Paradoxes in Blockchain-Technology Implementation and Use: Creation and Validation of a Tension Framework.

What are the tensions associated with implementing and using blockchain technology in a supply-chain context, and what are the resulting paradoxes revealed?

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Abstract

Blockchain technology has captivated the supply chain sector with its potential to boost transparency, traceability, and efficiency. However, its implementation brings unique challenges and tensions that organizations must tackle. This thesis evaluates the validity and applicability of Ostern and Perscheid's framework for managing tensions in implementing and using blockchain technology in supply chain management. Employing a qualitative research methodology, the study combines secondary research data with primary research through semi-structured interviews to analyze the tensions arising from implementing blockchain technology in the supply-chain context.

Critical tensions identified include public vs. private blockchains, value creation and capture, inclusivity and exclusivity, compliance, and trust in institutions and the blockchain code. The research findings suggest that careful attention to governance, incentives, data privacy, and transparency can help overcome these challenges and establish a foundation of Trust for the long-term sustainability of blockchain networks. This research adds to the existing body of knowledge on blockchain technology, offering a crucial understanding of the difficulties and tensions arising from its deployment and utilization within the realm of supply chain management. It also provides practical recommendations for organizations contemplating integrating blockchain technology into their supply chain processes.

Keywords: Blockchain technology, Supply chain management, Tensions and paradoxes, Governance and compliance, Value creation and capture

1. Table of Contents

1. Introduction 5

2. Related Work 7

2.1. Blockchain Technology 7

2.2. Blockchain in Supply Chain Management 8

2.3. Tensions and Paradoxes in Blockchain Implementation 9

2.4. Framework of blockchain-associated tensions 11

2.4.1. Controllable tensions 11

2.4.2. Manageable tensions 12

2.4.3. Tension area 1 - Growth vs. profitability 14

2.4.4. Tension area 2 – Long term vs. short term 14

2.4.5. Tension area 3 – Whole versus parts 15

3. Methodology 17

3.1. Case description 17

3.2. Sampling method: 18

3.3. Data collection 18

3.4. Data analysis 19

4. Empirical findings 20

4.1. Tension area 1 - Growth vs. profitability 20

4.1.1. Environmental positioning 20
4.1.2. Value Discipline 24
4.2. Tension area 2 – Long term vs. short-term 26
4.2.1. Organizational Alignment 26
4.2.2. Integration Model 28
4.2.3. Accountability Model 30
4.3. Tension area 3 - Whole vs. parts 32
4.3.1. Trust Model 32
5. Concluding discussion 34
5.1. Summary of results 34
5.2. Theoretical contribution 36
5.3. Practical contribution 37
5.4. Limitations 38
5.5. Future research opportunities 39
7. References 41
8. Appendix A: Blockchain's Key Characteristics 44
9. Appendix B: List of Interview participants 45

1. Introduction

With its unique characteristics and potential to transform industries, blockchain technology has captured the attention of businesses and researchers worldwide. In supply chain management, blockchain presents innovative possibilities for participants in the ecosystem to exchange, manage, and securely store transactions. Blockchain technology's core traits - a secure platform with transparent, unchangeable data and smart contracts - greatly benefit supply chains by improving visibility, lowering costs, and supporting sustainability (Saberi, Kouhizadeh, Sarkis, & Shen, 2019)

Despite its potential, blockchain adoption in supply chain management faces hurdles. When adopting this technology, businesses must navigate various tensions and paradoxes, balancing competing demands such as value creation and capture, inclusivity and exclusivity in blockchain networks, and compliance and innovation. Moreover, Trust in institutions and participants, as well as Trust in the blockchain code itself, must be established and maintained to ensure these systems' long-term success and sustainability.

In recent studies, only a few authors have explored the tensions and related issues in the context of blockchain implementation and use in an organizational environment from a paradoxical perspective. Technical and organizational hurdles have hampered blockchain implementation thus far, pointing to organizational tensions and contingencies (Ciriello, Beck, & Thatcher, 2018; Sternberg, Hofmann, & Röck, 2020; Zavolokina, Ziolkowski, & Bauer, 2020).

To address these challenges, Ostern and Perscheid (2022) developed a framework to assist researchers and practitioners in systematically thinking through blockchain-related tensions and corresponding design decisions. This study seeks to validate and apply the framework in supply chain management by examining blockchain implementation tensions and resulting paradoxes. The research questions addressed in this study are:

1. *What are the tensions associated with implementing and using blockchain technology/applications in a supply-chain context?*
2. *What are the resulting paradoxes revealed?*

A case study methodology was used to investigate these research questions, focusing on the IBM Food Trust, a blockchain-based platform that connects participants across the food supply chain. Semi-structured interviews were carried out with professionals from different areas related to blockchain technology and supply chain management. The gathered data was analyzed using a grounded theory methodology.

The findings of this study indicate key tensions that arise when implementing blockchain technology in supply chain management, such as public vs. private blockchains, creating vs. capturing value, inclusivity vs. exclusivity, compliance vs. innovation, and trust in institutions/participants vs. Trust in blockchain code. These tensions highlight the complex nature of implementing blockchain technology in supply chain management and emphasize the importance of carefully considering blockchain solutions' design and governance aspects.

Besides enhancing existing literature on blockchain technology, this study offers practical insights for organizations contemplating the adoption of blockchain technology in their supply chain management practices. It highlights the importance of a solid business case, the establishment of rules and standards, and a comprehensive comprehension of direct and indirect ROI for every stakeholder engaged in the blockchain network.

The remainder of this paper is organized into several chapters: Chapter 2 offers a literature review on blockchain technology, its applications in supply chain management, challenges and paradoxes in implementation, and the tension framework. Chapter 3 outlines the methodology and data analysis procedures. Chapter 4 showcases the research findings, succeeded by Chapter 5, which delves into the theoretical and practical implications. The paper

ends with a recognition of limitations and recommendations for potential future research opportunities.

2. Related Work

This chapter introduces blockchain technology and emphasizes its significance. It delves into the application of blockchain in supply chain management, concluding with a discussion on tension paradoxes stemming from blockchain implementation. Subsequently, Ostern and Perscheid's tension framework is described.

2.1. Blockchain Technology

The vast majority of people are aware that blockchain is the technology that underlies Bitcoin. Blockchain is a peer-to-peer network that employs cryptography to ensure security, is append-only (meaning data can only be added, not changed or deleted), and immutable (meaning it is difficult to alter). All peers in the network must agree upon any updates to the blockchain.. Blockchains are an additional application layer that operates on top of internet protocols and allows relevant parties to conduct economic transactions without the need for an intermediary or third party. Additionally, blockchains can be used as a ledger and inventory system for documenting, tracking, monitoring, and transacting different types of assets, including financial, legal, physical, and electronic. (Wang, Singgih, Wang, & Rit, 2019, p. 221)

Blockchain can be used to track transactions between peers in a public or private network of computers. The immutable ledger is a distributed database that tracks how peers in the network have traded assets in the past. Every transaction block in the chain is linked and chained to the previous one. (Lim, Li, Wang, & Tseng, 2021) Public or permissionless blockchains are networks of computers that share a typical record of all transactions. Private or permissioned blockchains are networks of computers that share a typical record of only the dealings between members of the private network.

In a public blockchain, all users can view and contribute to transactions, regardless of their stake in the network. In contrast, in a private blockchain, user access to transaction history and status checking varies based on their granted permissions. As a result, blockchain trust based on transparency is no longer required. It is possible to synchronize with permissioned blockchains by using consensus methods. Private blockchains have less transparency because the nodes can be identified, have restricted access, and have a lower degree of decentralization. (Gruchmann & Bischoff, 2021)

Blockchain technology is characterized by four key features: decentralization, persistency, anonymity, and auditability (Saberi et al., 2019, p. 2118). A comprehensive review of these features is available in the appendix.

2.2. Blockchain in Supply Chain Management

A supply chain is a group of companies that work together to move products, services, money, and information from one company to the next. Supply chain management needs participants to collaborate and exchange information (Mentzer et al., 2001).Given these definitions, blockchain technology promises to enhance supply chain management and performance by allowing members to share trustworthy, tamper-proof data directly. This technology allows full product tracking and improves supply chain visibility. (Agi & Jha, 2022, p. 2).

A few ongoing innovative use cases of blockchain in the supply chain have emphasized its untapped potential. For example, in healthcare, 12 major pharmaceutical corporations and 17 public and private institutions, including legal, regulatory, academic, research, and patient representative organizations, formed the pharmaceutical blockchain consortium in January 2020. Its goal is to demonstrate how this technology may benefit patients, foster more confidence among the many ecosystem members, and open up new possibilities for supply chain, clinical trial, and health data usage (Ziegler, Uli, & Wortmann, 2021).

Additionally, it intends to show how blockchain may help with some of the sector's major issues with identification and governance. In the food sector, Walmart partnered with IBM in 2016 to build a blockchain technology for tracing food origins and reacting quickly should a problem arise. The blockchain helped Walmart, and its suppliers document every transaction, reduce manual input, increase transparency, and visualize their digital footprint on the shelf (Vitasek, Bayliss, Owen, & Srivastava, 2022).

Jabbar, Lloyd, Hammoudeh, Adebisi, and Raza (2021) reported that the logistics industry, which faces significant regulatory barriers in moving commodities across borders, high shipping costs, and extensive paperwork requirements, has been the subject of blockchain innovation. In 2015, Maersk collaborated with IBM to develop and implement a sophisticated blockchain product to serve their extensive network of shippers and streamline their daily operations and documentation, aiming to reduce shipping costs and revolutionize their business model. Permissioned blockchains, limited to authorized participants, are the main focus of these initiatives.

Based on the above-mentioned practical cases, blockchain technology enabled full product traceability and enhanced visibility through the different stages of the supply chain. Product origin information aids in combating product counterfeiting, while tracking capabilities assist in improved planning, guaranteeing quality, and bolstering public trust. Despite the interest mentioned above and efforts in practice, empirical knowledge of the tensions arising in implementing and using blockchain technology in a supply-chain context remains limited.

2.3. Tensions and Paradoxes in Blockchain Implementation

Smith and Lewis (2011) say that paradoxical tensions are made up of "opposing but related elements that exist simultaneously and stay the same over time. Although paradoxical tensions occur daily across different situations, they only become apparent when others recognize and understand them (Schad, Lewis, Raisch, & Smith, 2016). As a result, paradox

theory explains why paradoxes can occur and suggests ways to manage them. (Van der Byl & Slawinski, 2015, p. 72)

Tensions and paradoxes are often recognized in the context of the supply chain. (Sandberg, 2017, p. 1; Schmidt, Foerstl, & Schaltenbrand, 2017, p. 3; Wu & Pagell, 2011, p. 589). However, few authors have explored the tensions and related issues in the context of blockchain implementation and use in an organizational environment from a paradoxical perspective. Technical and organizational hurdles have hampered blockchain implementation thus far, pointing to organizational tensions and contingencies (Ciriello et al., 2018; Sternberg et al., 2020; Zavolokina et al., 2020).

Sternberg et al. (2020) examined the challenges and tensions supply chains face in adopting Blockchain Technology (BCT) in a case study named ReLog. The study identified four major tensions: traceability-efficiency, visibility-privacy, trust-investment paradox, and performance-commitment. These tensions stem from the trade-offs between positive and negative IOS factors, which must be addressed for successful BCT adoption. The authors suggest that these tensions are likely applicable to other heterogeneous supply chain settings and vertical BCT applications, such as end-to-end traceability or transport applications.

Ciriello et al. (2018) explored the paradoxical effects of blockchain technology on social networking practices, using the Steem platform as a case study. The authors identified several paradoxical effects in blockchain-based social networks (BSNs) and suggested that these effects may apply to other technologies with similar characteristics. Their study provides valuable insights into the impact of blockchain technology on social networking practices and highlights the importance of understanding the challenges and opportunities presented by this emerging technology. The results also highlight the necessity for additional research to explore user perceptions of the identified paradoxical impacts and establish best practices for blockchain-based social networking.

2.4. Framework of blockchain-associated tensions

Ostern and Perscheid (2022) formulated a framework by collating and scrutinizing abstract-level blockchain-related tensions, which aids researchers in systematically examining these tensions and associated design choices. The framework aims to govern and manage tensions arising from blockchain technology implementation and usage. It helps anticipate the long-term effects of blockchain adoption on various technical, organizational, and cultural aspects within an organization. Using a paradox lens and literature reviews, the authors complied emerging tensions in the literature as blockchain technology is adopted and implemented. These resulting tensions are case-specific and context-sensitive.

Based on the framework, the potential tensions that arise in implementing blockchain can be categorized into two main groups, controllable and manageable, subdivided into different categories, as seen in Figure 1. The framework distinguishes between public and private blockchain as they showcase extremes on either end of the spectrum of blockchain design which is deterministic to design decisions further and hence the emergence of tensions.

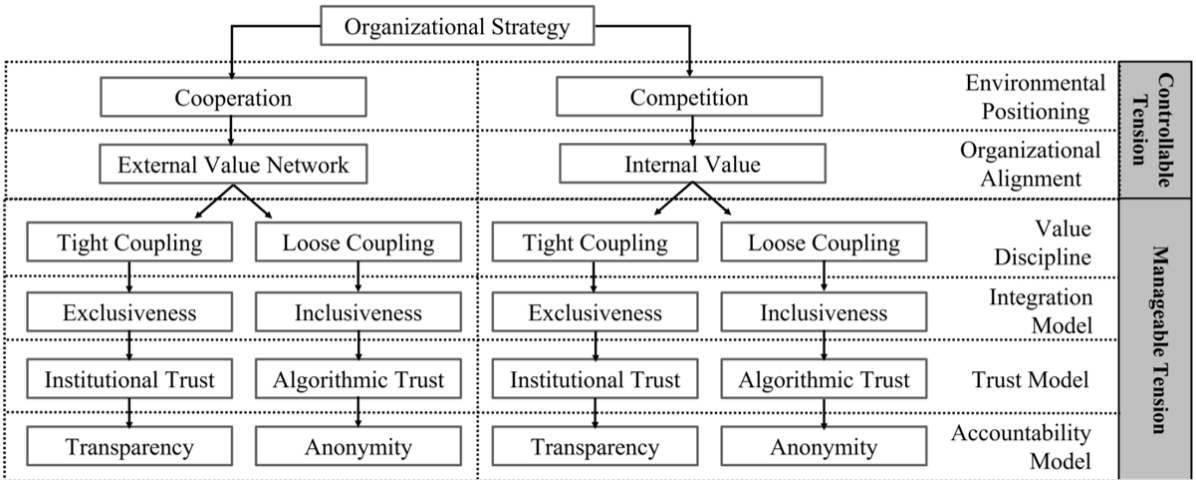


Figure 1: Framework of Blockchain-related Tensions (Ostern & Perscheid, 2022)

2.4.1. Controllable tensions

In this context, controllable tensions arise due to specific design choices on the blockchain infrastructure that align with a company's overall strategic goals. These tensions

concern how a company positions itself in its environment and aligns its operations. Controllable tensions are subdivided into environmental positioning and organizational alignment. *Environmental positioning* refers to a company's choice to engage in a public blockchain to foster participatory innovation and capture business value, as opposed to using a private blockchain that emphasizes competitive advantages through technology leadership. By participating in a public blockchain, a company embraces collaboration, openness, and shared value creation, which can lead to new opportunities, increased trust, and enhanced transparency among stakeholders. Conversely, a private blockchain enables a firm to retain control over access and information, concentrating on utilizing the technology to maintain a competitive advantage in the market. The tension of *Organizational alignment* emerges from the choice between emphasizing external value networks or focusing on creating and seizing internal value (Ostern & Perscheid, 2022).

2.4.2. Manageable tensions

Conversely, manageable tensions persist no matter how the infrastructure is designed. They result from the blockchain's distributed structure. In practice, these tensions must be considered in almost every blockchain design scenario. They cannot be controlled; thus, businesses must manage them by using them and determine how to address them over time. These tensions, namely value discipline, integration, trust, and accountability model, depend on these factors, including traceability and anonymity, exclusivity or inclusivity, and the type of Trust inherent in the blockchain's nature. These tensions are explained in the following.

The *value discipline* refers to tensions relating to aligning value creation with the needs and desires of a company's internal and external customers rather than value capture. The concept of value discipline can be categorized into two main groups, tight and loose coupling. *Tight coupling* involves aligning value creation with customer needs and demand fulfillment. In contrast, *loose coupling* involves proposing something beyond customer-centricity,

potentially risking failure if there is little demand for the infrastructure or service. Regardless of the infrastructure design, companies must determine the degree of innovation and novelty in blockchain applications, which poses tensions with advantages and disadvantages, as commonly observed with new technologies. Thus, companies must carefully balance their blockchain solutions' potential benefits and risks to achieve successful value creation.

The *integration model* refers to tensions associated with how open a blockchain application is to other participants, whether it follows an inclusive or exclusive strategy. Competitive strategies lean towards exclusivity, whereas cooperative techniques foster inclusion. Exclusivity regulates participation and involvement in a blockchain through access or validation rights, smart contracts, and general entry barriers. This tension between inclusivity and exclusivity may affect a company's profit or breakthrough emphasis and has implications for management trade-offs between growth and profitability. Thus, access to and readability of blockchain entries are governance or security issues and affect management decisions.

The *trust model* refers to tensions related to the Trust in blockchain code or Trust in institutions or participants of blockchain solutions. Trust in code requires that companies agree on universally applicable rules and metrics tied to smart contracts. In institutional Trust, the corporation is still in charge of maintaining the network, adhering to the law, complying with compliance requirements, and remaining a source of confidence.

The *accountability model* refers to tensions directly tied to organizational compliance elements —a company's capacity to demonstrate and account for human activities that comply with rules within or outside a blockchain ecosystem. Public blockchains often promote the pseudo-anonymity of actors or participants, threatening accountability, and anonymous solutions make companies or networks potentially more vulnerable to fraud, data misuse, and manipulation. In contrast, a private blockchain lets all parties know each other and incentivizes all actors or participants to behave honestly.

Following this framework, the authors examined and explained blockchain-related tensions concerning three primary, overarching tension areas every organization encounters: (1) profitability versus growth, (2) short-term versus long-term, and (3) whole versus parts (Dodd & Favaro, 2006). Businesses are constantly subjected to these tensions, and no unique strategy is required for coping with them. Tensions may evolve throughout the development and implementation of blockchain. The interpretations of these tension areas are summarized in the subsequent chapters..

2.4.3. Tension area 1 - Growth vs. profitability

The use of a private blockchain can help a company be more profitable. Providers of private and semi-private blockchains maintain control over the data. They can secure a long-term commitment from their members through service agreements. Using an open or semi-open blockchain could lead to the emergence of new business models and collaborative processes. A possible coping strategy may lie in whether a blockchain solution should primarily satisfy the existing demand and requirements of a company's (internal or external) customers or go beyond, e.g. by offering a completely new solution path. Expanding beyond customer-centricity may be feasible due to the increasing data on blockchain participants and contributors (Ostern & Perscheid, 2022).

2.4.4. Tension area 2 – Long term vs. short term

Organizations often face difficulties in effectively balancing long-term strategizing and current task execution. For companies using blockchain, resolving tensions between strategy and execution, organizational alignment, and integration and accountability models is crucial. Decision-making at the management level is key to addressing long-term and short-term tensions, requiring leaders to reevaluate objectives, processes, and routines, as well as blockchain-related organizational alignment. Organizational alignment considerations include

the fast implementation and integration of private blockchains for short-term gains, while open blockchains demand strategic partners for joint value creation, strategy, and shared values.

Focusing on sustainable earnings, as Dodd and Favaro suggested, can help manage these tensions, which are tied to blockchain's integration and accountability models. The integration model oversees data access and verification mechanisms, balancing short-term data control with long-term open network efficiency. Meanwhile, the accountability model calls for managerial alignment to weigh complete transparency for short-term internal operations against anonymity for long-term strategic planning and risk-taking. By making informed decisions and adjusting goals, organizations can unlock blockchain's potential while mitigating risks and maintaining sustainable growth (Ostern & Perscheid, 2022).

2.4.5. Tension area 3 – Whole versus parts

The *trust model* deals with the balance between trusting blockchain code and relying on institutions or participants in blockchain ecosystems. This tension arises because blockchain technology challenges traditional trust paradigms by eliminating centralized intermediaries. For instance, in a logistics tracking system, some participants might prefer to use established third-party services for monitoring shipments. In contrast, others have confidence in the blockchain's decentralized ledger for real-time tracking and data verification. Factors like technological understanding, security concerns, or organizational priorities influence this conflict. Consequently, a large corporation might opt for a private blockchain, maintaining control through familiar processes. At the same time, a smaller, innovative company might choose a public blockchain, embracing the decentralized trust model provided by the blockchain code.

The framework, developed by Ostern and Perscheid (2022), provides guiding questions for companies in identifying potential coping strategies and understanding where tensions are widespread. Figure 2 shows a summary of how blockchain tensions are interpreted and where tensions are widespread.

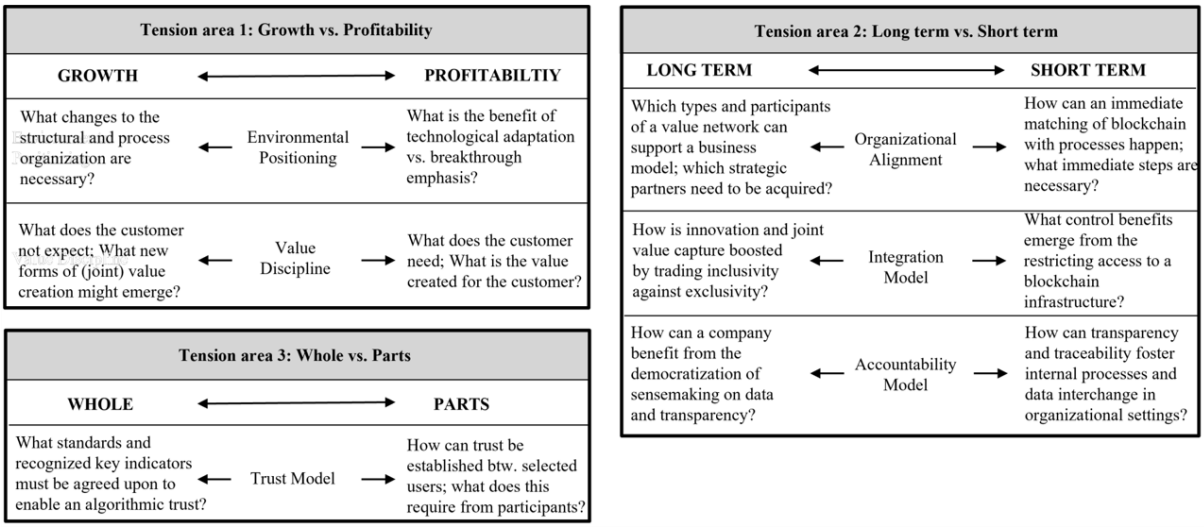


Figure 2: Guiding Questions to Address Blockchain Tensions in Organizations (Ostern & Perscheid, 2022)

Considering this framework, it is intriguing to examine which core tensions, as depicted in Figure 1, emerge when implementing blockchain in a specific field. Blockchain technology is being praised for its potential to improve supply chain management. A food-tracking blockchain, IBM Food Trust, was used for the case study. IBM Food Trust establishes a secure, shared, and verified transaction log that offers unparalleled insights into food handling as it progresses through the entire supply chain (IBM, 2019).

The study aims to find out if Ostern and Perschil's (2020) framework for managing tensions in implementing and using blockchain technology in a supply chain is correct. The main goal is to compare the study results to the existing framework and determine if the framework is valid and can be used in real-world situations.

The study sought to answer two research questions:

RQ1: What are the tensions associated with implementing and using blockchain technology/applications in a supply-chain context?

RQ2: What are the resulting paradoxes revealed?

3. Methodology

The study employs an exploratory case study approach to identify and comprehend the tensions associated with the implementation and utilization of blockchain technology in the context of supply chain management and the resulting paradoxes. A case study is a research technique that utilizes empirical inquiry to examine a subject in a real-world setting and captures experiential knowledge (Simons, 2014). Case studies are effective when the topic is extensive and intricate, the theory is limited, and the context is critical (Raf Jans & Koen Dittrich, 2008). As this study meets these three conditions, the case study approach was employed, which included semi-structured interviews to comprehensively understand and identify common challenges and tensions that organizations face in implementing and using blockchain technology in a supply-chain context and the resulting paradoxes.

The IBM Food Trust was selected as a single case study due to its many embedded units of analysis, including firms, farmers, distributors, processors, retailers, and other food sector actors working together to provide and trace food origins efficiently and safely using a food-tracking blockchain based on Hyperledger Fabric. As a reputable brand with strong technological foundations, IBM was chosen for its ability to address complex, costly, and widespread issues.

3.1. Case description

The global food supply chain has become complex and extensive, and it is the responsibility of food manufacturers and handlers to ensure product integrity. Contaminated food causes illnesses and deaths, with almost 1 in 10 people worldwide affected and 420,000 dying each year. The cost of unsafe food in low- and middle-income countries is US$110 billion annually (Nutrition and Food-Safety, 2022). In 2016, Walmart piloted IBM's food blockchain to trace food from farm to store, highlighting its potential for improved food safety through

traceability and authenticity. Two pilot projects were accomplished focusing on pork in China and mangoes in the Americas (Yiannas, 2018, p. 50).

IBM Food Trust establishes a secure, shared, and verified transaction log that offers unparalleled insights into food handling as it progresses through the entire supply chain. The platform was formed in partnership with Walmart and other influential food companies in 2017 and has since grown to include hundreds of enterprises of all sizes, from growers to food makers to merchants. Notable ecosystem members include Dole, Nestlé, Walmart, and Carrefour. The platform aims to improve food safety and traceability throughout the food supply chain (IBM, 2019).

3.2. Sampling method:

The initial sample design for this study involved using the IBM Food Trust as a single case study due to its many embedded units of analysis and reputation for addressing complex, costly, and widespread issues. However, due to limited access to companies and experts using the IBM Food Trust, it was necessary to modify the sample design. As a result, the sample was expanded to include experts using other blockchain applications in logistics and supply chain management. This facilitated a more comprehensive view of the tensions and paradoxes associated with the implementation and use of blockchain technology in supply chain management.

3.3. Data collection

To collect data on the tensions and paradoxes, semi-structured interviews were conducted with experts in the field. The initial sample design aimed to include companies and experts using the IBM Food Trust. However, due to limited access to these participants, the sample was expanded to include experts using other blockchain applications in logistics and supply chain management. The interview questions were designed to explore the drivers for

and against blockchain technology adoption in supply chain management and the resulting tensions and paradoxes. The interviews were recorded and transcribed for data analysis.

In total, nine semi-structured interviews were carried out with experts from various fields, including logistics service provider, major retailer, software developer, consultants, university professors, food tracking solution provider, blockchain researchers and entrepreneurs, and a representative from a blockchain association. The experts provided insightful perspectives on the tensions and paradoxes arising from applying blockchain technology within the realm of supply chain management. The selection of experts was based on their experience and expertise in blockchain technology and supply chain management, as well as their willingness to participate in the study. The interviews lasted 44 minutes on average. A table containing a list of participants can be found in the appendix.

3.4. Data analysis

This study's data analysis adhered to a grounded theory approach, utilizing a multi-step procedure as detailed by Glaser and Strauss (2017). The analysis was an iterative process involving several coding and theme development stages. During the analysis, a deductive method was also employed, drawing on the established framework for addressing tensions in blockchain technology implementation and usage (Ostern & Perscheid, 2022). The following three steps outline the data analysis process:

- First-level analysis (initial text scanning): Using a deductive approach, the researcher became familiar with the data and identified potentially relevant observations. Familiarization with the data involved listening to the interview recordings and reading through the transcriptions to make detailed corrections. This stage aimed to identify initial concepts and themes related to the tensions and paradoxes associated with blockchain technology in the supply chain context.

- Development of deductive codes: in this step, the objective was to pre-structure the analysis by establishing an analytical grid. The deductive codes that are the main focus of the research, such as "environmental positioning," "value discipline," "organizational alignment," "integration model," "accountability model," and "trust model," guided the researchers through the analysis on MAXQDA software.
- After initial codes were assigned, the data were analyzed again to identify relationships and connections between codes. This stage helped to refine the themes and concepts identified previously.
- Coding of all transcripts: The researcher used the aforementioned deductive codes to analyze all the transcripts, selecting the most relevant codes and themes to develop a coherent storyline that explained the key tensions and paradoxes associated with blockchain technology in the supply chain context.

4. Empirical findings

This chapter presents the empirical findings obtained from interviews with experts who provided their opinions and insights on the tensions associated with implementing blockchain technology. These findings were obtained through deductive coding.

4.1. Tension area 1 - Growth vs. profitability

4.1.1. Environmental positioning

As aforementioned in the framework of blockchain-related tensions chapter, the decision for a company to engage in a public or private blockchain is a balancing act between cooperation and competition. However, balancing innovation and value creation with competitive advantage can create tensions that can lead to various challenges. These tensions

arise from the need to innovate and create value while maintaining a competitive advantage enabling organizations to distinguish themselves from their rivals.

Experts agree that Trust is the primary source of tensions related to participation in public or private blockchains. Using public or private blockchains in supply chain management requires Trust in the system, the participating organizations, and the individuals involved. Trust is crucial in supply chain management as it determines the flow of information and resources between the different entities in the chain. Blockchain technology can enhance Trust by providing transparency, immutability, and security.

However, Trust is a significant concern on public blockchains because they are open to everyone, including unknown and untrusted entities. Expert A stated that "when it comes to a public blockchain, things become tricky because it's public, right? Anyone can participate; there's no central control, there is no central authority." In contrast, private blockchains are accessible only to trusted entities. Expert H stated, "public blockchains will not work for the enterprise...supply chains will be private because there are certainly …., no need to be not."

Another source of tension related to participation in public or private blockchains is the level of control organizations have over the system. In a public blockchain, no central control or authority exists, which can make organizations feel uneasy about participating. Expert A stated that "there's a lack of control...there's nobody who can come in and say 'stop doing that' or 'do it this way.'" In contrast, private blockchains are controlled by a central authority or group of authorities. Expert H stated that "private blockchains will have more control because they're private."

Moreover, there is tension related to the level of anonymity that organizations have on public or private blockchains. In a public blockchain, entities are anonymous, making it difficult to establish trust between organizations. Expert A stated that "public blockchains are generally anonymous, so you don't know who you're dealing with." On the other hand, private

blockchains require identifying entities, which can enhance Trust among participating organizations.

Another source of tension related to participation in public or private blockchains is the cost of implementation. Implementing blockchain technology in enterprises can be expensive. Expert H stated, "ostensibly with the goal of creating change within an enterprise. Almost always, it fails. And it fails not because of technology, not because of lack of expertise, ... it fails because of culture, values, and the socio-economic aspects of the organization, the enterprise, and the chain." Hence, the cost of implementation may create considerable tension for organizations contemplating participation in public or private blockchains.

Another source of tension related to participation in public or private blockchains is ensuring data privacy and security, while public blockchains prioritize transparency and decentralization. This fundamental difference in design has implications for adopting blockchain technology in supply chain management. Some experts predict private blockchains will be the dominant solution in the enterprise space.

On the other hand, public blockchains may be more suitable for smaller, decentralized supply chains, where transparency and decentralization are key requirements. Expert B explains that public blockchains are more suitable for decentralized systems because they don't require Trust between parties, making it easier to achieve transparency and security. This is because public blockchains have built-in mechanisms to guarantee that no single entity dominates the network, which is important for decentralized supply chains where participants may not know or trust each other.

However, the challenge with public blockchains is the issue of privacy, as public blockchains are designed to be transparent, which may not be desirable in some supply chains. Expert F explains that in some cases, privacy is crucial, especially for sensitive supply chains like pharmaceuticals, where data privacy is crucial to safeguard the organization's intellectual

property rights. This is where private blockchains come in, providing a solution that allows for transparency and security while ensuring data privacy.

Moreover, the choice between public and private blockchains is also influenced by the type of supply chain and the industry. Expert I explains that the choice of blockchain technology depends on the context, with operational efficiency being a key consideration in some supply chains. In such cases, private blockchains like IBM Food Trust and IBM TradeLens have successfully improved efficiency in existing supply chain processes.

Another consideration is the need for end-to-end traceability and sustainability in supply chains, which is increasingly important to customers and consumers. Private blockchains may not be able to provide the necessary transparency in such cases, making public blockchains a more suitable solution. Expert I explains that customers and consumers are interested in knowing the end-to-end traceability of products, including where the products were manufactured and how they were transported. Additionally, there is a growing need for sustainability, with customers and consumers interested in knowing whether the products they buy are sustainable in terms of carbon footprint and labor practices.

In conclusion, the choice between public and private blockchains in supply chain management depends on several factors, including the type of supply chain, the industry, and the need for privacy, transparency, and security. While public blockchains prioritize transparency and decentralization, private blockchains prioritize privacy and security. Therefore, private blockchains are likely to be the dominant solution in the enterprise space, while public blockchains may be more suitable for decentralized supply chains. However, choosing between public and private blockchains ultimately depends on the specific requirements of the supply chain and the industry. A thorough assessment of these factors is crucial in choosing the most appropriate blockchain solution.

4.1.2. Value Discipline

Aligning value creation with the needs and desires of a company's internal and external customers is essential to business success. However, this process can create tensions between various stakeholders within and outside a company. Experts have identified several sources of tension related to aligning value creation with the needs and desires of internal and external customers. These tensions can arise due to conflicting interests between stakeholders or misunderstandings about the role of value creation.

One source of tension arises from the conflict between the goals of a company's various stakeholders. Expert G stated, "But the question is not about technology, and the question is about the number of products and partners you're onboarding with you." The expert highlighted the importance of partnership and collaboration to create sustainable value. However, conflicts may arise when different stakeholders have divergent interests and goals. For example, shareholders' goals may conflict with those of customers or employees.

Another source of tension stems from uncertainty about the role of value creation. The expert I stated, "I think nobody cares about the consumer. But if you are giving flexibility and the advantage of the consumer to see the traceability of multiple products, then maybe they can see they can create the ROI." The expert highlighted the need for businesses to focus on creating value for customers to achieve a return on investment. However, some businesses may prioritize value capture over value creation, leading to tensions with customers who feel undervalued.

Moreover, expert G stated that a lack of understanding about the benefits of a particular value-creation approach could create tensions. "So, the end goal is to benefit the manufacturer itself. So, the consumer is the end customer, but it is still the manufacturer developing the solution, the perspective of the manufacturer or buyer supply context. So, I think nobody cared about the consumer," he said. The expert pointed out that focusing on the manufacturer's benefits could lead to neglect of customer needs, creating tension between the two groups.

Experts have suggested several strategies to address tensions related to value creation. These strategies involve improving communication, creating partnerships, and prioritizing customer needs.

Improving communication is one strategy experts suggest to address tensions related to value creation. The expert G stated, "So, traceability is very important because it's giving you as a producer, it's giving you the knowledge about the process that you do not see from your supplier, it's a way to go into the process and the actual process of your supplier." The expert emphasized the importance of traceability in creating transparency and building Trust between stakeholders. By providing information about the value creation process, businesses can improve communication and reduce tensions between stakeholders.

Creating partnerships is another strategy experts suggest to address tensions related to value creation. The expert G stated, "I think the good idea that IBM Food Trust is like, I would say a hub. If you're partnering with Carrefour or Nestle, it's easy to partner as a cooperative or meat producers." The expert emphasized the importance of partnerships in achieving sustainable value creation. By collaborating with other businesses, organizations can create synergies and reduce conflicts between stakeholders.

Prioritizing customer needs is another strategy experts suggest to address tensions related to value creation. The expert I stated, "If you are giving flexibility and the advantage of the consumer to see the traceability of multiple products, then maybe they can see they can create the ROI." The expert highlighted the importance of creating value for customers to achieve a return on investment. Businesses can reduce tensions and build long-lasting customer relationships by prioritizing customer needs.

4.2. Tension area 2 – Long term vs. short-term

4.2.1. Organizational Alignment

The concept of organizational alignment arises from the tension between focusing on external value networks or internal value creation and capture, which are not mutually exclusive positions. According to the experts interviewed, the tension between focusing on external value networks versus creating and capturing internal value is a critical issue in blockchain implementation. Some experts argue that blockchain's potential lies in facilitating collaboration among external partners, while others suggest that the technology's most significant value is in optimizing internal processes.

Expert F emphasizes the importance of defining a strong business case before applying blockchain technology, stating, "It is your business case that would count and whether blockchain can be applied or not. So you don't waste your time chasing shadows so fast. What is the goal you want to achieve?" This highlights the need for companies to carefully consider the specific areas where blockchain can add value to their operations rather than blindly adopt the technology for its own sake.

Once a business case has been established, expert F emphasizes the importance of designing rules and standards for implementing blockchain technology. This includes considerations such as data sources and integrations with existing platforms. The regulatory requirements must also be considered, as expert F states, "You need to design all the rules and all the standards, and how will data be assessed?"

Expert G provided another perspective, emphasizing the importance of understanding and translating the business process into a data model. "What's difficult is to represent the transformation process of chicken or tomatoes and to get to understand really in depth, the process of raising chicken or producing tomatoes and then translating it into a ledger or a data model that you will be ledgered I would say, and then to connect all the different partners to

this ledger or to this data model." This viewpoint highlights the need to understand the specific business process and the roles of each stakeholder involved to create an effective blockchain implementation.

The multi-party aspects of blockchain technology further complicate the tension between internal and external value networks. Expert H stated that the abdication or perception of abdication of control to code is not easy, "We are still facing this challenge of how will they abdicate or even the perception of abdication of control to code." and that the process of creating a multi-party contract is a very long, expensive process that involves a lot of negotiation, clauses, and outs. He believes there will be a hybrid mechanism of offloading compliance and offering governance, allowing blockchain technology to manage compliance, save time, save money, and prevent conflict.

Expert I acknowledges the challenges of balancing external and internal value creation in blockchain implementation. "Creating the shared revenue across the different distributed programmable actually implementing a blockchain and they can see the clear ROI out of alternatives, but how you can convince the supplier or another manufacturer to come on the same platform without slowing some ROI of their investment...So multilevel often failed around the governance structure of the particular network like to on what and what kind of the governance or ROI and all the things, if you're not giving, there's no benefit to all participants in the network, then its challenging stuff, in terms of bringing all the stakeholders in the same network?" This viewpoint emphasizes the necessity to balance the interests of all stakeholders participating in a blockchain solution, both internal and external parties.

Expert G's experience putting blockchain to use in the food supply chain demonstrates the significance of considering individuals beyond the scope of a given process. "So, speaking about the chicken we talked about in the first blockchain, we had to connect the farmers and the slaughterhouse. The packaging at the slaughterhouse, the transporter at Carrefour, and the

veterinarians...." This example demonstrates the need to consider external partners and their input in designing and implementing blockchain solutions.

In spite of these obstacles, experts agree that the prospective advantages of blockchain technology in supply chain management are significant. Expert G notes that using blockchain technology can increase transparency and traceability throughout the supply chain. This may enhance customer trust and assurance in the items they buy.

Overall, the experts suggest that the tension between external and internal value creation in blockchain implementation requires careful consideration of both factors. Developing a strong business case and identifying areas where blockchain can deliver the most value are crucial, as is engaging external partners in the design and implementation processes. However, starting with internal optimization and demonstrating the value of blockchain to the business can lead to more robust, more effective solutions for external value networks. Balancing the interests of all stakeholders involved is also essential for successful blockchain implementation.

4.2.2. Integration Model

The decentralized nature of blockchain allows for transparency, security, and immutability, making it a promising solution to address trust issues in industries where intermediaries play a crucial role, for example, the supply chain. Nonetheless, embracing blockchain technology comes with its own set of obstacles. A critical concern is a balance between the openness and restrictiveness of the blockchain for various participants.

Inclusivity refers to the idea that the blockchain should be open to all participants in a network, regardless of their size, location, or level of technical expertise. On the other hand, exclusivity implies that blockchain access should be confined to a specific set of participants who fulfill certain requirements.

Expert G highlighted the importance of inclusivity in the blockchain, particularly in supply chain management. According to G, it is essential to involve every participant in the supply chain, including small-scale farmers, in the blockchain network to ensure that the data entered into the system is accurate and reliable. To achieve this, G stated that the cost of entering data into the blockchain should be free for small farmers and that the access or license to the blockchain should be taken care of by larger organizations like Carrefour, who can afford it. G also emphasized the need for different ways of interacting with the blockchain, such as via portal, CSV file, or API, to accommodate the diverse technical capabilities of various participants.

The tension between inclusivity and exclusivity is also related to the issue of control, as pointed out by expert H. H argued that the illusion or perception of control is critical to commercial organizations, even if they might lack the degree of control they believe they do. Therefore, the perception of control is a significant factor in adopting blockchain technology. H also noted that the adoption of blockchain technology might reduce the level of control that larger players in the supply chain have over smaller players, as the code-based system makes it more challenging to mandate or enforce certain actions. This loss of control can be a significant concern for larger players, who may resist adopting blockchain technology.

As highlighted by expert I, inclusivity and exclusivity also hold a vital position in the governance of blockchain networks. Expert I pointed out that exclusive networks can be successful if the stakeholders can see the direct ROI and come up with a governance model that is inclusive and fair to all participants. Without a proper governance model, exclusive networks may fail due to a lack of participation and adoption. The We.trade case, a trade finance network that shut down due to insufficient inclusivity and governance models, demonstrates that inviting all banks and external parties to join a blockchain network without considering their needs and viewpoints could lead to an exclusive and unsustainable platform.

In blockchain technology, the tension between inclusivity and exclusivity stems from its distinct features like decentralization, immutability, and transparency. These characteristics necessitate a different approach to governance and access control compared to traditional centralized systems.

In conclusion, the tension between inclusivity and exclusivity in blockchain networks is a complex issue that requires careful consideration of various factors. On the one hand, exclusivity can provide benefits such as control and ROI, especially for commercial enterprises. On the other hand, inclusivity is necessary for ensuring widespread adoption and sustainability. Moreover, governance holds a vital function in establishing an inclusive network that meets the needs and perspectives of all stakeholders. As the experts have highlighted, the decision to make a blockchain network inclusive or exclusive should be based on a thorough analysis of the needs and perspectives of all stakeholders, as well as the specific business scenario and governance model. The success of a blockchain network hinges on striking a balance between inclusivity and exclusivity, ensuring that all participants reap maximum benefits from the system.

4.2.3. Accountability Model

Organizational compliance is a critical component of any blockchain ecosystem. It refers to a company's ability to demonstrate and account for human activities that comply with rules within or outside the ecosystem. While compliance is essential for maintaining Trust and transparency within the blockchain, it can create tension within organizations. This tension arises from balancing compliance requirements with the desire for decentralization and autonomy, key features of blockchain technology. The experts highlight some of the critical issues organizations face regarding compliance in the blockchain ecosystem.

One of the primary sources of tension regarding compliance in the blockchain ecosystem is the need for transparency while maintaining the intellectual property of the data.

Expert G highlights this paradox by stating, "I will maybe come back on the paradox between transparency and intellectual property of the data, which is certainly something that is key if you want to have, even a farmer in Europe will ask you about the intellectual property of the data because he is not crazy." This tension arises from the fact that blockchain technology provides transparency but also requires data sharing among network participants. This data sharing raises concerns about who owns the data and how it can be used.

Expert H also highlights the tension between compliance and trust, stating, "Trust is multi-dimensional; Trust is cultural; Trust is a decade of relationships, right? Trust is social; Trust is a lot of factors that come into play ..." In the context of the blockchain ecosystem, Trust is critical for maintaining the integrity of the network. However, compliance is often seen as a way to codify Trust, which can be met with skepticism from enterprise organizations. While compliance may be necessary to maintain trust, this tension arises because it cannot replace the complex web of relationships that make up Trust.

Another source of tension regarding compliance in the blockchain ecosystem is the need to balance decentralization with accountability. Expert I highlights this tension by stating, "if only one entity or one particular organization is accountable for the particular network or consortium, then I think there is no kind of decentralization." This tension arises from the fact that blockchain technology is designed to be decentralized and autonomous, but compliance requires accountability for the actions of participants in the network. The task lies in discovering a method to preserve decentralization while ensuring that participants are held accountable for their actions.

The importance of governance models and accountability mechanisms was also emphasized by Expert I, who stated that "creating the governance model is a very important factor for success with any blockchain network, especially in the enterprise world." The expert went on to explain that accountability should be shared across stakeholders in managing

operational costs, incentivization, and decision-making, as opposed to being given solely to one particular stakeholder. In order to achieve this, a decentralized governance model that includes decentralized autonomous organizations (DAOs) and smart contracts may be necessary.

Finally, Expert H pointed out that the term "trust" can be problematic in an enterprise context, since it encompasses various aspects that is difficult to codify. Instead, the expert suggested that compliance and governance may be more effective framing mechanisms when engaging with enterprise organizations. The expert stated, "when we say we can manage trust, they're gonna look at us and say, Well, you don't really know how we manage our partner relationships, right?" This underlines the significance of recognizing the particular requirements and concerns of enterprise stakeholders when designing blockchain solutions and framing them in a way that resonates with their organizational culture and values.

4.3. Tension area 3 - Whole vs. parts

4.3.1. Trust Model

The advent of blockchain technology has brought about new possibilities for secure and transparent transactions, enabling parties to exchange information and assets in a trustworthy and decentralized manner. However, the Trust that participants have in institutions and the Trust they have in the blockchain code itself can sometimes come into conflict, leading to tensions in the adoption and implementation of blockchain solutions.

According to expert F, Trust in institutions is vital for the success of blockchain solutions. However, he notes that the institution's credibility is crucial, as nobody has the time to read the code, even in software companies. He argues that legal agreements are necessary to protect participants' information and data, and they must be reliable and trustworthy. The importance of these agreements is further emphasized by the need for data encryption within the blockchain to ensure that only relevant information is accessible to each participant.

Furthermore, the experts acknowledge the importance of data encryption as another layer of building trust and reducing tension within the blockchain. Expert F stated that within the blockchain itself, data is encrypted, and individuals may only access data that is relevant to them. Data encryption is part of the data privacy agreement, which states that data will be encrypted, and individuals must agree to the encryption standard used. This provides another layer of trust, as individuals can trust that their data is secure and protected within the blockchain.

However, despite the efforts to build trust within the blockchain, some users express a lack of trust or confidence in the technology. Expert F cites a PwC survey, which found that 45% of new users lack trust in blockchain and do not believe it is sustainable. The lack of trust or low confidence in blockchain raises the question of scalability and sustainability. Can blockchain be applied in a large global enterprise, or are these small-pocket use cases the only viable applications so far? Expert F emphasizes the importance of tackling these issues and fostering trust in the technology.

Expert G also emphasizes the importance of trust and transparency within the blockchain to build stakeholder trust. The blockchain provides traceability and transparency, allowing the community to check the consistency of the process and be more trusting of each other. Expert G cites the example of eProvenance, which monitors the transfer of luxury wines from France to the US. By capturing the temperature of the wine during shipping and providing transparency on the shipping conditions, the community can trust the wine's quality and the supply chain's consistency.

While the experts acknowledge the importance of trust in the blockchain, they also recognize that Trust is complex and multifaceted. Expert H emphasizes the Trust paradox in current supply chains, where small farmers operate under the control of dominant players who possess the financial power to impose their will.. In this context, the incentive model becomes

essential to establishing trust. Expert H believes that codifying incentives and penalties into the blockchain protocol can benefit all parties involved by taking away potential legal wrangling and time spent on conflict resolution. By designing the right incentives and penalties, the code can help establish trust among stakeholders.

Expert I also highlights the importance of governance in building trust within the blockchain. According to Expert I, the suitable governance model and incentivization of stakeholders and users are crucial to sustaining the blockchain solution. In particular, the decentralized governance model is essential to establish trust and ensure that all stakeholders have a voice in managing the network. Expert I cites "Trust Your Supplier" as an example of an inclusive model with multiple stakeholders and governance roles that provide incentives to all participants.

In summary, the experts highlight the multifaceted nature of Trust within the blockchain. Although blockchain offers a secure and transparent foundation for fostering trust among stakeholders, it is crucial to establish trust in both the institutions/participants and the blockchain code to ensure the technology's success. Data encryption, transparency, and incentives are crucial to establishing trust and reducing tensions within the blockchain. Governance also is crucial in establishing trust and ensuring all stakeholders have a voice in the network. Finally, the experts recognize the need to address concerns about the scalability and sustainability of blockchain technology to build confidence in the technology and ensure its widespread adoption.

5. Concluding discussion

5.1. Summary of results

Ostern and Perscheid (2022) developed a framework to assist researchers and practitioners in systematically thinking through blockchain-related tensions and corresponding design decisions. This study aimed to validate the framework for managing tensions in

implementing and using blockchain technology in a supply-chain context, employing a qualitative research methodology with a combination of secondary research data and primary research (semi-structured interviews). The study analyzed blockchain-specific tensions in the supply-chain context to compare findings with the existing framework and determine if it is valid and can be applied in real-world scenarios.

The study sought to answer two research questions:

1) What are the tensions associated with implementing and using blockchain technology/applications in a supply-chain context? and

2) What are the resulting paradoxes revealed?

This study analyzed expert opinions on the challenges and opportunities of adopting blockchain technology in supply chain management, focusing on the tensions and paradoxes revealed by these opinions. This study's findings indicate that several key tensions emerge when implementing blockchain technology in supply chain management, including the tension between public and private blockchains, balancing value creation and value capture, navigating between inclusivity and exclusivity, addressing compliance concerns, and managing trust in both institutions/participants and the underlying blockchain code.

Table 1: Blockchain Tensions, Findings & Mitigations in Supply Chains

RQ	Tensions	Key Findings	Mitigations
1	Public vs. Private Blockchains	Private blockchains more suitable for enterprise	Focus on private/consortium blockchains for confidentiality, security, and control in supply-chain contexts
	Value Creation vs. Value Capture	Cultural and organizational barriers	Implement change management strategies, promote a culture of innovation and adaptability
		Value creation vs. value capture tension	Prioritize customer value creation, align with strategic objectives and financial goals

RQ	Tensions	Key Findings	Mitigations
2	Internal vs. External Value Networks	Balancing internal and external value networks	Develop a strong business case, design rules and standards, ensure understanding of the business process
	Inclusivity vs. Exclusivity in Blockchain Networks	Inclusivity vs. exclusivity tension	Establish decentralized governance models, include all stakeholders, balance openness with control
	Organizational Compliance	Organizational compliance challenges	Create clear governance models with incentives and penalties, consider technical and non-technical aspects of compliance
	Trust in Institutions/Participants vs. Trust in Code	Trust in institutions/participants vs. trust in code	Develop decentralized governance models, incentivize stakeholders, emphasize data privacy, strong agreements for data protection

Note: This table summarizes research questions, tensions in blockchain implementation, key findings, and proposed mitigation strategies for supply chain contexts.

In conclusion, the findings of this study suggest that the adoption of blockchain technology in supply chain management is not without its challenges and tensions. However, careful attention to governance, incentives, data privacy, and transparency can help overcome these challenges and establish a foundation of Trust for the long-term sustainability of these networks. Organizations considering the adoption of blockchain technology in their supply chain management practices should carefully consider the outcomes of this research to ensure the successful implementation of this technology.

5.2. Theoretical contribution

This study addresses the research gap concerning the validity and applicability of the framework for managing tensions in implementing and using blockchain technology in a supply-chain context. The framework, developed by Ostern and Perschil (2020), helps researchers and practitioners systematically think through blockchain-related tensions and

corresponding design decisions. The study reveals the tensions between value creation and value capture and the importance of balancing customer needs and strategic objectives to create sustainable competitive advantages.

It also highlights the tension between inclusivity and exclusivity in blockchain networks and the need for compliance elements, such as governance models and accountability, to ensure their success. The study also emphasizes the importance of Trust in both institutions/participants and the blockchain code. It suggests that strong agreements, legal documents, data encryption, and a decentralized governance model can help build Trust and ensure the sustainability of blockchain networks. In summary, the study enriches the body of knowledge on blockchain technology. It provides valuable insights into the challenges and tensions associated with its implementation and use in supply-chain management.

5.3. Practical contribution

The study contributes to the following:

Firstly, blockchain technology can increase transparency and traceability throughout the supply chain, which can help businesses identify inefficiencies and reduce costs. By delivering a transparent record of all transactions and activities, blockchain technology can help businesses identify areas where they can improve their processes and reduce waste. Additionally, blockchain technology can help businesses identify potential threats and vulnerabilities in their supply chain, enabling them to take proactive strategies to mitigate these risks.

Secondly, blockchain technology helps businesses establish trust with customers and suppliers by providing a secure, transparent transaction platform, leading to increased loyalty and sustained patronage. Furthermore, blockchain-enabled traceability solutions foster long-lasting relationships with suppliers and customers. Incorporating sustainability goals into supply chain solutions adds authenticity, enhancing trust and contributing to greater value creation.

Thirdly, blockchain technology opens up new business models and revenue streams by providing a secure, transparent transaction platform. This enables businesses to create innovative products and services with improved efficiency and cost-effectiveness or to tap into new markets and customer segments. Nevertheless, implementing blockchain technology in supply chain management necessitates a thorough evaluation of the business case and the design of rules and standards. The unique challenges arising from blockchain's multi-party nature must be tackled, and a solid business case should be established prior to implementation. Experts recommend balancing direct and indirect ROI for all stakeholders and incentivizing participation in the blockchain network.

5.4. Limitations

One of the major limitations of this research is the small sample size of participants, which could limit the generalizability of the findings to a larger population. The study faced limitations due to restricted access to businesses and experts using the IBM Food Trust - food tracking, which could have impacted the research scope and the analysis's depth. The study's findings may have limited applicability to the general population, as the IBM Food Trust is a commercial-off-the-shelf application built on a permissioned hyperledger blockchain architecture. The vast majority of participants in the IBM Food Trust would not be able to answer most of the semi-structured interview questions.

The study predominantly included experts with a technical or academic background, which may have limited the perspectives and insights shared. A more diverse participant pool, including experts with industry and business backgrounds, could provide a deeper comprehension of the challenges and prospects in blockchain adoption and implementation. Finally, the study relied on self-report data obtained through semi-structured interviews, which biases and constraints like social desirability or memory bias could influence.

5.5. Future research opportunities

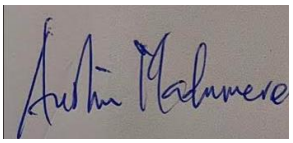
Based on the expert opinions and the constraints of this research, it is evident that several avenues for further research can be suggested. Future extensions of this research could include expanding the participant pool to include a more diverse range of experts with industry and business backgrounds and incorporating additional data collection methods, such as observations or surveys, to provide a more objective and comprehensive understanding of the issues.

Moreover, future research could focus on addressing the limitations of the small sample size and limited access to companies and experts using specific blockchain applications. Additionally, it could explore the tensions and paradoxes associated with implementing and using blockchain technology in contexts beyond supply chain management. Finally, further research could investigate the potential benefits and challenges of different governance models and compliance elements in blockchain ecosystems and the role of incentives and penalties in promoting compliance and building trust among stakeholders.

Declaration

I hereby certify that I have independently written this master's thesis. Any text passages not written by me are appropriately cited, with specific references to their sources. All utilized sources are included in the bibliography.

16th March 2023.



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Augustine Madumere

7. References

Agi, M. A., & Jha, A. K. (2022). Blockchain technology in the supply chain: An integrated theoretical perspective of organizational adoption, *247*, 108458. https://doi.org/10.1016/j.ijpe.2022.108458

Ciriello, R., Beck, R., & Thatcher, J. (2018). The Paradoxical Effects of Blockchain Technology on Social Networking Practices. *SSRN Electronic Journal.* Advance online publication. https://doi.org/10.2139/ssrn.3920002

Dodd, D., & Favaro, K. (2006). Managing the right tension. *Harvard Business Review*, *84*(12), 62-74, 160.

Glaser, B. G., & Strauss, A. L. (2017). *Discovery of grounded theory: Strategies for qualitative research*. Routledge.

Gruchmann, T., & Bischoff, O. (2021). Blockchain driven handling of digital freight information: a tensions perspective, *14*(1).

IBM (2019). IBM Food Trust: Supply chain intelligence suite. Retrieved from https://www.ibm.com/products/supply-chain-intelligence-suite/food-trust

Jabbar, S., Lloyd, H., Hammoudeh, M., Adebisi, B., & Raza, U. (2021). Blockchain-enabled supply chain: analysis, challenges, and future directions. *Multimedia Systems*, *27*(4), 787–806. https://doi.org/10.1007/s00530-020-00687-0

Lim, M. K., Li, Y., Wang, C., & Tseng, M.-L. (2021). A literature review of blockchain technology applications in supply chains: A comprehensive analysis of themes, methodologies and industries, *154*, 107133.

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2001). DEFINING SUPPLY CHAIN MANAGEMENT, *22*, 1-25.

Nutrition and Food-Safety (2022). Food safety report. Retrieved from https://www.who.int/news-room/fact-sheets/detail/food-safety

Ostern, N., & Perscheid, G. (2022). *Meta-View of Blockchain Technology Tensions in Organizational Implementation and Use*. Retrieved from https://scholarspace.manoa.hawaii.edu/handle/10125/79897

Raf Jans, & Koen Dittrich (2008). A review of case studies in business research. In J. Dul & T. Hak (Eds.), *Case study methodology in business research* (pp. 19–29). Oxford: Butterworth-Heinemann. https://doi.org/10.4324/9780080552194-3

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, *57*(7), 2117–2135. https://doi.org/10.1080/00207543.2018.1533261

Sandberg, E. (2017). Introducing the paradox theory in logistics and SCM research – examples from a global sourcing context.

Schad, J., Lewis, M. W. [Marianne W.], Raisch, S., & Smith, W. K. [Wendy K.] (2016). Paradox Research in Management Science: Looking Back to Move Forward. *The Academy of Management Annals*, *10*(1), 5–64. https://doi.org/10.1080/19416520.2016.1162422

Schmidt, C. G., Foerstl, K., & Schaltenbrand, B. (2017). The Supply Chain Position Paradox: Green Practices and Firm Performance. *Journal of Supply Chain Management*, *53*(1), 3–25. https://doi.org/10.1111/jscm.12113

Simons, H. (2014). Case Study Research: In-Depth Understanding in Context. *The Oxford Handbook of Qualitative Research*, 455.

Smith, W. K. [W. K.], & Lewis, M. W. [M. W.] (2011). Toward a theory of paradox: A dynamic equilibrium model of organizing. *Academy of Management Review*, 2–381.

Sternberg, H., Hofmann, E., & Röck, D. (2020). The Struggle is Real: Adoption Insights from a Supply Chain Blockchain Case.

Van der Byl, C. A., & Slawinski, N. (2015). Embracing Tensions in Corporate Sustainability. *Organization & Environment*, *28*(1), 54–79. https://doi.org/10.1177/1086026615575047

Vitasek, K., Bayliss, J., Owen, L., & Srivastava, N. (2022). How Walmart Canada uses blockchain to solve supply-chain challenges. *Harvard Business Review*, *5*.

Wang, Y., Singgih, M., Wang, J., & Rit, M. (2019). Making sense of blockchain technology: How will it transform supply chains?, *211*, 221–236. https://doi.org/10.1016/j.ijpe.2019.02.002

Wu, Z., & Pagell, M. (2011). Balancing priorities: Decision-making in sustainable supply chain management. *Journal of Operations Management*, *29*(6), 577–590. https://doi.org/10.1016/j.jom.2010.10.001

Yiannas, F. (2018). A New Era of Food Transparency Powered by Blockchain. *Innovations: Technology, Governance, Globalization*, *12*(1-2), 46–56. https://doi.org/10.1162/inov_a_00266

Zavolokina, L., Ziolkowski, R., & Bauer, I. (2020). Management, Governance, and Value Creation in a Blockchain Consortium. *MIS Quarterly Executive*, *19*(1), 1–17. https://doi.org/10.17705/2msqe.00022

Ziegler, Y., Uli, V., & Wortmann, J. (2021). Blockchain innovation in pharmaceutical use cases: PharmaLedger and Mytigate. *Journal of Supply Chain Management, Logistics and Procurement*, *3*(4), 312–325.

8. Appendix A: Blockchain’s Key Characteristics

Table 2: Summarizes the blockchain's key characteristics.

Characteristics	Description
Decentralization	In contrast, in a traditional transaction system, each transaction must be validated through a central trusted agency, which costs and slows down the system. The consensus algorithms used in blockchains can maintain data consistency without requiring a third party to verify each transaction.
Persistency	Transactions can be verified quickly, and miners will not accept invalid transactions. Deleting or reversing transactions once included on the blockchain is nearly impossible.
Anonymity	Each user can interact with the blockchain using an address generated by the blockchain, which does not reveal their real identity. Blockchain does not always provide perfect privacy protection, as the technology's inherent limitations bind it
Auditability	A transaction must reference past transactions to be valid. Once the current transaction is recorded into the blockchain, any unspent transactions refer to its switch from unspent to spent. Transactions could be easily verified and tracked.

Note Table 2 is a summary of blockchain core characteristics

9. Appendix B: List of Interview participants

Table 2: Interviewees

Person	Respondent	Company type	Role of interviewee	Length (Minutes)
Pierre Kaufmann	Expert A	Blockchain solution provider	Blockchain Leader	39
Patrick Brandtner	Expert B	Blockchain consultancy/University	Head of Research Department	38
Chibuzor Udokwu	Expert C	Blockchain consultancy	Blockchain researcher associate/data analytics	39
Alex Norta	Expert D	Researcher and entrepreneur	Head of Technical professional organization	60
Muhammad Saqlain Abbas	Expert E	Software developer	Mead Stack Developer	28
Ifeanyi Ojoh	Expert F	Logistics service provider	Digital Procurement Transformation Manager	56 .
Emmanuel Delerm	Expert G	Major Retail	Director of Project, Blockchain Implementation	54 .
John DeVadoss	Expert H	Blockchain association	Chairman, IEEE Blockchain	48 .
Kamlesh Nagware	Expert I	Blockchain consultancy	Chief Technology Officer	38 .

Note Table 3 is a list of participants interviewed