chain could extend current knowledge. (Yin, 2003)

### 3.3 Development of Constructs

The literature review in Chapter 2 identified several trust constructs that are applicable to the single case under observation. These trust constructs and the central variable of *provision of information* provide the conceptual framework that will be explored through the research methodology.

In organisational research, constructs are abstract theoretical formulations about phenomena of interest (Edwards & Bagozzi, 2000). A construct is denoted by its descriptor and formulated so it can be measured empirically. The purpose of a construct is to represent an underlying set or domain of attributes that can be operationalised, and quantified as variables (Gioia, Corley & Hamilton, 2013). Constructs and variables allow parsimony and consensuality in making sense of organisations. In a case study, constructs and variables provide the building blocks for the formation of a high-level conceptual model that can delineate and explain organisational processes. Berger and Luckmann (1966) see organisational studies as primarily dealing with social worlds that are socially constructed, and through research investigators can make sense of how members go about constructing and understanding their experience through the delineation of a construct that describes the observable activities, rather than the frequency of measurable occurrences.

Because this case study will use four types of Data Analysis, the aim will be the development of major constructs. These major constructs will have associated variables that provide explanations for theoretical interrelationships and complete the conceptual framework.



### 3.4 Research Design

The research design for this project consists of five key activities that will inform the sequence of the approach. The first, *Developing the Conceptual Framework*, was achieved through the Literature Review in Chapter 2. This activity in case study terms is developing theory or identifying extant theory or constructs that will guide the second activity, which is the production of *Data Collection Instruments*. The Instruments are developed through identifying the *unit of analysis*, the *Case Protocol* and the selection of the study *Participants*. The third activity is *Data Collection* in which the researcher will collect primary and secondary data through fieldwork, consisting of semi-structured interviews, collecting related documents (e.g. information sheets, brochures, supply chain information and material, etc) and field notes or observations. Data Analysis is the fourth activity and will consist of four analytical tools, *case description*, *word count analysis*, *pattern-matching* and *explanation-building*. The results of the analysis will inform the fifth activity, which is the development of the *Logic Model*.

The activities are represented diagrammatically in Figure 3.1 below.

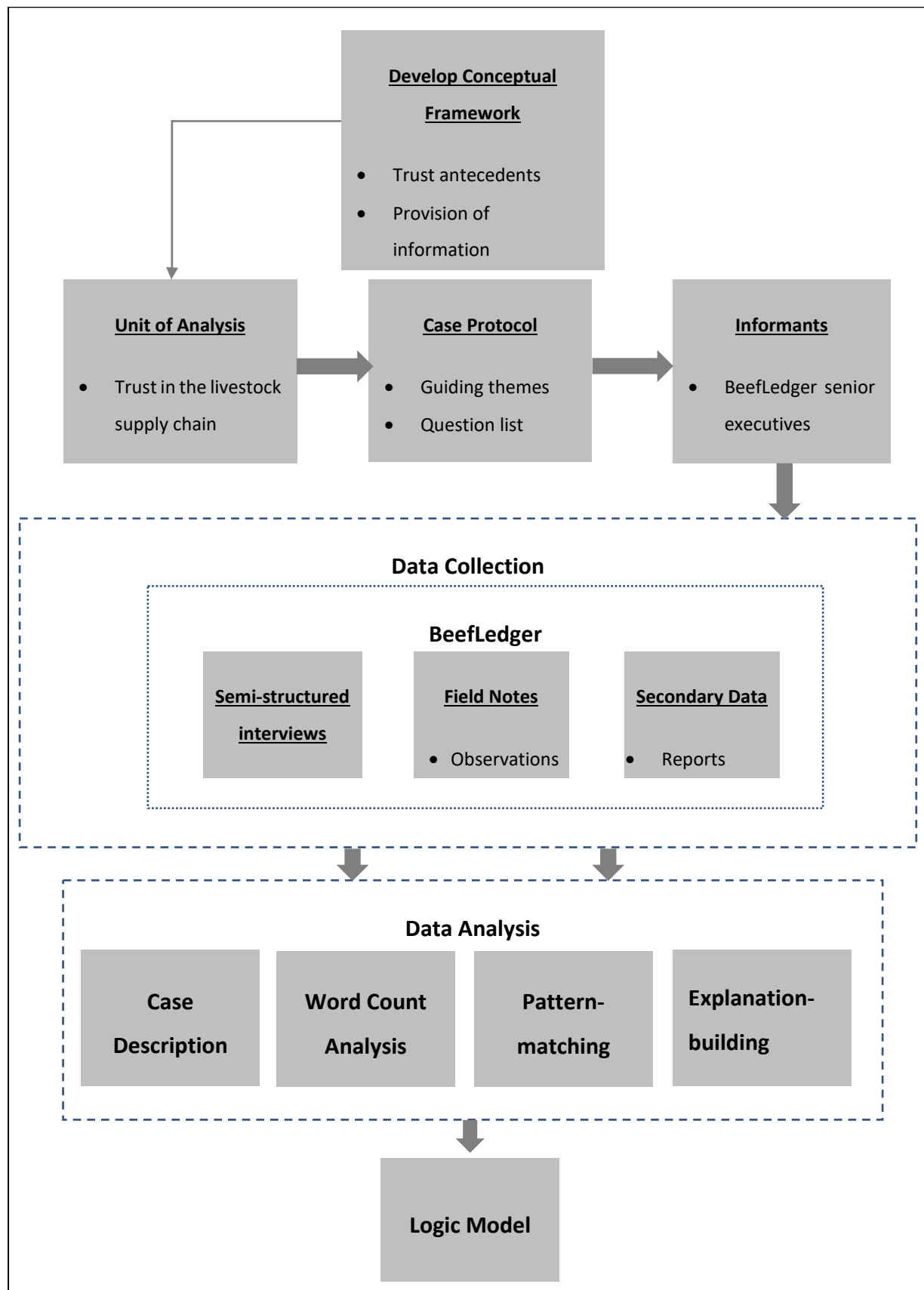


Figure 3.1: Research Design Flowchart

### 3.5 Unit of Analysis

A critical element of Case Study research is defining the 'case'. According to Yin (2003), a case can be anything from individuals to a group within an organisation, to an event or entity such as a decision, a program, an implementation process or organisational change. Establishing the case is dependent upon the research question, which should provide the necessary constructs and boundaries of the study; a well-defined question will in turn identify a precise *unit of analysis*. A unit of analysis is the specific object under investigation and provides the theoretical constraints of the study. For exploratory research in particular, Markus (1989) states that "a unit of analysis helps to define the boundaries of a theory which in turn set the limitations in applying the theory" (p. 23).

The phenomenon under study provides guidance to determine the unit of analysis with the boundaries, theoretical constructs. When the unit of analysis is unclear, this influences the research questions and outcomes (Yin, 1989). Dubé and Paré (2003) note that a clearly defined unit of analysis is critical for understanding how the case might relate to the overall body of knowledge. A clearly stated unit of analysis will also identify applicable extant literature that can help clarify the phenomenon under investigation (see Chapter 2).

Authors such as Grunbaum (2007) have observed that the explicit definition of a unit of analysis has been problematic; indeed, Yin (1994, 2003) is not particularly clear on what constitutes this object of study. However, Grunbaum posits that a case is the equivalent of the unit of analysis and that it can be considered the boundaries of the study.

In a summation of the case study of the unit of analysis, the following is considered:

- The object of the study is the interpretation of the social actors' perceptions of a phenomenon or the meaning that social actors attribute to the phenomena (Grunbaum, 2007)
- It is a system of action that, rather than focusing on individuals or group of individuals, considers the voices and perspectives of the collective and all of the relevant interactions between them (Tellis, 1997)

It follows then that the unit of analysis should have the constructs of the study, the social actors, the specific interaction between them and a specific context. All of these elements will provide a closed boundary to the study which will enable the researcher to adhere all data to the scope and will provide a sense of beginning and end to the study.

For this study, the unit of analysis is deemed to be the *how BeefLedger's data provenance supports trust in the supply chain trust process*.

### 3.6 Methodological Rigour

Qualitative methods like case study are predominantly interpretivist and inductive, in which the constructs generated and the explanation between constructs and variables are influenced by the researcher's worldview. As a result, potential bias may influence on the findings elicited from empirical evidence. With case study, Yin proposes several tests to establish the rigour and robustness of the results and ensure that the findings and resultant constructs and models genuinely describe what has been observed in the study.

Test	Tactic	Activity	Phase
<b>Construct validity</b>	<ul style="list-style-type: none"> <li>● Multiple sources of evidence</li> <li>● Chain of evidence</li> <li>● Key informants review</li> </ul>	<ul style="list-style-type: none"> <li>● Semi-structured interviews, documents and field notes</li> <li>● Constructs compared against theory</li> <li>● Transcripts and final report will be sent to informants on request</li> </ul>	Data Collection, Data Analysis

<b>Internal validity</b>	<ul style="list-style-type: none"> <li>● Pattern-matching</li> <li>● Explanation building</li> <li>● Address rival explanations</li> </ul>	<ul style="list-style-type: none"> <li>● Empirical patterns will be mapped back against theory</li> <li>● Case descriptions will contribute to logic model</li> <li>● Theory will identify other theories of trust</li> </ul>	Literature Review, Data Analysis
<b>External validity</b>	<ul style="list-style-type: none"> <li>● Use of theory in a single case study</li> </ul>	<ul style="list-style-type: none"> <li>● The empirical data will be compared against extant theory in the conceptual framework</li> </ul>	Data Analysis
<b>Reliability</b>	<ul style="list-style-type: none"> <li>● Case Study protocol</li> <li>● Case Study database</li> </ul>	<ul style="list-style-type: none"> <li>● NVivo will be used to produce themes</li> <li>● Multiple coders will be used</li> <li>● Data will be stored electronically</li> </ul>	Data Collection, Data Analysis

*Table 3.1: Methodological Rigor attributes*

### 3.7 Case Protocol

A case protocol is the main study instrument for a case study, containing the procedures and rules for collecting data, information of the study background for informants, the guiding themes and the interview questions. Typically, the case protocol contains all background information about the study synthesised for informants and includes the conceptual

framework for easy reference to ensure that the data collected adheres to the aims of the study at all times.

The case protocol also contains the questionnaire that will be used to prompt the interview with the key informants. The derivation of the questions came from the Guiding Conceptual Model in Figure 2.2. For each question, the researchers framed the inquiry around the key concepts of extant literature and phrased them as open-ended question. The questions aren't intended to be leading, with the intention being that informants could expand upon the concepts in relation to their business practices. Additionally, informants will not be given intricate detail or definitions about the concepts to remove bias. As stated previously, the aim is to gather empirical evidence from the language of the area, which will lead to more rigorous study outcomes.

The case protocol can be found in the Appendix.

### 3.8 Data Collection

This research will aim to collect both primary and secondary sources of information. Primary sources of data will consist of semi-structured interviews with BeefLedger and field notes collected by the researcher onsite. Secondary sources will be documents such as existing reports, research articles, news articles and pamphlets about the organisation. As this is a single case study, multiple sources of data are required to establish the methodological rigour of the study.

There are three principles for case study research that will enhance the quality of data collection. These principles are:

- 1) Use multiple sources of evidence for *triangulation* of themes and evidence in empirical data;
- 2) Create a *case study database* for the organisation and documentation of all data gathered in the field, including notes, observations and narratives; and

- 3) Maintain a *chain of evidence* (established through the case study database) to provide external examiners with the ability to follow the derivation of themes from case evidence

When the researcher uses multiple sources of data, this satisfies all three requirements for robust data collection. Multiple sources of data also provide data credibility (Patton, 1990). An experienced case study researcher recognises that the inherent temptation is to attempt to collect as many sources of data as possible, however, overwhelming data can be problematic for management and the data analysis process and the novice case study researcher can become lost in the data (Baxter & Jack, 2008).

For this study, there are two sources of primary data: participants or the key informants of the study, consisting of senior management personnel from BeefLedger, and field notes that will be kept by the research team upon visitation, communication with the informants. Visits onsite might provide additional insights into the supply chain process. Field notes have been discussed by Yin as a useful source of data, because it provides the researcher's insights and helps to build an understanding and context for the empirical evidence as it is gathered. Secondary sources of data will be research reports, pamphlets, news articles and websites that provide information about BeefLedger. As they are a recently established firm, there is to date few in-depth reports published about their processes, however, these secondary sources of data will assist in triangulation and help to contextualise the data analysis and explanation of major constructs.

Each source of data is described in detail in the following sections.

### **3.8.1 Informants**

Informants are the participants of the study who provide data through an active participation in the research as interviewees and access to data within their organisation or domain by their seniority. The more senior the informants, the richer the sources of data become. Informants are not simply interviewees or participants, but key personnel who provide both rich textual data in answering research questions during semi-structured interviews, and provide history and information about the organisation and sector that is used in the case

description as well as providing documentation and evidence supporting the unit of analysis that will form part of the data analysis. They are the primary source of data collection and are potentially involved at multiple points in the collection of data, especially in a single case study. The informants normally have a vested interest in the outcomes of the case study, as the findings support or inform their business and potentially impact processes.

The participants of this study are selected through the professional relationships of the lead researcher. While these pre-formed relationships existed, great care was taken to ensure there was no sample bias and that the relationships would not affect data collection. The inclusion criteria were that the participants are involved in key entities of the supply chain for their respective organisations and have deep knowledge and experience of the process involved in moving their product from 'paddock to plate'.

The investigator has relationships with senior management at BeefLedger. These senior personnel have in-depth knowledge of their organisation and can provide historical perspectives, motivations for organisational actions and insights into key organisational processes.

### **3.8.2 Research Ethics**

This research project was conducted in accordance with the QUT Office of Research and Integrity policies. The ethics application was submitted, and the research was deemed to be *negligible risk*. The QUT ethics reference number is 1900000697.

To maintain adherence to the ORI framework and in conjunction with the case study approach, the research applied four practices of ethical case study research.

- Consent forms were given to participants prior to each interview. Participation was voluntary and the forms contained the conditions of the interview and the reference to the QUT ethics number for authenticity.
- Participants were provided with information on the purpose and aims of the study, the central research questions and the constructs and definition identified in the developing theory phase of the research design



- The personal details of participants were only identifiable on signed consent forms. Their identity was otherwise anonymous through the study, with the only identifiable information in primary data being reference to their job titles and descriptions. Any references to themselves or use of names in interview transcripts were edited out as this was not necessary for the purpose of the primary data. Transcripts were available to participants if they requested them.
- Primary data and processed data were stored securely on shared drives at QUT and on portable devices only accessible to the lead researcher and the supervisory team. Consent forms and physical data such as documents provided by the informants were stored in locked filing cabinets.

### **3.8.3 Semi-structured Interviews**

Interviews allow a researcher to identify insights into processes and activities that they may not be able to observe otherwise (Stake, 2010). When the researcher adopts a semi-structured nature to interviews, this will allow the questions to guide the timeframe while also allowing informants to give their views. By being flexible through open-ended questions and providing time for participants, this yields rich textual data and allows the researcher to uncover evidence that they may not have planned for.

Interviewing is a tool to find the personal thoughts, perceptions, feelings and individual perspectives in learners' own formulation, which could not be collected otherwise (Patton, 2002). The interview method was used to explore the learners' personal and individual experiences and to reveal their insights (Seidman, 2012). The ability to establish rapport and trust with participants in a qualitative study is an important characteristic of a researcher in collecting data (Marshall & Rossman, 2011). As Marshall and Rossman (2011, p. 118) state, "closeness, engagement, and involvement can enhance the richness of the research".

Following Patton's (2002) method for designing research questions, relevancy, recognisability with the problem and the presence of clear constructs to shape the questions will be used in the case protocol. The language used will be made as simple as possible and provide meaning to any jargons. The questions will be framed with no or least bias as possible. The interview

time will be kept within 100 minutes and prior appointments, calendar invites will be sent to block and confirm the interview timings.

Interviews will be conducted at the convenience of the participants in a central location to all parties. Prior to the interviews, participants will be emailed the case study protocol which includes the study objectives, background and the intended questions. Interviews will be audio recorded. Recordings will only be available to the research team and the participants on request, to preserve their anonymity. Interviews will be transcribed using NVivo 12 and the transcripts will be created as a word document.

#### **3.8.4 Field Notes**

Field notes are a collection of the researcher's observations and notes about the organisation under study. These observations take the form of brief memos, analytical insights or unique observations about the organisation that are made or collected during contact with key informants, visits to the organisational site or through contact with members of the organisation.

Because the lead researcher has ties to BeefLedger through work, these professional relationships and discussions about the business can provide additional empirical data that will support the richer semi-structured interviews. Field notes can add explanatory power to the data analysis process by providing further evidence of constructs or variables or provide a causal link between insights and theoretical relationships.

### **3.9 Data Analysis**

Data analysis is a process of investigation in which the researcher extracts knowledge, information, and insights about reality by examining empirical data (Grolemund & Wickham, 2014). There is no universal approach to the investigative process of data analysis, particularly for qualitative research, and there are many debates about the merits of different approaches. However, case study provides a powerful narrative mechanism, allowing the researcher to provide a chain of evidence that provides a narrative or story for how the findings were developed from empirical data.

The data analysis for case study parallels the goals of sensemaking as a whole: to create reliable ideas of reality from observed data (Grolemund & Wickham, 2014). It is performed by the human agents and as such, the analysis phase of this study will involve three coders: the lead researcher, the principal researcher and a research assistant. Through case study data analysis, researchers make sense of all the gathered evidence through a triangulation of the findings, comparing theory to fact, finding patterns in the data and modifying theory accordingly. Successful data analysis may even have implications on the unit of analysis, causing the researcher to reenvision or reconsider boundaries through the development of new variables or constructs (Yin, 2013).

A quote by Hatch (2002) appropriately establishes the sensemaking activity of the intended data analysis process:

*“Data analysis is a systematic search for meaning. It is a way to process qualitative data so that what has been learned can be communicated to others. Analysis means organizing and interrogating data in ways that allow researchers to see patterns, identify themes, discover relationships, develop explanations, make interpretations, mount critiques, or generate theories. It often involves synthesis, evaluation, interpretation, categorization, hypothesizing, comparison, and pattern finding.”* (Hatch, 2002, p. 148).

For Yin, a case study analysis is driven by three major activities:

- 1) All interpretations should exhaust the gathered evidence, including all transcripts, field notes and documents collected from the field
- 2) All major rival explanations must be addressed, that is, if there is an alternative explanation or theory for a particular observation, then it must be discussed against the empirical evidence
- 3) Should use all professional knowledge of the researcher

In a case study report, the intent of the findings section is to narrate an informative story driving toward new concept developments and theoretical discoveries through the

presentation of transparent evidence (Goia, Corey & Hamilton, 2011). The developing theory or propositions need to be unravelled through a convincing, data-driven account using the empirical evidence as the scaffolding narrative. According to Goia, Corey and Hamilton (2011), the data collection and analysis, or findings, section of a case study is built around quotes from informants - this theoretical scaffolding is important to test the relevant theories, and to tell the story of the case through the links between constructs, propositions or models.

There are three types of data analysis that will be applied to help develop a narrative for the findings chapter. These are case description, pattern-matching and explanation building.

### **3.9.1 Case Description**

Case description uses the history, facts and operations of the organisation under study to develop a rich narrative about their key processes and programs that are of interest to the study. Through case description, the researcher uses the case study database and chain of evidence to build rich contexts for the case under investigation. It is thus important to maintain the case study database and collate all evidence. Documents, observations, field notes and data from participants allow the researcher to form insights into the history and activities of the organisation. Building a rich context for each of the cases makes the boundaries of the study clearer and provides.

In the absence of comprehensive theoretical propositions or a lack of rival explanations, case description develops a detailed descriptive framework to organise the case study. These are particularly relevant when the aim of the research is descriptive, or aims to provide a description of the complex interconnection of events that may aid in explaining behaviours and establishing the cause-effect patterns observed in empirical data. In applying case description, Yin (2003) identified it as providing insight of practices and activities that could quantify decisions. Case description gives the researcher the ability to identify or clarify an embedded unit of analysis and determine the pattern of complexity used in a causal sense to explain a particular process.

With a rich case description, the researcher matches recurring patterns prescient in the empirical data against the theory derived from literature. A case description provides

objectivity to the data analysis process (Eisenhardt, 1989). In a single-case study, a single case description that is comprehensive and highly detailed will provide the context for key constructs that emerge from pattern-matching and helps to frame the narrative around how the relationships are delineated. Barratt, Choi and Li (2011) see case descriptions as core to the creation of insights and give researchers an early mechanism to establish the emerging issues that warrant further explanation and assist in the development of a history or background section of a publication or report.

### **3.9.2 Word Count Analysis**

Leech and Onwuegbuzie (2007) believe that word count analysis is a useful tool for analysing textual data, in particular interviews, to understand the perspective of participants by identifying their most commonly used words. This is particularly important for a new group of people or a previously unresearched organisation such as an emerging technology domain, where little to no previous qualitative studies have been performed. Understanding the language of the participants by counting the frequency in which they use certain words or terms in the transcript will eventually allow the analysts to establish codes for guiding the process of triangulation (see 3.9.3). By eliciting the most commonly used words from an interview transcript, the researcher can use these codes to guide analysis of the multiple sources of data using these codes as preliminary patterns. This will enable the researcher to establish which codes have the most significant meaning within a larger picture of the research setting.

Using word count to conceptualise preliminary codes has several benefits for a case study analysis: (1) it provides the coders with prompts for patterns across the multiple sources of data, (2) it allows a more efficient verification of any hypotheses or constructs in a conceptual framework and (3) it maintains analytic integrity (Miles & Huberman, 1994).

### **3.9.3 Pattern-Matching**

Pattern-matching is a technique in which empirically observed patterns in the data are compared against predictive patterns. These predictive patterns are derived from extant literature and, in turn, elicit initial codes from primary data sources – for this research, this

activity will be the Word Count analysis described in the previous section. Predictive patterns provide qualitative researchers with a technique to measure observations in participants or events, thereby ensuring internal validity. Pattern matching allows the investigator to establish independent and dependent variables, which can help develop the explanatory elements of the research stemming from the inductive logic.

In this phase of data analysis, the initial codes from the Word Count will be used to identify occurrences of patterns across the multiple sources of data. Patterns in this context are supporting statements that will be used verbatim as quotes or theoretical ideas that ascribe to the initial code. In this process, intercoder reliability will be conducted. Kurasaki (2000) discusses intercoder reliability as the action of the measure of agreement between multiple coders about how initial codes are applied to data. In this process, coders identify and mark themes in a textual source, which provide the basis for constructs that can be observed consistently across all the data. Having multiple researchers code the data can strengthen the trustworthiness of the findings via investigator triangulation and increases reliability (Leech and Onwuegbuzie, 2007).

Trochim (1989) describes pattern-matching as being similar to hypothesis testing and model-building approaches. In this activity, theoretical patterns begin with hypothesis about what is expected in the data based on preliminary themes. Because this research is interpretive, the preliminary themes will be extracted from the data itself and observed patterns use empirical evidence to examine the conceptual framework. In pattern-matching, the researcher develops their themes through the use of complex or detailed hypothesis that adopts a multivariate (triangulation) approach rather than a univariate one. Pattern-matching is used to:

- 1) Identify major relevant constructs, then;
- 2) Describe the theoretical interrelationships among them

This research will use what Yin refers to as rival explanations for pattern-matching. In the context of this study, rival explanations are the antecedents of trust that have been defined in Chapter 2 and are present in the case protocol. These trust antecedents have been 'operationalised', that is, the trust continuum has been formed to match the predicted

activities of a livestock supply chain. With a single-case study, matching the variable defined in the conceptual framework against empirical evidence in the data will either allow explanation for the existence of that variable within the case or if the pattern is not observed, then this will lead to an alternate explanation.

Pattern-matching could lead to the generation of new variables or constructs that are unique to the BeefLedger context. If new constructs are identified, then an explanation for their appearance will strengthen the analysis by establishing the need for causal links.

### 3.10 Explanation Building

Explanation building is of particular importance to explanatory case studies. This analysis builds on pattern-matching by explaining the phenomenon with variables and establishing causal links between the observed variables. These causal links are often critical insights into process or theory. Generally, the aim is not to conclude a study but develop ideas that will generate further research, with the end result being hypotheses or propositions.

Yin (2003) discusses steps in the iterative nature of explanation building, which stems from inductive thinking and interpretivism (Walsham, 1995). The iterative process includes:

- 1) Making an initial theoretical statement or proposition about policy or social behaviour
- 2) Comparing the findings of the initial case against the statement or proposition
- 3) Revising the statement or proposition
- 4) Comparing other details of the case against the revision

As can be noted, the iterative summarises the procedure of this data analysis chapter. In case study research, Atkinson (2002) indicates that studies generally begin with study propositions to be answered upon completion of the research. Because this research is exploratory, rather than initial theoretical statements or propositions, this study will employ the two research questions (identified in Sections 1.2 and 2.11) as motivation for the research activities such as the formation of the case protocol and the list of questions. These questions are not intended to produce positivist results, rather, they are general directions of inquiry and the insights will likely be more novel and derived from the language of participants.

In case study analysis, explanation-building will lead to a series of propositions (Miles & Huberman, 1994). The objective of this analysis will be to develop propositions based on the empirical observations (Atkinson, 2002; Yin, 2003) that will provide testable future contributions to the existing research knowledge.

### 3.11 Logic Model

While logic models are closely linked with pattern matching, most case study research distinguishes it as a separate form of data analysis (Yin, 2003). Wholey (1981) developed logic models as a technique to analyse dependencies among programs, whereby outcomes could be produced from events or events could be represented as a sequence of outcomes. Logic models have since evolved to be an analytic technique for matching empirical events against theoretically predicted events. The development of a logic model extends the products of pattern-matching and cross-case analysis by allowing the researcher to map emergent or confirmed constructs through a diagrammatic representation of their inter-dependencies. Peterson and Bickman (1992) identify logic models as representing a complex chain of events over time, in which events are staged in cause-effect-cause-effect patterns. This allows a dependent variable (an event) at an earlier stage becomes an independent variable (causal event) in the next stage. Previously, logic models have been used to represent complex time events in clinical decision making, mental health and program logic.

Logic models are often used to describe or represent a program (Kellogg Foundation, 2004). For the purpose of this study, a program can be seen as similar to a process. Logic models offer a useful tool to represent the relationships between key elements. A logic model is flexible, and it allows the organisation to identify areas of strength and/or weakness and allows stakeholders to run through many possible scenarios to find the best. In a logic model, approaches can be adjusted and changed as program plans are developed. Another critical element of a logic model is identifying and describing the key contextual factors external to the program or process that may influence it positively or negatively and how these conditions might affect the outcomes (McLaughlin & Jordan, 1999). Ongoing assessment, review, and corrections can produce better program design and a system to strategically



monitor, manage, and report program outcomes throughout development and implementation.

Common elements that are used to frame logic models are *resources/inputs*, *activities*, *outputs*, *outcomes* and *impact* (Kellogg, 2004, p. 8):

- Resources are inputs such as the human, financial, organizational, and community resources that a program directs toward doing the intended work.
- Program Activities use the resource inputs for the processes, tools, events, technology, and actions within the program implementation.
- Outputs are the direct products of program activities and can include types, levels and targets of services to be delivered by the program.
- Outcomes are the changes in program participants' behaviour, knowledge, skills, status and level of functioning.
- Impact is the fundamental intended or unintended change occurring in organizations, communities or systems as a result of program activities.

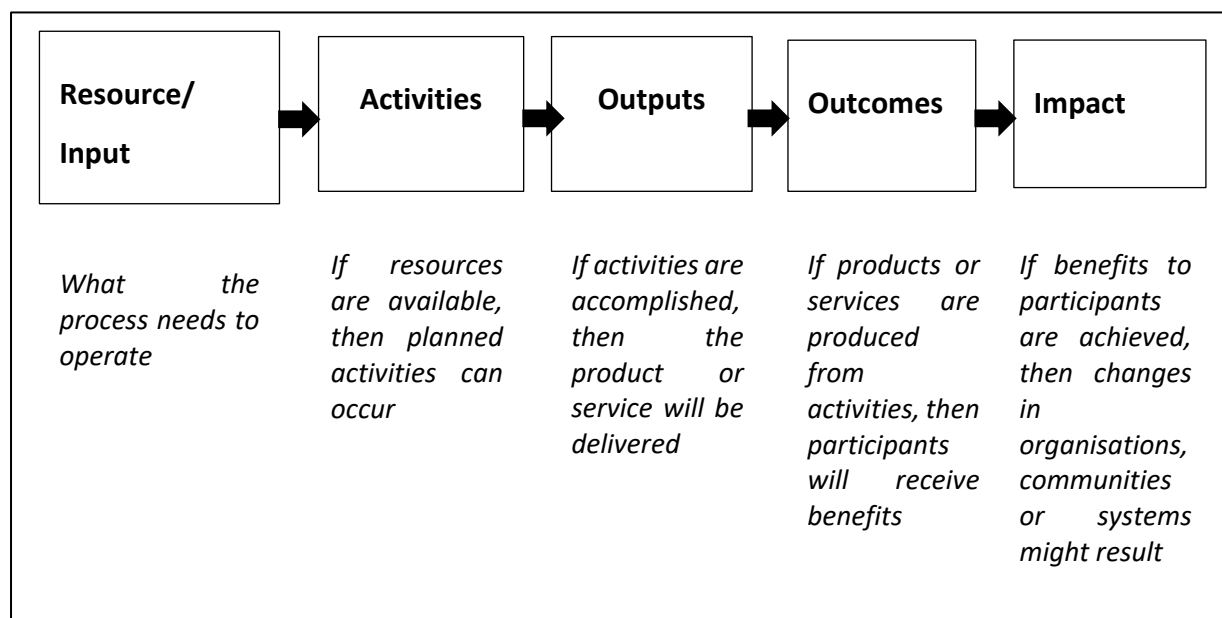


Figure 3.2: Conception of a Logic Model (Kellog Foundation, 2004, p. 8-10)

Logic models are useful in exploratory research to identify major constructs in settings with diverse stakeholders to evaluate processes among the community (e.g. Helitzer et al., 2009)

and in explanatory research to map the fidelity of a program or process (Holiday, 2014). Their production has a contribution to practice in that they provide a conceptual view of the key components of operations that clarify the strengths and weaknesses of a particular process.

### 3.12 Summary

This chapter discussed the method of the study. It firstly established the rationale for a case study approach in this context and discussed why a single case study design was the most appropriate. It then discussed the development of constructs which is a key aim of an exploratory and explanatory qualitative study. The overall research design was presented and the major data collection procedures (semi-structured interviews, field notes and documents) were detailed and the data analysis process (case description, word count analysis, pattern-matching and explanation-building) were described. A logic model is the final stage of the data analysis and this was defined and its relevant to making sense of the data determined. The logic model will be presented in Chapter 5 as a separate section, as it provides substantial conceptual modelling and defining of the major constructs that emerged from the data collection and analysis.

## CHAPTER FOUR – DATA COLLECTION AND ANALYSIS

### 4.0 Introduction

This chapter discusses the data collection and data analysis activities of the study. The data collection and analysis is based on the methodology outlined in Chapter 3. This chapter describes both the process and reports on the analysis of the data provided. The data consists of a semi-structured interview with the principal respondents and field notes gathered by the main researcher. Additional information from secondary sources such as supporting documents were also gathered. Throughout data analysis, a process of triangulation is employed, with multiple researchers analysing the primary and secondary data sources. In explanation-building, the extant literature from Chapter 2 is compared against the developing themes as the study starts to extract constructs and variables significant for the logic and conceptual model.

### 4.1 Data Collection Process

The principal data collection process was a semi-structured interview with BeefLedger.

#### 4.1.1 Interview with BeefLedger

A face-to-face interview with two BeefLedger senior executives was conducted on September 4, 2019. The interview was semi-structured and followed the case protocol procedure found in the Appendix. Prior to the interview, the informants were asked to provide verbal consent to the interview and to the audio recording, which would later be transcribed.

The questions were guided by the list of questions assigned to the relevant themes in the case protocol. The protocol can be found in the Appendix. Informants were asked to express their insights and personal perspectives in their own words. The interviewees were specifically asked not to consider trust too deeply but to provide an authentic viewpoint about how they saw their organisational operations in the supply chain process. During the interview, when

the informants provided answers to a question yet to be asked, then that question was skipped. Alternatively, when an unanticipated response was given or a construct that had not been previously identified in the unit of analysis or the literature review was identified or stated, then the respondent was asked to follow up on this point with further detail. The aim of the interviews was to gather rich insight into the organisational process of BeefLedger and the processes in the Agrifood supply chain that their product supports.

At the end of the interview, the researchers provided a wrap-up and discussed follow up protocols with the informants. Both informants were happy to have been involved in the discussion and agreed to provide further information and access to the researchers should more questions arise, or further themes or constructs required clarification. The informants were offered to have the transcripts emailed to them following the assembly of the word document.

The audio recording of the interview was 1 hour and 39 minutes. The transcript was produced using NVivo and exported as a Word document. The document was 41 pages.

#### **4.1.2 Field Notes**

Throughout the engagement with BeefLedger, notes were maintained following visits to the site and after interactions with the senior executives through email and phone calls. Field notes are statements and observations made by the researcher in an A4 notebook following site visits and are used throughout the analysis to support and offer explanations for patterns found in the coding of the raw data.

#### **4.1.3 Documents**

Secondary sources of data include photographs taken onsite, news articles (Butterworth, 2017; Queensland University of Technology, 2018; Foth & McQueenie, 2019), a research report (Foth, 2017) and a brochure downloaded from the BeefLedger website (BeefLedger, 2018).

## 4.2 Case Description

BeefLedger have had several news features written about them (e.g. Queensland University of Technology, 2018) and two research reports at the time of this writing (Foth, 2017; Foth, 2018). Another source of data is the self-published brochure by BeefLedger (2018). These sources provide general information about the operations of the organisation, but to date there has not been an in-depth or comprehensive study conducted about the operations and theoretical constructs of their operations. This case description will build an historical account of BeefLedger which will provide rich context to situate the data collection and analysis and the generation of the variables.

BeefLedger was established in 2017. Their formation was driven by the need for greater transparency and streamlining in the beef supply chain in Australia. The senior executives that were interviewed have finance backgrounds, consistent with the mission of the company, which is primarily financial services and facilitating cross-border trades. In particular, BeefLedger focuses heavily on business with China, who are one of Australia's largest markets for exported meat products. In China, food safety and food fraud are major issues that are confronted by the market.

According to the BeefLedger interviews, the major drivers sought by the Chinese market are that the meat is beef, it is imported from another country, that it is the cut of meat that it purports to be, that the condition of the meat is suitable for consumption and animal welfare is a consideration. The industry in China is rife with counterfeit and adulterated beef, with the main problem being that consumers not purchasing what they believe they paid for.

*The research estimate is that for every kilogramme of beef sold in China, there's another three that isn't beef at all, or is adulterated. There's another three that is beef that is beef, but not from the country that it claims to be from, and there's another three that is beef, but is not the cut that it claims to be. So, nine out of every ten kilogrammes of beef sold in China, at the moment, is in one way or another misrepresented through to being counterfeit. Let alone concerns around just branding and labelling and all that sort of stuff. So, it's quite significant.*

The BeefLedger platform is a food provenance and payments platform, that is underpinned by credentialed data provenance and smart contracts. The informants come from finance backgrounds and perceive the platform as a technological solution to a financial problem. BeefLedger don't see themselves as in the business of exporting beef but providing a mechanism to simplify payments for correct transactions. From the interview, the top drivers for the formation of BeefLedger were:

- 1) Issues in the supply chain around payments and the need to execute contracts digitally
- 2) Traceability to resolve disputes around whether the products that arrived at the destination are the products ordered

The financial problem that generated the need for BeefLedger was what they termed a “sticky supply chain”, in that the product, whether a live animal or boxed beef, goes through many entities with different responsibilities on its journey from paddock to plate. Ownership may change as the product moves between different entities. BeefLedger engage with entities “up and down the supply chain”, and design and refine solutions around the key issues they discover.

BeefLedger perceive themselves as operating in an environment of zero-trust. This stems from their Blockchain underpinnings, which borrow from the theoretical thinking discussed previously in terms of the trust machine (Greiner and Weng, 2015). While they don't consider trust as an element of their practice (“if two people end up trusting each other more because of this, that's well and good, but the first thing that a supply chain actually needs is simple dependability...our transactions have been very dependable”), their development of what they term a ‘provenance premium’ can be considered as a huge step forward in an industry that is grappling with how to provide trust with the diverse and cross-cultural entities that are conducting business. The provenance premium is how they determine the value of goods for their clients, and this provenance information records all information about the cross-client transactions over the supply chain.

Their provenance flow includes a data-driven environment with three layers: the blockchain layer, the internet of things layer that tracks real-time information about the product and the Oracles (e.g. PICs, Organic certifiers, Food Safety officers, Animal Welfare, etc) who add information to the lifecycle of the product (BeefLedger, 2018). The data layer supports the

product movement across the supply chain, which typically consists of Production, Processing and Distributors, and Retailers. A user interface allows all parties to access the Blockchain framework, providing a window into the veracity of data that blockchain technology provides.

Central to their blockchain operation is the production of the innovative BEEF token, a digital cryptocurrency developed in 2017 to be part of the design and implementation of the world's first application of distributed ledger or blockchain technology to the entire beef supply (Queensland University of Technology, 2019). Through their BEEF token, BeefLedger provide credentialed food provenance data that addresses the issues of food fraud and security and adds to the value-driven need in the sector for new forms of interaction between producers, processors and consumers (Foth, 2017).

The novelty of BeefLedger is their innovative use of blockchain and IoT technology to solve a series of previously intractable issues in the beef supply chain that extends into the South-East Asian and Asian markets.

BeefLedger also conduct qualitative research on their customer experiences.

*We obviously conduct our own qualitative research based on customer interviews, feedback, spending time with customers and just listening to people. Observing the marketing messages, of course, in the marketplace generally; they don't come out of the blue from nowhere. Keeping a very close eye on public discourse in social media around things like food safety, etc.*

To date, BeefLedger have not had a systematic, in-depth case study conducted on their organisation or their processes. This thesis presents the first attempt. As they are a new and novel firm, their context presented the opportunity for an innovative and revelatory study that will provide a platform for future research into their business.

This case description provides a historical context and brief detail about their operations, which establishes the context for the formal analysis of the primary and secondary data.

### 4.3 Data Analysis

Initial data analysis began immediately following the transcription of the interview. The transcript and field notes were collated, and the researcher applied the case study data analysis strategies. The data analysis was conducted with three researchers: the lead

researcher, the Principal supervisor and a research assistant. This demonstrates intercoder reliability and removes potential biases that one coder may bring to the data. Additionally, this process follows the methodological rigour tests described in Chapter 3.

Pattern matching was conducted to begin establishing the relationship between primary data and the conceptual framework variables.

#### 4.3.1 Word Count Analysis

A word count analysis was performed initially on the 41-page transcript using Microsoft Word. Conducting this initial quick analysis on the transcript is useful to begin to explore the language of the participants and establish which words have the most meaning to their practice. These words form codes that can then be re-used against the transcript to explore the data more deeply, with the transcript being codes against other sources of data.

The following table lists the most commonly occurring words throughout the document.

<b>Word</b>	<b>Number of Instances</b>
<b>Data</b>	67
<b>Trust</b>	63
<b>Information</b>	28
<b>Risk</b>	25
<b>Validity, Validation, Validated</b>	23
<b>Dependability, Dependable, Dependably</b>	18
<b>Provenance</b>	16
<b>Agreement, Agree, Agreed</b>	16



<b>Confidence, Confident</b>	14
<b>Certification, Certified, Certificate</b>	10
<b>Consensus</b>	9

*Table 4.1 Word Count Analysis*

As discussed in Section 3.9.3, these codes can be used to inform speculative hypotheses about patterns that might emerge across the data sources. In the next phase of analysis, these words are used to frame the cognitive searching methods and ensure that the researcher can identify and explain the predominance of each of these high-level themes. In Figure 2.2, the main constructs from existing research are compared against the codes that emerged from this word count to further establish which words have the most significance and meaning. This process also confirms which major constructs from Figure 2.2 have the greatest applicability to the data collected in this study, while also providing the researchers with different other possible constructs and variables to search for in triangulation.

The codes were given to the three researchers (lead, principal and research assistant) for independent analysis of all data sources. With these preliminary codes, the researchers can start to form speculative hypotheses. It must be noted that these are not formal hypotheses that are guiding research, but rather, combine concepts and codes to enable the coders to elicit key relationships that can further explain them. For example, one speculative hypothesis was that “consensus among all entities will lead to higher openness among all parties.” Each researcher may independently form their own hypotheses about which statements or evidence will best explain a code, leading to a more efficient gathering of empirical statements. These are the observable “patterns” across the data, quotes or statements that can be directly linked to a code. The more significant the pattern, the more significant the codes, which will ultimately lead to the formation of key themes. This has significance for the next process.

### 4.3.2 Pattern-Matching

Pattern-matching used preliminary codes from Section 4.3.1 to compare the interview transcript, field notes and supporting documentation by looking for consistent patterns across them. In this process, the word counts from 4.3.1 were preliminary themes that would guide how the researcher would analyse the interview transcripts. As discussed in Section 3.9.3, pattern-matching is a data analysis technique in which the building blocks (constructs and variables) for the intended logic model are formed. Trochim (1989) describes pattern-matching as being similar to model-building approaches.

Transcripts were printed off and distributed between the lead researcher, the principal supervisor and one research assistant for independent coding. Each coder would scan the transcript for statements that support each of the preliminary codes. In this activity, the codes from the Word Count analysis are used to explore the interview transcript in more depth and compare the empirical evidence against the field notes and the supporting documents. The codes function as hypotheses as described in Section 4.3.1, or as key words or prompts for the researchers to gather sufficient data to support the existence of the word. Through this process, patterns began to emerge, either supporting the speculative hypotheses or forming new ones which could be confirmed or disproved by the other coders.

Through triangulation, the researchers:

1. Exhausted all empirical data
  - 1) Identified major relevant constructs through consensus; and
  - 2) Described the theoretical interrelationships among them

Once empirically supported patterns emerged, the coders would confer on what statements supported a particular code.

Following this, the observed patterns were grouped under particular themes. These themes were either speculative hypotheses that have remained as they captured the central pattern under observation or emerged through triangulation and have been added to the number of concepts. The goal of each theme was to build understanding about the relationships between the major concepts from the Guiding Conceptual Model in Figure 2.2 and further

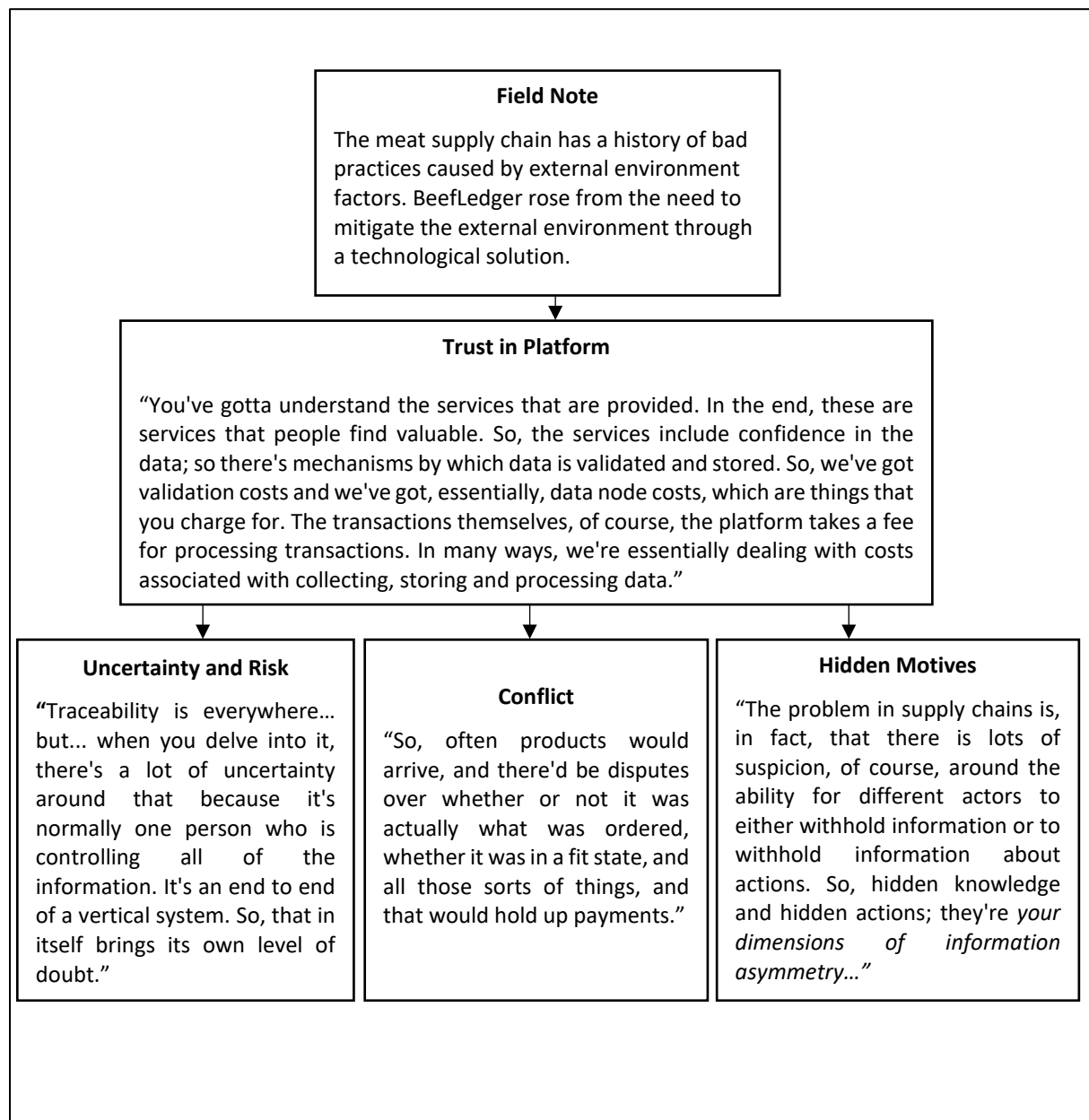
establish the interaction between system-level and individual-level layers of trust. In the following sections, the themes will form headings that encompass the connections between major concepts from research and the codes used to discover patterns. These patterns are matched through empirical support, which are quotes or statements extracted from the data sources.

The connections between concepts, codes and the empirical patterns will be displayed as visual maps to more appropriately illustrate the process of triangulation. This process leads to the formation of *new* concepts and/or variables that will be important building blocks to expand the conceptual framework of Figure 2.2 and shape the logic model. Quotes from informants are from the interview transcript, and where possible the quote will be linked to the question that extracted it. Field notes are added to support the path toward the new concept or variable. The new concept or variable is named using the language of the participants. In some cases, the concept is simply a verbatim word that was the most frequently employed by informants or is a synonym that better captures the pattern in the data. These are used to group ideas, themes and codes together and offer a high-level explanation for the occurrence or observed phenomenon that was present in the conceptual framework. In the diagrams under each theme, the matching is done by triangulating all the evidence and demonstrating how it leads to the formation of a concept.

Each major concept will be discussed within the theme and extant literature is used to support its development, further establishing rigour by ensuring that each discussion is theoretically rich with both existing research and empirical data.

### Theme 1: The external environment creates a need for Trust in the Platform

The need for the BeefLedger platform is driven by external environment factors that influenced how parties were traditionally influenced to act in the meat supply chain the past.



## **Conflict**

Most conflict in the meat supply chain arises from instances of counterfeiting, food safety and products arriving in a state that is different to what was expected. One BeefLedger informant clarifies this by stating:

*but it could also cause other anomalies in the supply chain which was things like the product would sit somewhere for ages, it would sit in adverse conditions which would lead to condition degradation, which would further compound the economically losses being suffered, and at some point in time, it results in an insurable event, etcetera, etcetera. So, the existence of information of asymmetry, if you will, in the supply chain, create a very significant risk around payment smoothness, reliability of payment; it created issues around cost of finance consequently, and also risks to the product itself, which raised a bunch of additional costs around insurability.*

## **Hidden Motives**

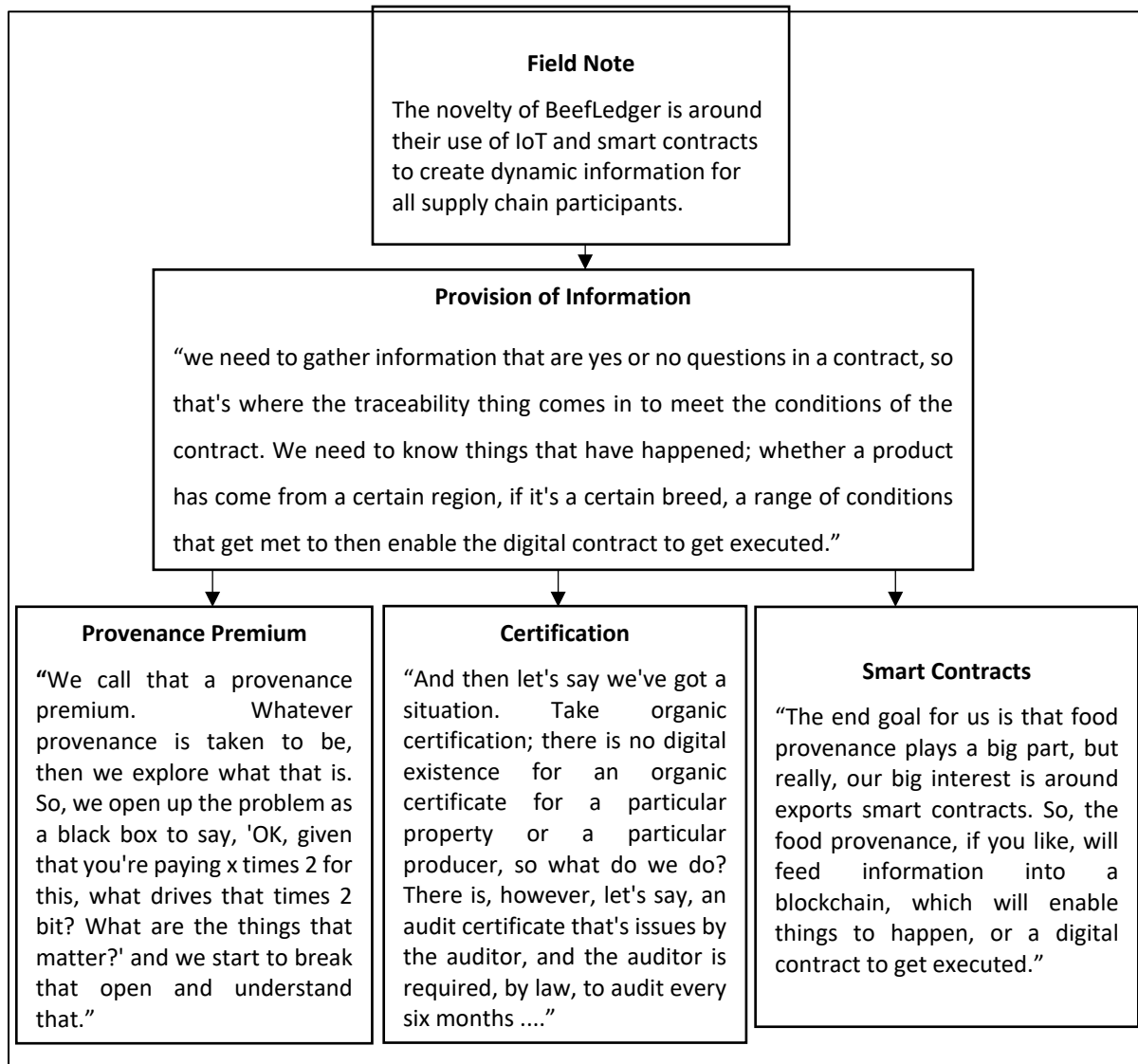
Because supply chains in the past operated offline, there was sometimes an opportunity for participants to either withhold or retain information that would enable them economic or organisational leverage in the movement of a product.

*... Does that make two parties trust each other more or less?*

*Well, in due course, if two people end up trusting each other more because of this, that's well and good, but the first thing that a first that a supply chain actually needs is simple dependability, that in fact our transactions have been very dependable, and there's reasons for that, because the data from these sources, from these digital signatures, etcetera, etcetera, have consistently delivered, in a sense, what they have claimed to delivered.*

**Theme 2: Provision of Information has three underlying activities**

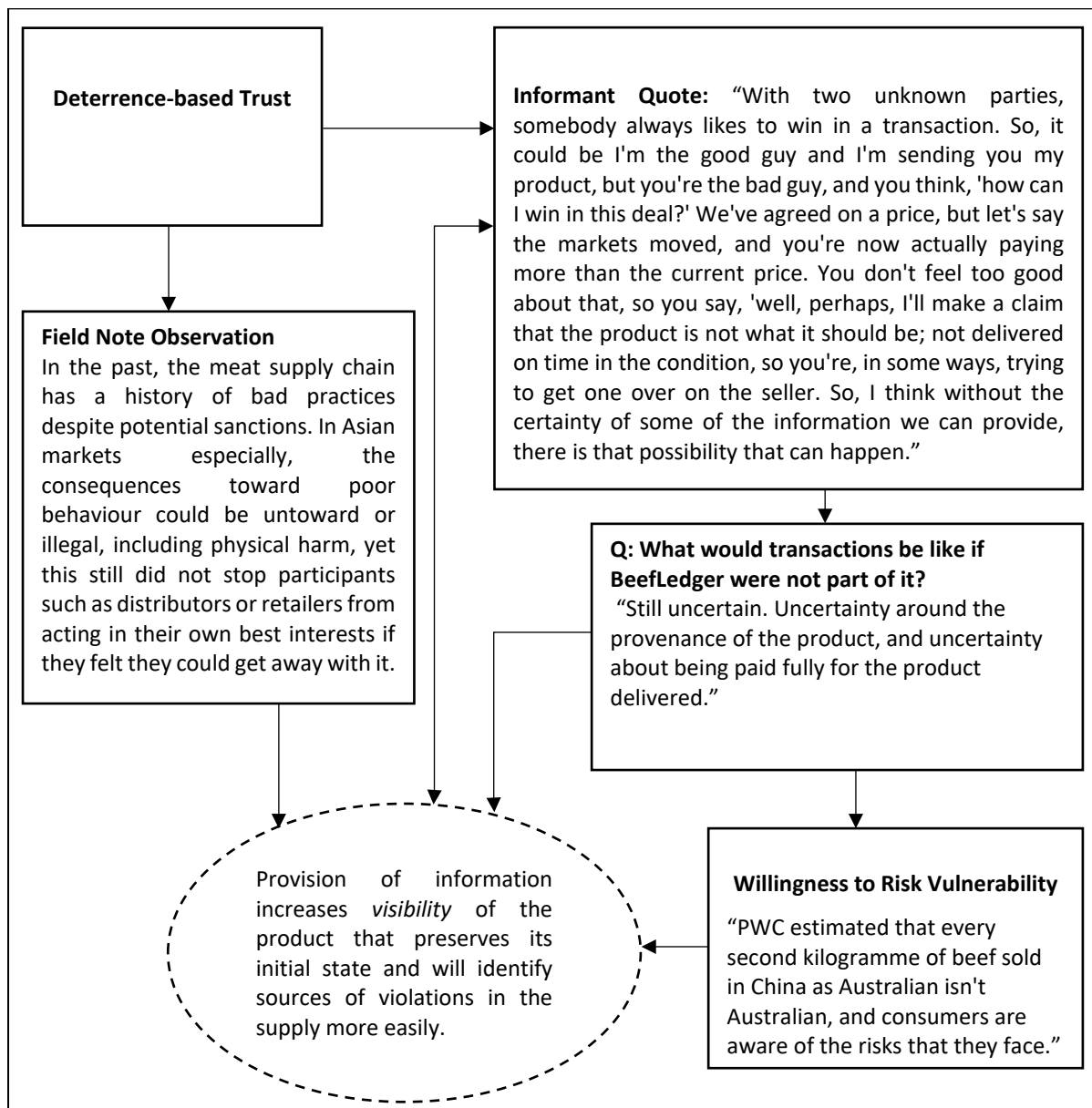
Information sharing is critical to all supply chains, but BeefLedger introduces a novel form of information sharing by provision of information that is timely, accurate and enables real-time data capture. The informants noted that they offer three activities in provenance premium, certifications and smart contracts, each of which contain the original information of the product but are also ‘organic’ in the sense that they add real-time information to the activities which enables the products to update themselves as it moves through the product lifecycle.



### **Theme 3: The relationship between Deterrence-based Trust and Willingness to Risk Vulnerability**

Willingness to Risk Vulnerability is a trust antecedent, where trust is perceived as a willingness to be vulnerable under conditions of risk and interdependence in which the perceived probability of loss is weighed against the potential benefits of an exchange (Rousseau et al., 1998). Deterrence-based trust is generated through the presence of costly sanctions in a transaction whereby when the transaction is not executed to the satisfaction of all parties then a sanction or sanctions may be imposed. Examples could be non-payment, legal action or discontinuance of future trading opportunities.

According to the data, Chinese purchasers are willing to risk vulnerability when purchasing beef products. Ultimately, the people who suffer the loss are the final consumers of the beef products. Furthermore, the example below demonstrates how the sanctions arising from deterrence-based trust may be manipulated / used in their favour (perhaps illegally) by supply chain participants when other financial conditions arise separate to the conditions of the transaction contract terms. The important component that can prevent or reduce these risks is the provision of accurate information about the product.

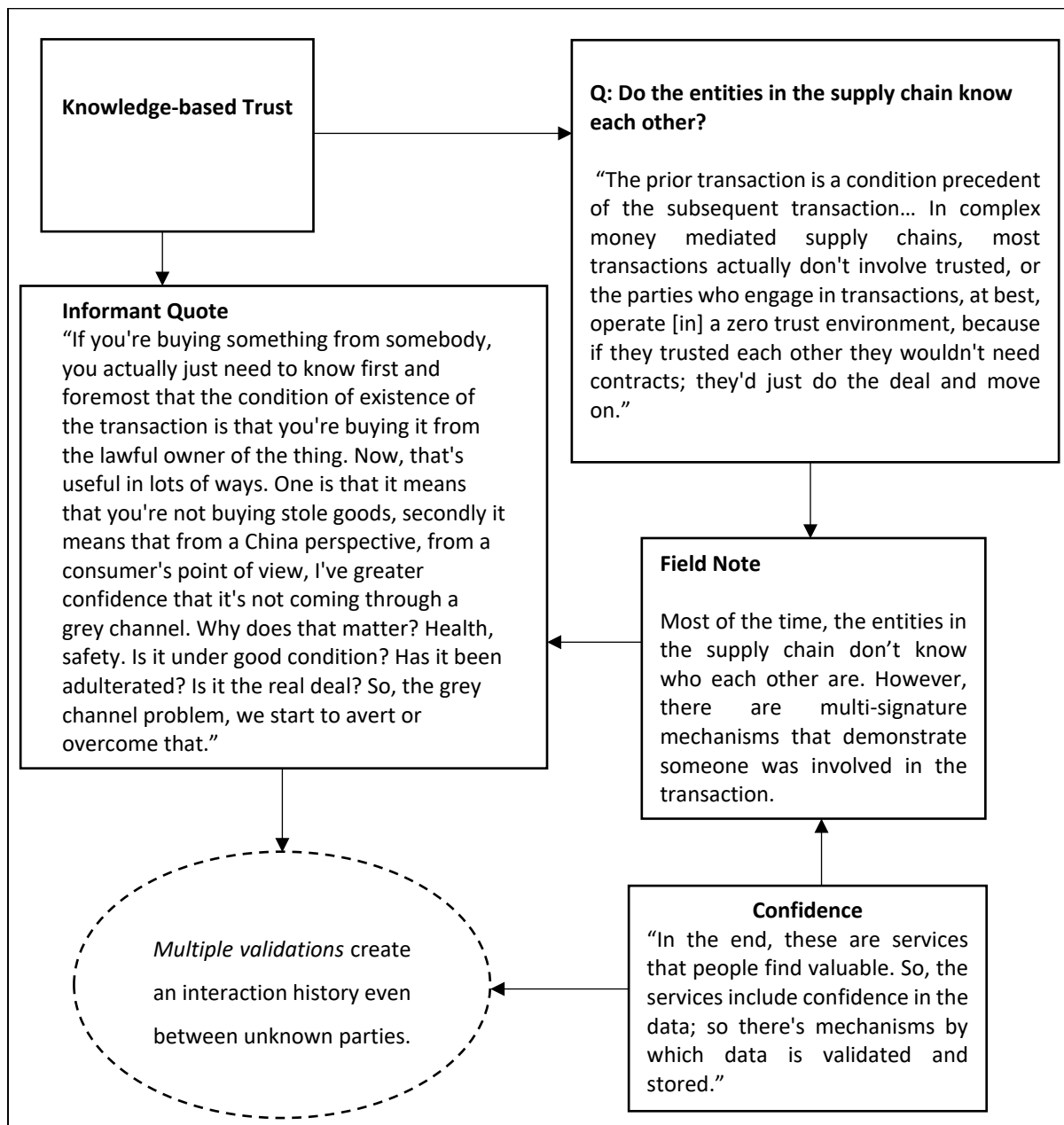




#### **Theme 4: Knowledge-based Trust and Confidence**

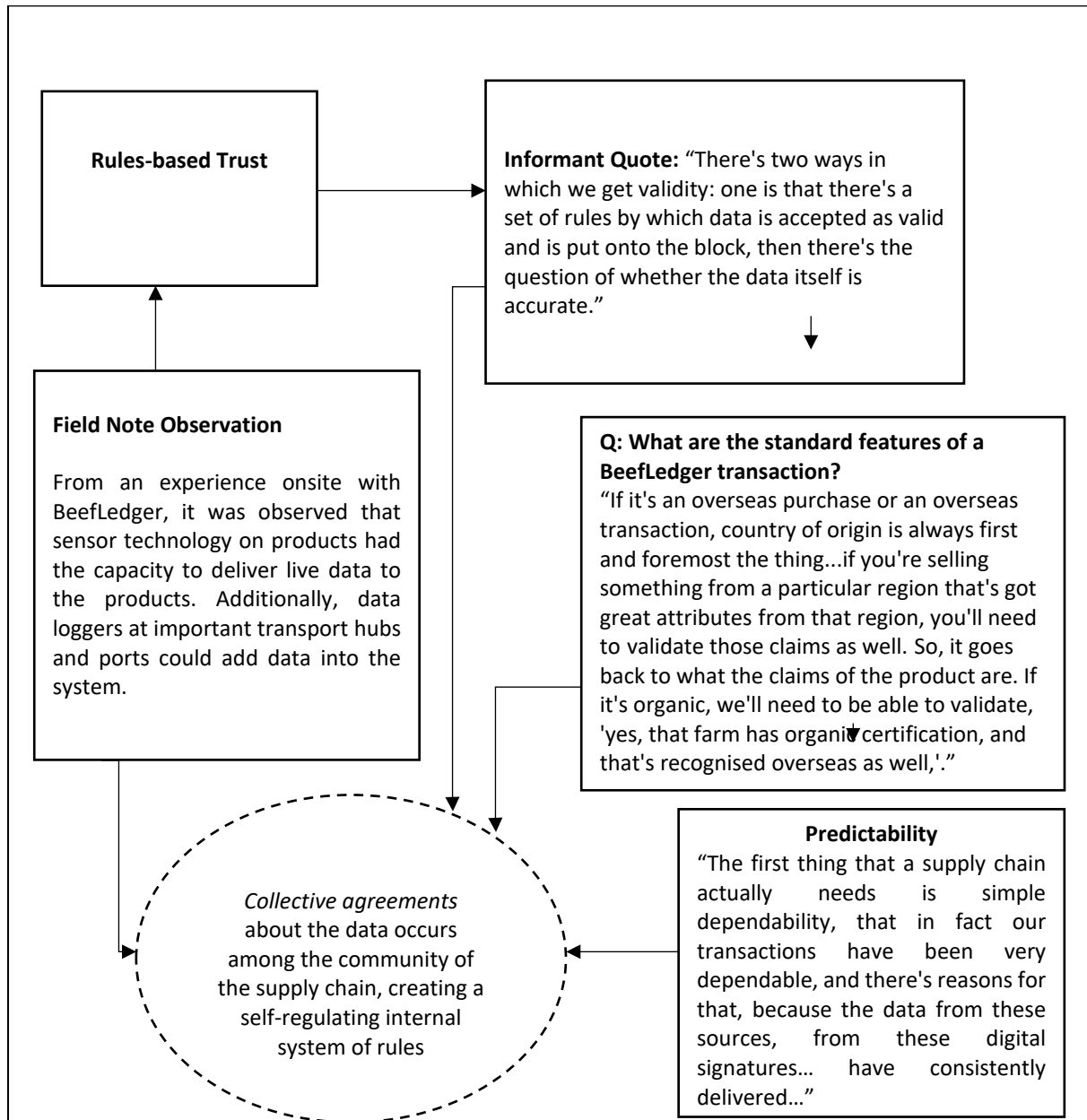
As exchanges repeat and recur in the supply chain and such exchanges can be physical goods and / or their associated information products Knowledge-based trust can build between the participants (Zucker, 1986; Shapiro et al., 1992). A pattern arises that reinforces the confidence that the parties can predict each other's behaviour. Confidence is an antecedent of trust that Rousseau et al. (1998) describe as the degree of confidence one holds in the face of risk rather than in the choice or action that increases the risk.

As Luhmann (1988) explains, if one party does not consider alternatives in an exchange, such as an alternative supplier for example, then this is a situation of confidence whereby one supplier transaction is chosen in preference to another in spite of the possibility of being disappointed.



### **Theme 5: Rules-based Trust and Predictability**

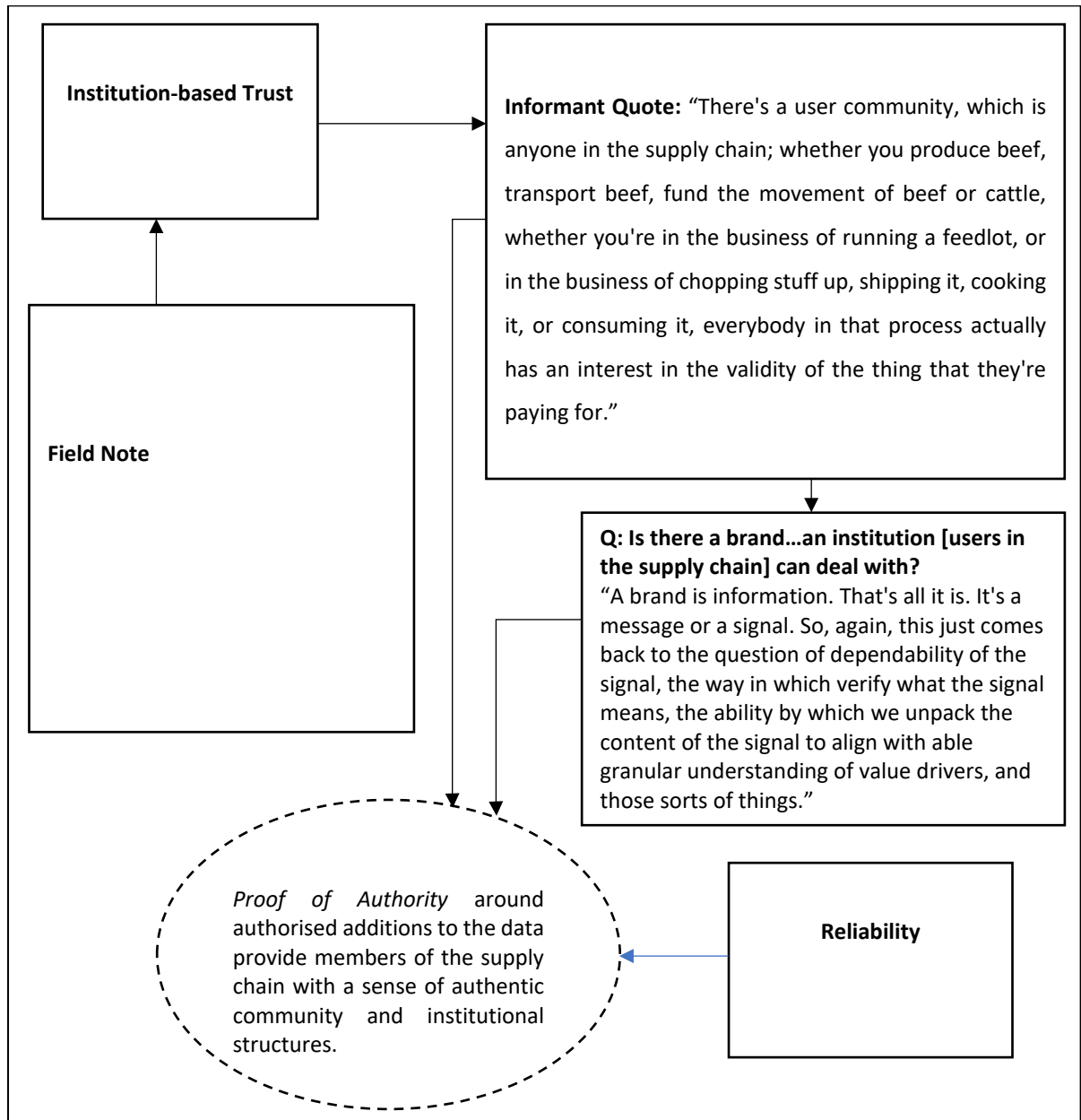
The questions were around how data in the supply chain was validated or if there were established rules about the way things operate. The next pattern builds on the idea of multiple validations by discussing the rules associated with these validations. The rules are generally held to by a collective agreement, in which all contributors in the supply chain agree to changes in the blocks and the data is not added to unless all parties agree to that addition.



### **Theme 6: Institution-based Trust and Reliability**

The creation of an authentication trail using the data that travels in parallel to the physical goods, which may be supported by IoT sensors attached to the physical goods, is a way to create trust in the collection of supply chain participants. The use of the BeefLedger system along the complete supply chain provides a level of reliability in the system and behaviour of the participants themselves. Tschanne-Moran and Hoy (2000) described reliability as predictability combined with benevolence and Kim, Yoon and Zo (2015) describe benevolence as the belief that the sharing service is genuinely interested in the consumer's welfare. By being interested in the general welfare of the supply chain participants, including the safety and welfare of the ultimate consumer, BeefLedger establishes trust in the supply chain as an institution through the perceived reliability of its system including the institution of rules, protocols and guidelines in place.

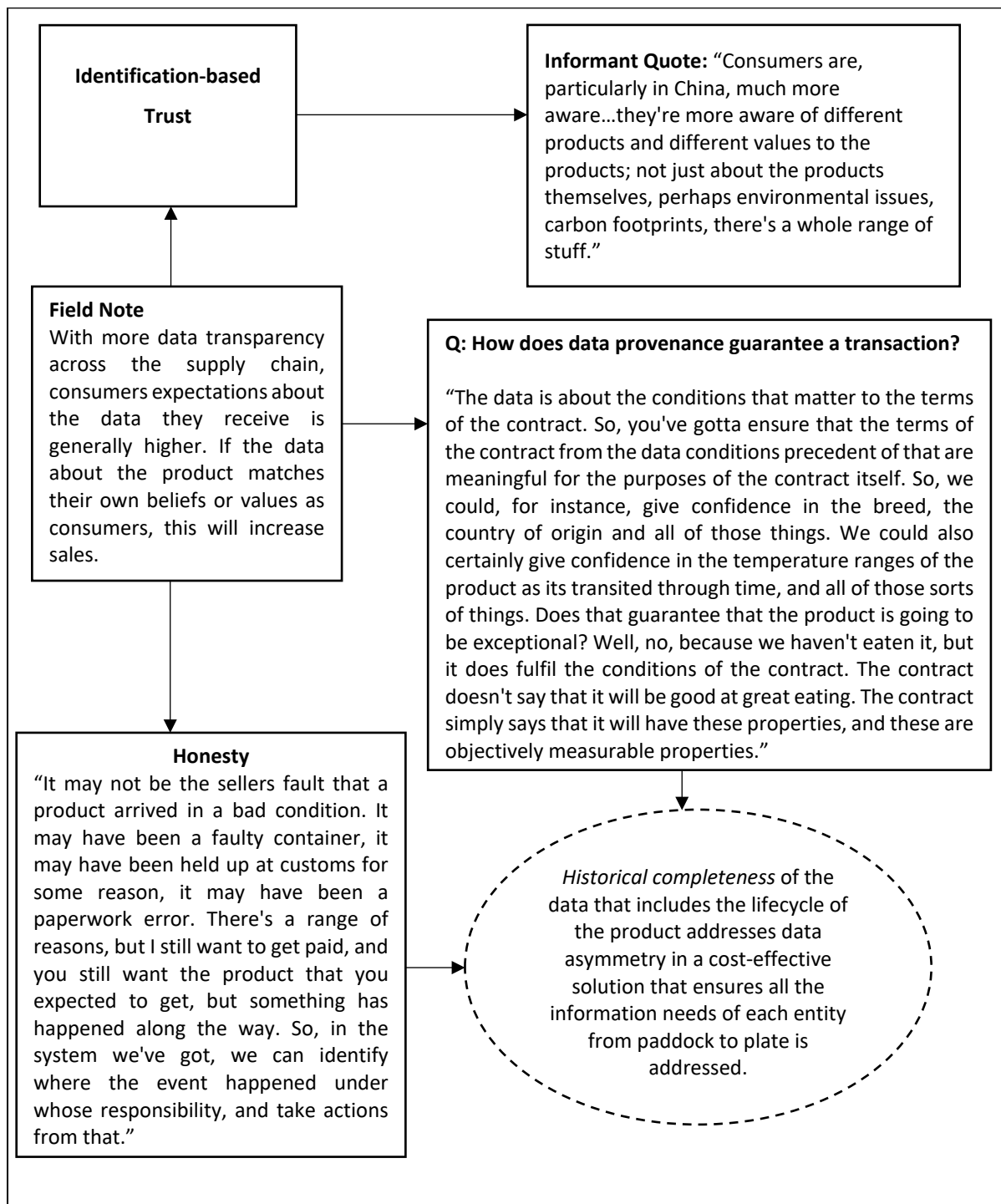
Again, we see evidence of a collective agreement amongst supply chain participants to abide by the rules and protocols creating sufficient reliability to support and protect beef brands, which generally originate within the farm gates but need to survive the supply chain process. In effect, supply chain becomes the institution that the participants, including the end consumer, trusts.



### **Theme 7: Identification-based Trust and Honesty**

Identification-based trust is characterised by shared goals and values between actors (Li et al., 2012). One shared value that helps to attain this high level of trust is honesty, a trust antecedent that speaks to a person's character, integrity, and authenticity (Tschannen-Moran & Hoy, 2000). Since the correlation between a person's statements and deeds characterises integrity, so does the correlation between the data and the physical goods in the beef supply chain.

By using blockchain technology, where participants can see the veracity of the transactions and smart contracts execute only when all conditions of a transaction have been met, records are kept permanently on the chain, this creates a complete historical record of all participant activities.



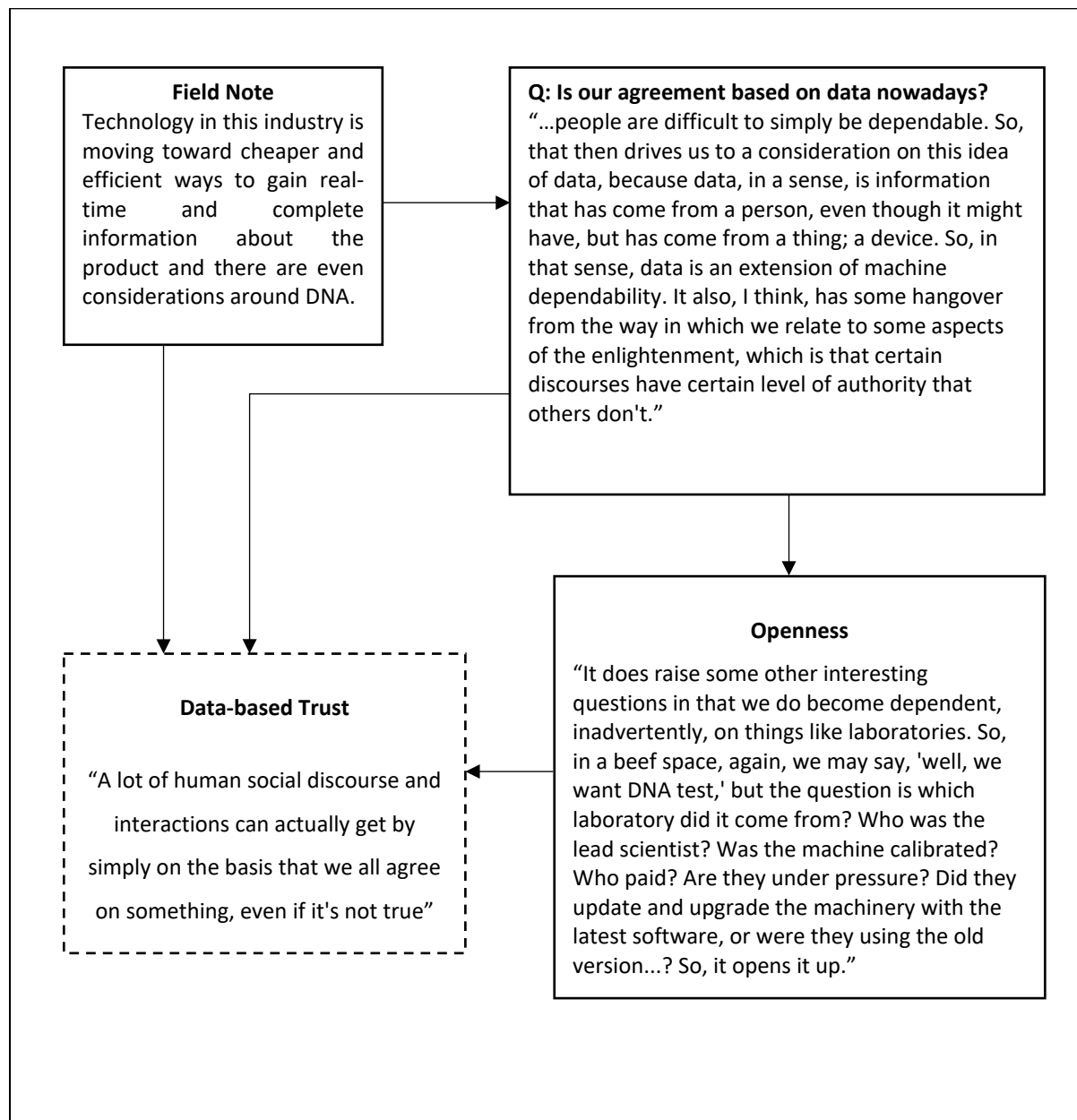


### **Theme 8: Data-based Trust and Openness**

In this pattern, a new system-level variable emerged: data-based trust. It explained the lifecycle of the data and provided the missing link between openness of the data and the actions of the supply chain entities in providing the data through the history of the product.

*I think without the certainty of some of the information we can provide, there is that possibility that can happen. Generally, that then falls back on the insurer. It may not be the seller's fault that a product arrived in a bad condition. It may have been a faulty container, it may have been held up at customs for some reason, it may have been a paperwork error. There's a range of reasons, but I still want to get paid, and you still want the product that you expected to get, but something has happened along the way. So, in the system we've got, we can identify where the event happened under whose responsibility and take actions from that.*

It is the emergence of a major construct that extends the system-level layer of trust, making this case study revelatory.



## 4.4 Explanation Building

Following the coding procedure of the pattern-matching analysis, the explanation of the major constructs and variables follows. These explanations are about how these concepts relate to the supply chain activities BeefLedger creates. At this point, extant literature is used to further establish the rigour of the concepts by positioning the findings of this study within the frameworks of existing understanding. By doing this, we build on previous knowledge and begin to offer further insight into how key practices lead to varying levels of trust within supply chain settings.

### 4.4.1 Provision of Information

As described in Chapter 2, Provision of Information resolves the information sharing needs of a supply chain through the services of the platform. Provision of Information by BeefLedger has three underlying elements that are the specific activities they combined to provide information service to their clients: Provenance Premium, Certification and Smart Contracts.

### 4.4.2 Provenance Premium

One of the most crucial forms of information BeefLedger provides is a Provenance Premium. They described this as a 'black box' that is dependent upon what is requested, which varies from product to product, whether it is livestock or boxed meat. As stated by one informant:

*It's just what the client wants. It's probably relevant to the product as well. So, if it's a cheaper commodity type product, they may just want to validate country of origin, and that it's safe when it arrives; that's probably enough. But if somebody is paying top dollar for a particular piece of Wagyu, they'll wanna know, perhaps even back to DNA analysis. It just depends. So, we have a range of levels of service available, and it just depends on what the client is looking for, depending on the client's needs.*

Further discussing what provenance could potentially comprise, one informant says:

*It'll be, you know, the following five factors, but they're not of equal significance. Factor number one is worth three times more than factor number two, and we're able to build a hierarchy, if you will, of value drivers. In economic theory terms, that's essentially a hedonic pricing approach. So, we look at the composition of price.*

Provenance Premium is an innovative way to conceive data provenance in that it addresses two of Li et al.' (2012) trust considerations in virtual transactions, *information asymmetry* and

*context-dependency*. Provenance considers these by providing information for all parties in the supply chain from the origins through to the product lifecycle, including its price, alterations or conditional changes, which is important at different points in the supply chain – for example, retailers will be interested in temperature changes and variances in the meat, while consumers will require information about the grading of the meat. This is consistent with the study by Van Wezemael et al. (2012) who found that detailed information about the beef product increased consumer acceptance toward various meats.

#### **4.4.3 Certification**

Certification information was another mechanism to deal with information asymmetry. It provides authentication to the product through an active process in which agents or Oracles could add physical data to the information as it moves through the supply chain. Describing the process, one informant says:

*Take organic certification; there is no digital existence for an organic certificate for a particular property or a particular producer, so what do we do? We either scan it and convert it into a PDF or have it as an image file of some sort, or we take a photograph of it and we upload that photograph of the certificate onto a decentralised web-server environment. So, in fact the storage itself is off chain, in that there is no consensus mechanism, it's just a storage place, but it gets stored in a decentralised world. That process now, actually produces a hashtag that is connected to that file, and the metadata of that file. The hashtag comes to our blockchain into a smart contract, which is a multi-signature smart contract, which then validates that hashtag by looking at the file, for example, and going, 'who did it come from? Who was it, who submitted it,' and all that?*

#### **4.4.4 Smart Contract**

As part of provision of information, smart contracts are organic systems of data that retain the initial payment of the product on the blockchain while adding any variances that may change the price of the product through its lifecycle. This ensures a *dynamic* form of trust that all solves the *non-transitive* issues. As one informant illuminates:

*Everyone on the supply chain who needs a common knowledge architecture and needs to access the tools or the smart contract that integrate the movement of the two types of data, which is the data about the things, and the data about the financial ledger.... So, when I buy something, even though the price is just x, in fact, inherent in that price is actually a price of the thing and the physical costs of its production and movement,*

*plus duties and all of that, as well as the price of the information about the thing; it's actually inherent in that number.*

Provision of information is a major construct that impacts on Trust in Platform. As stated by Möhlmann (2016), the reputation of a platform and the information it provides was found to have an influence on trust. Another study by Kang et al. (2016) found that third-party recognition (e.g. a third-party seal, accreditation) influences trust in the platform.

#### **4.4.5 Visibility**

Visibility is critical in addressing needs such as food safety and fraud. Data reduces the risk of counterfeit products by providing a clear, visible traceability of the product. Visibility assists by providing signals about attributes such as credibility, imported products and origins of the meat that enhance their willingness to risk vulnerability and increase purchase likelihood. Particularly in the context of China, visibility of data is a high need, as evidenced by a statement from one informant.

*Well, the Chinese don't necessarily know. That's the research. They just have a concern that things are fake, so they depend upon other signals at the moment to mitigate their sense of risk. So, what are the signals? Well, they buy things that are labelled as imported, that's one. They go to restaurants that they believe are credible. Why do they believe that they're credible? Well, their friends told them they're credible. They go to restaurants that are expensive, because expensive gives you a sense that there's a better chance that the product is truly imported.*

Visibility maintains both the origin of the data and raises trust to a level of honesty not previously observed in the supply chain. For instance:

*On a ship, the practical problem is even if the temperature goes to the wrong side for you, what are you going to do about it if your container or your refrigerated containers are under three others and they're in there? There's actually nothing you can do it anyway. So, what can you actually do? So, operationally there's nothing you can do about it. From an insurer's perspective, you simply wanna know where it happened and who is responsible.*

Visibility resolves the asymmetry of trust consideration and ensures that its bi-directionality is preserved. In a report on BeefLedger by Butterworth (2017), she quotes co-founder and director Anthony Dunn, who states “Platform users, whether they are producers, consumers and everyone else along the supply chain can benefit from access to credentialed provenance

*data and streamlined payments by using our purpose-designed digital token - the BeefLedger Token (or BLT) for transactions”.*

Furthermore, Handfield (2017, p. 5) states that *“Visibility allows individuals to see what is going on, and in an empowered ways, allows these individuals to interpret information and rapidly make decisions in response to data...When individuals have visibility that results in velocity of decisions, the system becomes frictionless.”*

#### **4.4.6 Multiple Validations**

Multiple validation is achieved through the addition of additional data such as audit information, ownership changes and certifications from different sources across the lifecycle of the product. BeefLedger refer to these as ‘Oracles’, and they include personnel across the supply chain from the Grazier end to the distributors, to data-loggers at ports or transaction points who record or update information about the condition of the product. BeefLedger describe this process as ‘multi-signatures’. The signatures are virtual but are controlled by the actions of a human contributor, and

*I think most supply chains tend to operate in zero trust environments as opposed to heavily trusted dependent environments, and they function anyway, and we say that partly because trust is an attribute of processes of engagement between people, and therefore, trust is something that happens through time*

Data being transferred in real-time between entities increases interactions, not with the previous entity, but with the product. The product having information attached to it at the change of ownership and data captured about the movement of the product between those points creates a virtual interaction history. Further to this process, BeefLedger state:

*There are three of us that nominate this data to be true and to be submitted and published to the blockchain, and the data is actually under the hash. What that now does though, once you've got the hash on the blockchain, is if the next transaction in a month's time needs to prove that it's from so and so's farm, Greg's farm, organic, you actually call on that hash and the file. Now, if somebody tries to submit the file again on a different day, it's got a different timestamp straight away. What does that do? Well, it creates a different hash. So, we now know that, in fact, that hash and the original hash is not the same, therefore that file is not valid. The file itself might be true, but it's not valid. Now, that raises questions as to why it's not valid. Why is somebody not actually referring to the original hash, but is duplicating this file? It could be someone fake. What that tells the blockchain, in a sense, or tells the validator community is something's not right.*

Multiple validation is a feature of the digitised supply chain, in which contributors to the information should participate to develop the data. This makes the data organic in a sense, in which the original provenance premium, certification and smart contracts have the capacity to capture real-time exchanges and additional information critical to the transitive and asymmetry trust considerations. Handfield (2017) describes this as the velocity of the real-time supply chain, in which every aspect of how an entity conducts their business is captured along the movement of the product. Further, he states: "... the object of the real-time supply chain is to achieve velocity in every aspect of how companies run their business. This includes how inventory is tracked and monitored, how much is produced, how quickly material and service suppliers respond, what modes of transportation are the most efficient and responsive, how to organize distribution and warehouse operations, how to move product through logistics systems, and most importantly, how quickly people in all aspects of the supply chain (suppliers, distributors, customers) are able to react and make decisions related to unexpected events and disruptions that impact the supply chain" (Handfield, 2017, p.5).

#### **4.4.7 Collective Agreements**

In considering the bi-directional, context-dependent and transitive considerations for trust in online transactions, Collective Agreements are an in-built mechanism that provide the supply chain system with institution-based trust through a community of trust exchanges. In describing this, one informant states:

*The risk of data being invalid, a consensus mechanism is better than a world in which any actor can arbitrarily and capriciously add, modify, take away data. So, again, that's just an attribute of decentralised ledgers with some kind of a consensus mechanism involving a multiplicity of people. So, those attributes immediately deal with those problems more effectively than traditional data systems.*

Information assists the rules of the supply chain system. It provides asymmetry in the data in that insurers require information about one aspect which is satisfied by the addition of certificates and audit information, while consumers have expectations around origins of the product and the quality of the meat product.

*We know it because that's his identity, and in fact, he does this religiously once every six months, and here it is again. The multi-signature parties look at that, 'yep, that's OK, we*

*agree, put it onto the blockchain.' Or, alternatively, it could be something that requires us to say to data community, our consensus mechanism, 'this is a piece of data that requires a vote of a community.'*

Pavlou and Gefen (2004) discuss institution-based trust in online transactions as requiring digitised forms of structural assurance, that are implemented or created by third parties to deal with the lack of legalities and governance of electronic exchanges. The BeefLedger Collective Agreements addresses this need. In a study about blockchain enabled systems, Hawlitchek et al. (2018) stressed that the verification of a human contributor was a necessary component for these systems and that future research needed to discuss how decentralised data-driven environments can account for this. Through Collective Agreements, it can preserve anonymity while delivering a human contributor interaction that is both timely and visible to the network.

#### **4.4.8 Proof of Authority**

Proof of Authority is a variable stated verbatim by one BeefLedger informant.

*An interesting feature of these consensus mechanisms, particularly the one that we're developing which is a Proof of Authority mechanism; it actually sets off, if you will, a social institution that is formed through the behaviour of the people in the supply chain. So, the brand actually does have a reputational value, either as messenger or as message, but that is ephemeral, in that you can let people down. So, that's one problem. So, that actually creates an incentive for the brand (the messenger) to maintain reputation.*

In a report on BeefLedger, Butterworth (2017, November) states that: “In China, there is very little trust within the marketplace. A Chinese woman could enter a supermarket, scan a code on a piece of steak claiming it is grassfed from Central Queensland and use BLTs to purchase that information and then purchase the steak from the store. Essentially, that woman has added value to the steak by purchasing the origin information.”

Further to this, Foth (2017, p. 515) says “BeefLedger becomes a secure source of verifiable truth for not just the meat industry, but also consumers, border control and law enforcement agencies, government and tax authorities”. Through their Proof of Authority mechanisms, BeefLedger creates the structural assurances and situational normality of a normal transaction process. As Fasli (2007) notes, norms or social constraints are the sense of institutions and the behaviour of agents within virtual multi-agent systems can be regulated



through appropriate electronic social institutions, including protocols that are augmented by stability, robustness and performance.

#### 4.4.9 Historical completeness

Maintaining the data of the product from its origins to the product lifecycle addresses all of Li et al.'s (2012) trust considerations in virtual exchanges and environment. One BeefLedger discusses the value of historical completeness:

*Now, if you actually know well beforehand that that meat has a shelf life of x, this is when it's landed...you've actually got the ability to one, inform the restaurateur that that pallet needs to be consumed before that pallet, even though you bought them at the same time, because one pallet was closer to the bad seals, and therefore, was half a degree warmer for longer, and therefore, it's lost ten days in shelf life. Consume that pallet first. They're the sorts of things that we can start to drive as far as supply chain behaviours are concerned that nip problems in the bud.*

*I think there's a range of, going back to the technical, the multi-signature stuff, there's a range of measures, we feel, we've implemented that would be not impossible for somebody to replicate, but we're pretty confident we were, by far, first to market with what we're doing, and regardless of domestic reputation, which we still feel is strong, overseas reputation is really strong. Our reputation, particularly in China, is I would say second to none of any of the big people that are doing something aligned to this. So much so...we now have people coming to us for products, because they're confident in us being able to deliver a product.*

In an early study, Verbeke's (2005) felt that information in a supply chain data system is not necessarily useful to all parties. This was previously critical due to cost and time, but with automated data and blockchain, the efficiency of the information process can lend itself to addressing the information needs of all supply chain participants. BeefLedger (2018, p. 3) state: "BeefLedger combines the blockchain's attribute of being a robust validator of historic states (as a record of past events) and the power of crypto-economics to drive incentivised systems shaping behavioural optimisation in supply chains."

Further to this, the credentialed provenance can address food security, safety and fraud, while simultaneously creating validated brands that consumers are willing to pay a premium price for (Foth, 2017).

#### **4.4.10 Data-based Trust**

Data-based Trust is identified as a major construct that extends system-level trust. It creates trust among all supply chain participants through the visibility, multiple validations, collective agreements and historical completeness of the data that has been provided through the BeefLedger platform. It is an extension and is directly related toward Provision of Information.

As BeefLedger state:

*We may all exist in a world of falsity together, but because we do it together, we can actually go about doing what we do, so long as we're deluded together, but what happens in this space is that we may be, for example, onerous together that a particular shipment of beef was at the right temperature, or someone can get sick, and when someone gets sick, that actually tells us that, in fact, all of that information that we all thought was correct and we took as true was actually not. Now, collectively that causes us to respond; something wrong with the device.*

*Were we duped? Who by? Why? Who amongst us proposed that data? Have they proposed data before that's been dubious? Actually, in fact, now that we think about it, we go back and audit through the last few years of transactions, and there have always been concerns about stuff that, low and behold, has always had James involved, but usually, it'll be that little group that seem to get together every now and then to propose nonsense. They collude.*

*So, collusion risk is actually the greatest risk in a social knowledge environment. Now, collusion risk is quite different to capricious conduct, where capriciousness is something an individual does by themselves arbitrarily. Collusion requires a level of coordination to do things that people think is no good, because the flip side of collusion when groups of people get together to do something that people like, we call that collaboration. So, collusion is actually one of the greatest risks in consensus algorithm environments, and you've gotta build solutions around that.*

In borrowing a term from the industry, one underlying element of data-based trust is that it is 'community grown'. A second underlying element is that this data has recognisability and accessibility to every participant and interested party in the supply chain. In effect, data-based trust is a shortcut to providing high-level trust within the supply chain. As stated by Verbeke (2005), information is only effective when it addresses specific information needs and can be processed and used by its members. He further states that 'identification' is needed with the

data and appropriate management of the information provision is the only activity that can achieve this. Therefore, data-based trust can only be achieved through defining the provenance premium, certifications and smart contracts of the platform.

Data-based trust has received definition in security and artificial intelligence studies, particularly in the domain of vehicular control and driverless systems (e.g. Truong & Lee, 2017). To the knowledge of this researcher, it has not been formally conceptualised in supply chain research. The data collected in this study provides empirical evidence that the BeefLedger platform is clearly using data to engineer trust between entities in the supply chain, particularly across those who have no communication or knowledge of another entity. It is evident that the provenance data in particular, which begins at the grazier and finishes with the end consumer, is maintained by blockchain mechanisms and ensures that the product can be trusted to be what it was at the start. Any modifications or alterations to the data need to be agreed upon by all parties and this only adds to the experience or history of the product. In a sense, this data is organic and is continually refined, transferred and developed through its transaction lifecycle until it finishes with completeness.

Data-based trust is the final major concept identified from analysis and concludes this section. This section on explanation-building identified new concepts that will form the building blocks for the models to be discussed in Chapter 5. Furthermore, these new concepts can be discussed as propositions that offer descriptive, explanatory and predictive insight into supply chain trust.

## 4.5 Chapter Summary

This chapter described the data collection and analysis process that draws from the methodology presented in Chapter 3. The data collection involved semi-structured interviews, field notes and secondary data such as documents. This primary and secondary data provided the analysis with empirical findings that could be analysed using a case description, word count analysis, pattern-matching and explanation-building. Through this process, major constructs and variables were identified. These major constructs and variables will be further discussed in Chapter 5, which presents the logic model and conceptual model that are the major findings of this research.

## CHAPTER FIVE – LOGIC MODEL AND CONCEPTUAL MODEL

### 5.0 Introduction

This chapter will discuss the logic model developed from the data analysis described in Chapter 4. It will firstly describe the initial logic model that was developed using the findings of the Data Collection and Analysis in Chapter 4, which is the fourth and final data analysis technique identified in Chapter 2. A Conceptual Model will be presented that provides an overview of the unit of analysis and demonstrates the interrelationships between the identified major constructs and variables. Firstly, we will consider the Logic Model.

### 5.1 Logic Model

A logic model is the demonstration of the core activities and outcomes of a program or process. The logic model groups all the major constructs and variables discovered in the data collection and analysis of Chapter 4 and maps their relationships within the data-driven environment of BeefLedger supply chains. As stated previously, BeefLeger is a novel organisation with an under-researched process. A logic model is the first step to gaining candid insight into their operations from a research perspective that still has practical implications for a business by mapping concepts under operational practices. With this logic model, we offer a sensemaking approach that maps the theoretical observations against the practices and workflow of the organisation. Figure 5.1 provides an operational view of the BeefLedger trust process.

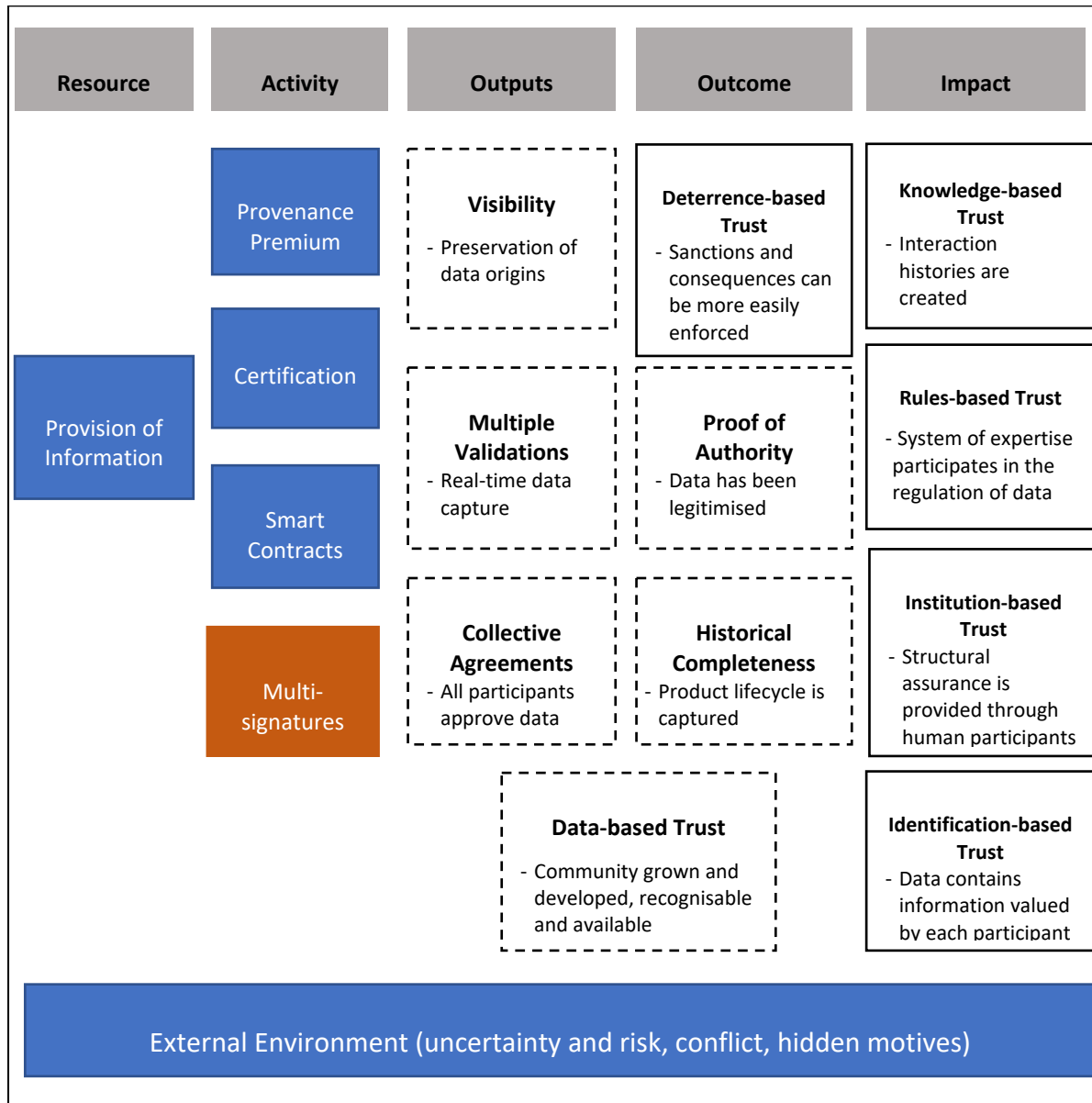


Figure 5.3: Logic model

In the Figure 5.1, the blue constructs are the existing practices provided by BeefLedger as the main **resources/inputs** and **activities** of their process. Multi-signatures in orange was an activity that was discovered through the interview process and isn't advertised in their pamphlets or as a major part of their service, however, it is an activity that is available to all supply chain participants and engages them in the lifecycle of the data. The **outputs** are the physical actions created by the inclusion of activities. The *visibility* of the data is developed through the provenance premium and inclusion of certifications agreed to initially by clients. *Multiple validations* are provided through the blockchain-enabled smart contracts and multi-

signature activities, allowing for real-time capture of the data in a systematic and authentic way. Here, participants such as the supply chain Oracles add information to the data in the form of audits and certificates, which are validated through the blockchain mechanisms. This visibility and the multiple validations co-exist along with *collective agreements*, in which the addition of new data to the provenance premium must be agreed upon and approved by each of the participants at once. These outputs are physical actions that create a system of human agents.

The outcomes are the constructs and variables that result from the physical actions. With these major outputs, *deterrence-based trust* is more easily enforced as the visibility, multiple validations and collective agreements preserve the data and any source of disagreement from the external environment can be more readily identified. This will ensure that costly sanctions and consequences can be more easily enforced.

The other variables identified from this research are Proof of Authority and Historical Completeness. Proof of Authority is a summation of the outputs, comprising all of the contributions of the platform and the supply chain participants and providing legitimacy through the level of agreements and the additions to the data being authoritative, increasing its authenticity. Historical Completeness is all of the information gathered across the lifecycle of the transaction, resulting in the complete history of the product from paddock to plate.

*Data-based trust* overlays both outcome and output in the BeefLedger process. It is both a physical product created by the supply chain participants and an outcome of their engagement, resulting in a systemised base of trust that is shared across the entire network for the lifecycle of the product exchange. It is a community-developed base of trust in that all participants contribute to the data, have control over its legitimacy and, even if the data is not true, is a representation of the shared understandings of all supply chain participants.

The impacts these outcomes have on system-level trust and, by implication, individual-level trust are: (1) creating a history of interactions between all participants even when they have not met or have no direct dealings, resulting in knowledge-based trust; (2) establishing rules-based trust by having rules associated with the validation and agreements of the data which is managed and maintained through the smart contracts and multi-signature blockchain

attributes, creating a self-regulating system of expertise; (3) ensuring that there is a high level of institution-based trust by having a social system being created digitally, through the interaction of multiple validations and collective agreements; and (4) developing strong identification-based trust for all supply chain participants by having a recognisable and accessible product of data that will ensure all values are accounted for, through a product lifecycle that has been ‘community ‘grown’.

This logic model in Figure 5.1 presents the BeefLedger supply chain as a complex adaptive system, as discussed by Handfield (2017). Trust is not an iterative process in this particular context but instead is one that begins with the creation of data. The data establishes trust through precise activities, and it is developed through time, changing from one base to another depending upon the information that is being added and the needs of the participant accessing it. If all the outputs are engaged, then all of the outcomes will result and provide high bases of trust at the system-level.

This model provides BeefLEdger with a deeper understanding of how their processes and operations function within the supply chain. By identifying these new concepts, the company is provided with trust variables that may enable them to further marketing and better explain what they can offer to potential clients. In terms of this study, the logic model also identifies the building blocks for another conceptual model that has implications for research.

## 5.2 Conceptual Model

The following model represents the summation of this explanatory and exploratory single case study within the BeefLedger supply chain. It represents the major contribution to knowledge by this research. It extends the guiding conceptual model of Figure 2.2 and presents the concepts generated from the data analysis in Chapter 4 as an intricately linked, observable complex adaptive system of trust. To understand the model, the chief findings can be summarised as:

- It is maintained that the External Environment and Trust in the Platform are necessary prerequisites for the Provision of Information.

- Data-based trust was developed from this research as a sixth concept that occurs within system-level trust, and is observed to be the highest-form of trust in this layer within the supply chain setting.
- Provision of Information is a process that leads into its own layer of trust, speculatively called *data-level trust*.
- Like system-level trust and individual-level trust, the data-level trust layer is a spectrum that increases in trust over time. The layer arranges the main concepts identified in Chapter 4 as a flow from visibility, to multiple validations, to collective agreements to proof of authority and finally historical completeness. This is a progressive approach and the flow of these data-level concepts align with the flow between concepts in the system and individual levels.
- The relationships among concepts and how trust is mediated and changed through data can be explained by a series of propositions (see Section 5.2.1).
- Trust changes as data moves through the supply chain, becoming increasingly higher and more personal due to the data-level layer allowing all entities to participate in the formation of trust.

In capturing each of these findings, the Conceptual Model aims to unify the work of Chapters 2, 3 and 4. The model is presented as a sequence of complex causalities.



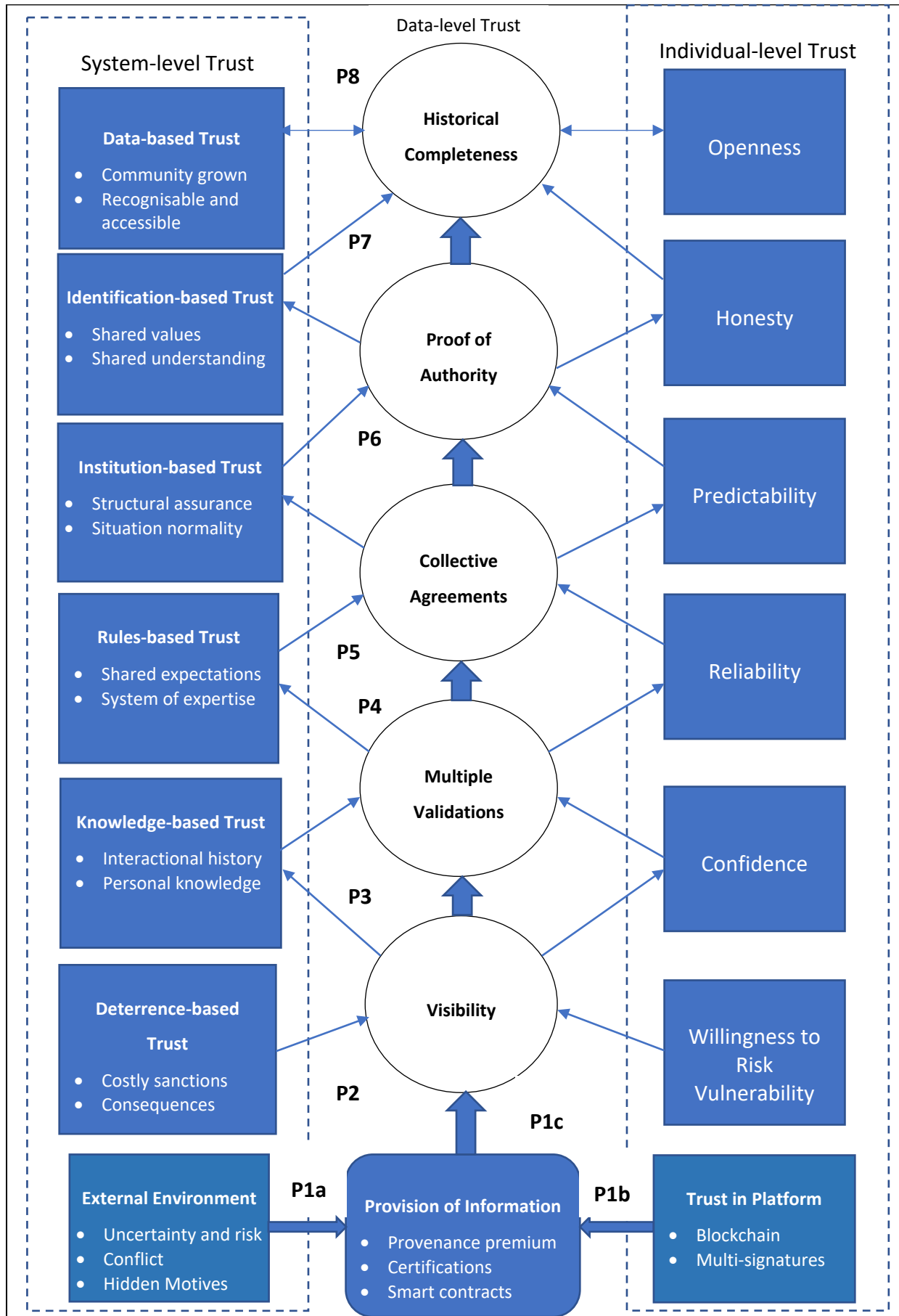


Figure 5.2: Data-driven environment trust model (previous page)

The reader will note that the Guiding Conceptual Model presented in Figure 2.2 differs from the Guiding Conceptual Model in Figure 5.2. This demonstrates the inductive nature of this study which, while guided initially by consistent concepts from existing research, evolved into an expanded understanding of the area. Figure 5.2 confirms the uniform nature of the major trust concepts derived from research and how they are consistent within most social transactions and exchanges, particularly when technology and multiple entities are involved.

The model also addresses the proposed research gap in Figure 2.2 regarding the unknown concepts of the data layer. After the analysis detailed in Chapter 4, the data-driven layer is developed as an ordered sequence of concepts moving from low trust to high trust. The main suggestion is that at the deterrence-based and willingness to risk vulnerability points of the spectrum, data-level trust is simply the visibility of the data to all participants. As the product moves through the supply chain and data develops organically as trust increases along the spectrum. The major extension to the system-level layer in this context is the addition of data-based trust, which is provided through the provision of information by BeefLedger. Data-based trust is seen to be the high form of trust in supply chain relationships.

When trust is at the high end, historical completeness is the concept between data-based trust and openness. The model is explained further in the following section.

### **5.2.1 Explanation of the Data-driven Environment Trust Model**

Figure 5.2 presents the data-driven environment trust model of the digitised meat supply chain using major constructs and variables to extend and explain the extant constructs and theory. System-level trust is the overarching layer of trust developed by the organisational transactions and individual-level trust is the underpinning layer of trust established by the individual participants, either as part of organisations or as independent operators. This model adds a new conceptual layer from the research of this thesis, named data-level trust. This consists of the variables identified in this study: *visibility*, *multiple validations*, *collective agreements* and *historical completeness*. Data-based trust has been identified as a major construct and becomes the sixth trust antecedent in the system-level layer.

As a platform, BeefLedger provides an additional layer of trust. In the model, this layer of trust is data-driven trust that adds additional features to the supply chain relationships, which will allow collaboration and communication at all times, removing the need for entities to have previous dealings or awareness of each other. In the extant theory and the empirical data from BeefLedger, a common perception is that most transactions in the Supply Chain are initiated in a system of “no-trust”. However, this is consistent with the literature on supply chain, in which transactions often occur without entities or participants not having any knowledge of who the other is. This is not necessarily no-trust but is a range of low forms of trust established by deterrents, to high forms of trust in which identification between all participants occurs. The data layer can be seen as a new remediator, if all of the variables are provided at high levels, then the supply chain can potentially operate at a high level of trust in which each antecedent is automatically addressed through the provision of information.

Provision of Information is driven by external environment factors, such as uncertainty and risk, conflict and hidden motives. Traditionally, these factors were accepted as possibilities within supply chain transactions by everyone from graziers to even the end consumers. Uncertainty such as diseases and food safety, risks caused by unknown elements such as food fraud and counterfeiting and hidden motives caused by supply chain participants withholding information or not being completely honest with their exchanges comprised many of the bad practices that affected trust in the meat supply chain. As stated by BeefLedger in the interviews, these factors still occurred today in spite of the presence of new technologies and information systems. The Provision of Information is a new layer to the supply chain and to date, this is the earliest study to begin conceptualising how it affects the traditional supply chain transactions.

The model should be viewed as a complex system of trust in which the antecedents represent stages of trust in the supply chain. On the left, system-level trust is established by organisations. These are created through inter-firm relationships that are moderated and regulated through the transaction of data. To the right, the individual-level trust layers contains the cognitive trust antecedents. The interrelationships in this model are remediated by the variables in the data-level trust layer.

This conceptual model leads to a set of associated propositions that explain the causalities and can be tested through further research (to be described in Chapter 6).

### 5.2.2 Propositions

The following is a list of propositions that are denoted as P1a through to P7 in the conceptual model in the preceding section. In accordance with Atkinson (2002), study propositions often result from case study research as useful theoretical outputs. These propositions are statements that explain the relationships between the major concepts that comprise the data-level, system-level and individual-level layers presented in Figure 5.2. They summarise the complex adaptive supply chain system of BeefLedger and will potentially drive future research studies in this area.

The discussion of each proposition will draw on extant theory from Chapter 2 and triangulates this with the empirical results of Chapter 4. It must be noted that these propositions use the concepts derived from the data analysis and provide theoretical statements that can be testable with future research. These propositions are restricted purely to the Conceptual Model of this study and are intended as high-level explanations. The propositions will directly address each of the virtual trust transaction characteristics listed from Li et al. (2012) in Section 2.7.

**Proposition 1a: Provision of Information reduces external environment factors such as uncertainty and risk, conflict and hidden motives.**

These factors are common to the meat industry, but, through providing information, these external factors can be potentially addressed early and actions can be taken to mitigate them. This proposition incorporates the *subjective*, *context-dependent* and *non-transitive* considerations of transactional trust.

**Proposition 1b: If provision of information is clearly defined for all parties, with underlying elements such as provenance premium, certifications and smart contracts, this will increase Trust in the Platform.**

By providing information based on agreed upon underlying attributes, BeefLedger ensures that their platform can be a source of trust and will provide forms of data that will fulfil the needs of all parties. This addresses the *dynamic* consideration of trust.

**Proposition 1c: If the technological-attributes of the platform such as blockchain and multi-signatures maintain the provision of information across all participants, then a data-driven layer of trust is created.**

The BeefLedger platform provides a secure, transparent and socially oriented form of data that can fulfil the needs of all participants. This addresses the *dynamic*, *bi-directional* and *asymmetric* considerations of trust.

**Proposition 2: If provision of information facilitates a high visibility of data, then this will increase deterrence-based trust and reduce the risk of vulnerability to supply chain participants.**

High visibility of data enables all supply chain participants access to the origin information initiated at the point of provision of information. This will mean participants are more willing to risk vulnerability as they have access to information from the source. While it may not stop participants from acting in their best interested, the provenance premium, smart contracts and multi-signatures make it easier for all supply chain participants to observe any potential sources of violations. This will ensure that the sanctions or consequences are taken against the correct party. This addresses the *non-transitive* consideration of trust.

**Proposition 3: If Multiple Validations occur with the data, then this will create a knowledge-based trust and increase confidence in the data.**

Multiple Validations are a way for the system to create a history of previous interactions without entities ever needing to know the identity of another. This will result in knowledge-based trust where the next transaction knows that the previous was authentic. This in turn creates confidence that the data is the original information sent from the origin and that it has not been manipulated or tampered with, which becomes more important for transactions later in the supply chain in which the end consumer requires far greater knowledge than, say,

a distributor. Through multiple validations this also creates real-time data capture. This addresses the *dynamic* and *asymmetric* considerations of data.

**Proposition 4: Multiple Validations and Collective Agreements will create a rules-based trust system, resulting in high predictability of the data.**

By having an organic system of data in which multiple validations are verified by collective agreements, this creates a rules-based trust system where there are shared understandings and a system of expertise is established in which all participants can acknowledge the receipt of new information. These create a self-regulating system of trust and thus the predictability that the data has been maintained from what it was at the start will be increased. This addresses the *bi-directional* and *dynamic* considerations of trust.

**Proposition 5: Collective Agreements establish institution-based trust through the activity of human participants and will ensure that the reliability of the data is high.**

As stated in previous literature, while technologies such as blockchain facilitate faster transactions, there is still the need for a human contributor to help participants know that the data is being socially produced. Collective agreements are social actions that give all participants equal opportunity to participate in the development of the data. This increases the legitimacy of the data that in turn establishes its reliability as being authentic and unaltered. This process creates the structural assurances and situational normality which are important for institution-based trust to function in the digitised supply chain which is increasingly removing uniform rules and regulations due to cross-cultural transactions by maintaining a community of contributors. This addresses the *dynamic*, *bi-directional*, *non-transitive* and *dynamic* considerations of trust.

**Proposition 6: Proof of Authority establishes high levels of identification-based trust and results in honesty in the data.**

Through multiple validations and collective agreements, real-time data capture mechanisms collect new information that is being added by Oracles in the supply chain. Audit information, certification, product data like temperature and movement is recorded into the data, but these are only verified through the processes of multiple validations and collective

agreements. Everyone in the supply chain, then, is acknowledging these additions as valued and as proof of authority, therefore the data is maintained as trustworthy. While the risk of collusion has been mentioned by BeefLedger, the visibility that is maintained will allow all participants to be able to access what was authentic information and what may be questionable, meaning that at all times the data will be honest. This addresses the *context dependent, dynamic, bi-directional* and *asymmetric* considerations of trust.

**Proposition 7: Historical Completeness that captures the entire product lifecycle will establish Data-based Trust and provide openness for all supply chain participants.**

Historical completeness contains the entire product lifecycle, maintaining the provision of information elements and gathers the transaction of the product, including its visibility, multiple validations and collective agreements. By providing this traceability, authenticity and completeness, it will result in data that has a high level of openness for all supply chain participants. This addresses the *subjective, bi-directional, asymmetry* and *dynamic* trust considerations.

**Proposition 8: Data-based Trust must be ‘community grown’ and demonstrate recognisability and accessibility for all supply chain participants to result in high system-level trust**

For Data-based Trust to be instantiated, the data must be grown by the community of the supply chain. This will result in data that has recognisability for every participant and it also must be accessible to everyone involved in its growth. Data in this sense can be thought of as organic, beginning with its provision of information and developed through the additions of the community as the transaction and exchanges move through the product lifecycle within the supply chain. Data-based trust accounts for the *subjective, dynamic, bi-directional, asymmetric, non-transitive* and *dynamic* considerations of trust.

### 5.3 Chapter Summary

This chapter presented the logic model and conceptual model and its associated theoretical propositions that summarise this research study. The conceptual model is the major

contribution to knowledge stemming from the research of this explanatory and exploratory single case study into the BeefLedger supply chain. The final chapter will conclude the thesis.



## CHAPTER SIX - CONCLUSION

### 6.0 Introduction

This thesis presented an explanatory and exploratory single case study into BeefLedger, an Australian blockchain firm that provide data for the beef supply chain. Their context is cross-cultural, with the industry's most significant export being into the Chinese market. This context is characterised by a history of bad practices, including uncertainty and risk, conflict and hidden motives. The research explored how BeefLedger address these external environment factors and presents a theoretical explanation for how their technology, operations and processes provide a data-level layer of trust from paddock to plate of the supply chain.

The motivation and directions for this research were two research questions first presented in Section 1.4 and justified in Section 2.11. It must be noted that because this research was exploratory, the aim was not to produce direct answers to the questions using a positivist approach. Furthermore, as the research was not positivist, the researcher did not set out to prove a hypotheses or propositions; rather, the research questions served a purpose of a general direction of novelty based on proven research gaps. Nonetheless, there are possible suggestions for each of the questions as follows:

1. How does BeefLedger engage in the provision of information to create data-driven trust in the beef supply chain?

BeefLedger provides information in the form of data. This data is essentially organic, beginning with the origins of the product and gradually becomes complete as it moves through the supply chain. When all data is retained at the final destination point, trust is maintained throughout entities.

2. What are the processes that BeefLedger provide to manage and maintain data in the lifecycle of a product to create high levels of trust among all supply chain participants?

Blockchain preserves the provenance information of the data through unalterable means. BeefLedger employs a consensus mechanism that ensures all entities in the supply chain agree upon the correctness of information as it is added to the product lifecycle. While one participant dwelled on the philosophies of trust in this context, the fact that multiple validations are conferred is enough to promote high-levels of trust. Historical completeness of the product indicates levels of data-based trust and openness, which are posited as the highest form of trust in this thesis.

In addition, both questions are addressed through the presentation of the logic model and conceptual model and the associated major constructs and variables.

The main findings for this thesis were the logic model and conceptual model, that summarise the research findings developed from the data collection and analysis. These models summarised the theoretical interrelationships between system-level, individual level and data-level trust. The research also provides a set of propositions as an extension of these models.

## 6.1 Contributions to Research

The major contributions to research knowledge are the theoretical interrelationships of the BeefLedger supply chain process, initiated by the provision of information and maintained across the product lifecycle through data-based trust.

Among the significant findings of the empirical study were the case description the further describe BeefLedger's operations. This case description can provide a starting point for history and information about BeefLedger for any new researchers.

A significant research contribution was the creation of the supply chain system as being scaffolded by a trust continuum of two layers: the system-level trust layer and the individual-level trust layer.

The study identified data-based trust as a major construct that extends the system-level trust layer in the supply chain construct.

The creation of a data-level trust layer is another major research contribution. This data-level layer consists of the variables visibility, multiple validations, collective agreements, proof of authority and historical completeness.

Stemming from the conceptual model are the eight Propositions, discussed in detail in Chapter Five.

**Proposition 1a: Provision of Information reduces external environment factors such as uncertainty and risk, conflict and hidden motives.**

**Proposition 1b: If provision of information is clearly defined for all parties, with underlying elements such as provenance premium, certifications and smart contracts, this will increase Trust in the Platform.**

**Proposition 1c: If the technological-attributes of the platform such as blockchain and multi-signatures maintain the provision of information across all participants, then a data-driven layer of trust is created.**

**Proposition 2: If provision of information facilitates a high visibility of data, then this will increase deterrence-based trust and reduce the risk of vulnerability to supply chain participants.**

**Proposition 3: If Multiple Validations occur with the data, then this will create a knowledge-based trust and increase confidence in the data.**

**Proposition 4: Multiple Validations and Collective Agreements will create a rules-based trust system, resulting in high predictability of the data.**

**Proposition 5: Collective Agreements establish institution-based trust through the activity of human participants and will ensure that the reliability of the data is high.**

**Proposition 6: Proof of Authority establishes high levels of identification-based trust and results in honesty in the data.**

**Proposition 7: Historical Completeness that captures the entire product lifecycle will establish Data-based Trust and provide openness for all supply chain participants.**

**Proposition 8: Data-based Trust must be ‘community grown’ and demonstrate recognisability and accessibility for all supply chain participants to result in high system-level trust**

## 6.2 Implications for Practice

There are four important implications for practice that arise from this thesis.

- 1) The development of a systemised research model about the key operations of BeefLedger provide the industry with an insight into the advantages of a blockchain based system and how it can strengthen trust across a supply chain.
- 2) A case description strengthens the presence of BeefLedger and through building a history of their operations and motivations may inspire other start-ups in the supply chains of other industries.
- 3) A conceptual mapping of the major BeefLedger inputs, activities, outputs, outcomes and impacts on their industry through the development of a Logic Model, providing them with marketing tools to further discuss their processes and services
- 4) Tools to assist their internal communication and information to stakeholders about their products and services

## 6.3 Future Research

The conceptual model in Figure 5.2 represents an attempt to extend existing understanding about trust in supply chain settings through empirical evidence collected in the BeefLedger context. With data-driven transactions becoming more and more widespread and technologies such as blockchain and data provenance impacting on how entities form trust without engaging in personal communication, this research is a timely opportunity for future studies to build on its suggestions. Importantly, it suggests a distinction between system and individual-level trust and also re-examines how researchers can perceive these layers in terms of underlying concepts. Future research needs to utilise a similar approach to either further

establish this idea of a trust spectrum or solidify understanding about it. As such, this model is purely speculative and requires further testing or validation. The system-level and individual-level layers could possibly involve additional trust concepts in other online transaction settings. The data-level layer is the main contribution this research makes to the literature but is also speculative, requiring research attention in other contexts or scenarios.

It is important to note that because the model was developed using the transcripts and field notes gathered from this research, this model is speculative. The individual-level trust layer and the arrangement of concepts is a theoretical suggestion based on the needs of this study. Though the concepts are grounded in literature, the arrangement of concepts within this layer and the anticipated relationships with the system-level trust layer is speculated from the perspective of this study. More rigorous work is needed to interpret individual-trust, particularly how arrangement of concepts will result in a more generally applicable spectrum.

There are two potential future research opportunities:

- 1) Using the conceptual model to establish the relevance and rigour of the variables in different AgriFood supply chain contexts such as water and groceries
- 2) A descriptive study testing or measuring the variables within a data-driven supply chain context would be useful in determining the significance and causality of the variables

## 6.4 Concluding remarks

As a person who is embedded in the business world across a range of technology industries I did not realise how much I would benefit from this research process. I look at my businesses with different eyes now and will be eternally thankful for the opportunity to critically analyse things I took for granted, arrange my thinking in a structured manner and create new ideas that are not just navel-gazing philosophies but real insights that will give me the edge in the business world.

Thank you for this opportunity!

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## APPENDIX ONE – CASE STUDY PROTOCOL / PARTICIPANT INFORMATION FORM

### **Purpose of the Study:**

This is an exploratory study that aims to understand how BeefLedger establishes trust in the supply chain process as an external platform. The study measures the specific ways in which BeefLedger provides information that enable the four bases of trust, deterrence-based, knowledge-based, rule-based and institution-based. The results will determine whether the provided information through data provenance is either explicitly or implicitly provided the supply chain entities.

### **Research Questions:**

- 1) How does BeefLedger engage in the provision of information to create data-driven trust in the beef supply chain?
- 2) What are the processes that BeefLedger provide to manage and maintain data in the lifecycle of a product to create high levels of trust among all supply chain participants?

### **Key Constructs**

**Provision of Information:** By sharing true and reliable information, perceived trust is built and perceived risk is reduced.

**Trust:** A behavioural intention between a trustee and a trustor based on a willingness to depend (Merhwald et al, 2019).

**Bases of Trust:** Key trust constructs that will be measured against the data collected from BeefLedger. The bases of trust are presented as a stage of trust-building.

**Facets of Trust:** Underlying elements of trust that enact as a continuum, these increase in intensity in tandem with the bases.

## **Theory**

In literature, trust is often distinguished as either *personal* or *institutional*. Our context is institutional, based on the assumption that transactions and exchanges in our organisation under study are conducted business-to-business.

**Deterrence-based Trust:** This is trust at its lowest form (Lewicki et al., 1998). It is based on utilitarian considerations that enable one party believes another will be trustworthy because costly sanctions are in place for any breaches or opportunistic behaviour. It is largely prevalent in the intra-organisational context. In our context, a key question is whether sanctions foster trust, particularly in inter-firm situations with exchanges being international or cross-cultural. Underlying elements: *Deterrents, Costly sanctions, Consequences*.

**Knowledge-based trust** is based on familiarity or process. It is belief about future behaviour based on past behaviour of individuals or organisations. Knowledge about past functions is generated from the trustor's personal experience and knowledge of previous exchanges. In this trust, it is trust about a person or a vendor. Authors such as Shapiro et al. (1992), Lewicki and Bunker (1995), and Kramer (1999) call this base 'history-based' or 'personalised' trust in an organisational context. Underlying elements: *Interactional history, Personal knowledge, Predictability*.

**Rule-Based Trust:** Rules, both formal and informal, capture much of the knowledge members of organizations have about explicit and tacit understandings regarding transaction norms, interactional routines, and exchange practices that provide a basis for the inference that others within an organisation (or outside) are likely to behave in a trustworthy fashion (Kramer, 1999). It is trust in the system of expertise, that is, even if an individual is responsible for the exchange, the individual has been socialised in the rules of the system that is facilitating the exchange. Rule-based trust is predicated on shared understandings regarding the system of rules regarding appropriate behaviour. Underlying elements: *Shared understanding, System of Expertise*.

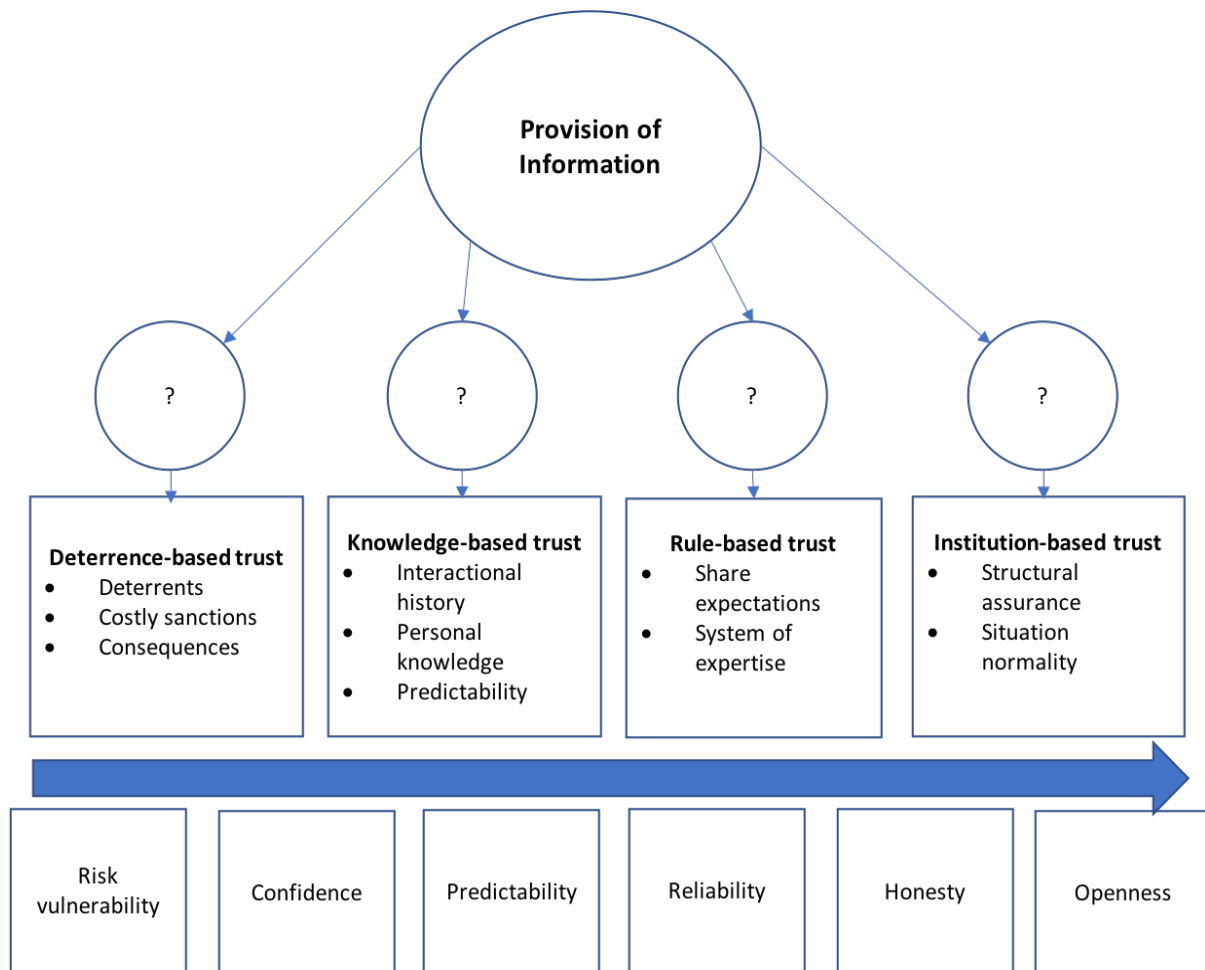
**Institution-Based Trust:** The norms and rules of institutions such as organisations guide the behaviour of individuals. A person extends their trust on the belief that necessary structural assurances are in place like guarantees, regulations or legalities. In exchanges between organisations, situation normality exists in that there is a perceived highly successful interaction because the environment is in a proper state to facilitate it (Mehrwald et al., 2019).

Because the nature of blockchain can often remove the presence of institution-based trust with transactions being encrypted and potentially anonymising users, the only ‘institution’ that maybe recognisable is the platform i.e. BeefLedger. Therefore, we need to explore how BeefLedger provides information that establishes each of these bases of trust within clients. Furthermore, these bases can be viewed as a continuum that are further informed by underlying facets of trust.

FACET	DEFINITION
<b>Willingness to Risk Vulnerability  (Low Trust)</b>	Risk is the perceived probability of loss and denotes a degree of vulnerability. In a relationship, there is interdependence, which is where the interests of one party cannot be achieved without reliance on the other. Trust in this circumstance is a willingness to be vulnerable under conditions of risk and interdependence
<b>Confidence  (Low-medium trust)</b>	Trust lies in the degree of confidence one holds in the face of risk, rather than in the choice or action that increases one’s risk. The degree to which a person can rest in uncertainty with a certain amount of confidence is the degree to which that person can be said to trust.

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<b>Predictability</b> <b>(Medium trust)</b>	If one expects that a party will predictably behave positively, one will be disposed to cooperate with the party. However, the reason for that predictability may be external to the party, such as strong control mechanisms.
<b>Reliability</b> <b>(Medium-high trust)</b>	Reliability, or dependability, combines a sense of predictability with benevolence. In a situation of inter-dependence, when something is required from another person or group, the individual can be reliably counted on to supply it.
<b>Honesty</b> <b>(High Trust)</b>	Correlation between a person's statements and deeds characterises integrity. An acceptance of responsibility for one's actions and avoiding distorting the truth characterises authenticity.
<b>Openness</b> <b>(High Trust)</b>	Reciprocal trust; a confidence that neither the information nor the individual will be exploited, and recipients can feel the same confidence in return.



Is trust an antecedent or is it formed through the provision of information?

In short, we are trying to discover the “?”s.

## **INTERVIEW QUESTIONS**

- 1) Can you give me a brief history of BeefLedger?
- 2) Who are your customers?
- 3) How novel is BeefLedger?
- 4) What is the value proposition of BeefLedger?

### BeefLedger in Operation:

- 1) What role does BeefLedger play in the transaction process?
- 2) How does data provenance guarantee a transaction?
- 3) Do the entities in the supply chain know who each other is? Is this information present in every transaction?

### Deterrence-based Trust:

- 1) Why was there a need for BeefLedger in the supply chain process?
- 2) What would transactions be like if BeefLedger were not part of it?
- 3) What are the consequences of a negative transaction?
- 4) What are the risks for the consumer without data provenance?

### Knowledge-based Trust:

- 1) What are the standard features of a BeefLedger transaction and how do clients become aware of this?
- 2) How are relationships with participants formed?
- 3) Which entities in the supply chain do you have the most dealings with? Why them?

### Rule-based Trust:

- 1) What are the key features of its technology that BeefLedger share with new clients?
- 2) Which supply chain entity is most likely to contact BeefLedger if there is an issue?
- 3) Why is the information that you provide trustworthy? And how do you make it so?
- 4) What is the information that users can access in real time? To what extent do they access it? Why?



Institution-based Trust:

- 1) How do BeefLedger make themselves known in a transaction?
- 2) How do clients react to the presence of BeefLedger?
- 3) What assurances do BeefLedger provide in a transaction?
- 4) How does BeefLedger market to potential participants?