School of Management and Marketing

Exploring Factors and Impact of Blockchain Technology Adoption in the Food Supply Chains

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This thesis is presented for the degree of
Doctor of Philosophy
of
Curtin University

August 2023

Declaration

To the best of my knowledge and belief, this thesis contains no material previously published by any other person except where due acknowledgment has been made. This thesis contains no material that has been accepted for the award of any other degree or diploma from any university. This study was approved by the Curtin University Human Research Ethics Committee (approval number: HRE2019-0230).

Signature: Abubakar Mohammed

Date: 15 August 2023

Abstract

Globalization of the food supply chains (FSCs) has resulted in significant challenges in food supply systems, such as food fraud, food safety, quality issues, and food security, due to information asymmetry. Globalization has also increased the complexity of FSCs, in production, shipping, and other operations. The complexity of the supply chain, however, raises the risk of product fraud and a failure in confidence among the supply chain participants. Therefore, blockchain technology (BCT) has proven to have the potential to transform FSC based on its potential benefits. BCT promises to improve the FSC processes. However, there is limited knowledge on the driving factors of blockchain adoption within the FSC and the impact of BCT on food supply chain processes, given the scarcity of empirical evidence in the literature. Therefore, this study explored blockchain adoption's key factors, impacts, and challenges in an FSC.

Firstly, this study undertook a systematic literature review (SLR) to understand the current knowledge on blockchain adoption within the FSC. This work was published in 2023 in the IEEE ACCESS journal. Secondly, this study also adopts an exploratory qualitative research approach. The qualitative data is collected from two sources – 21 interviews, and 40 digital contents (white papers, news reports, social media reports, etc.) were analyzed using thematic analysis techniques in NVivo (v12), identifying thirteen factors classified under three groupings (Technology, Organization, and Environment) influencing blockchain adoption in the FSC. In addition, five impacts on BCT adoption were identified (efficiency, transparency, visibility, value creation, trust and collaboration). This study also identifies the significant challenges of BCT

(scalability, interoperability, privacy, infrastructure conditions, and lack of knowledge). Based on this, this study develops a conceptual framework for blockchain adoption in FSCs. The findings of this study were published in 2023 in the Foods journal. Another peer-reviewed paper was presented at China's International Conference on Big Data and Security ICBDS, 2019.

This study contributes to the body of knowledge by providing insights into adopting blockchain technology and its impact on food supply chains while providing the industry with evidence-based direction to build its blockchain strategies. Furthermore, this study offers a thorough understanding and awareness of blockchain technology adoption issues among executives, supply chain organizations, and government bodies.

Acknowledgements

In the name of ALLAH, Most Gracious, Most Merciful. All praise is due to Allah (SWT), the lord of the universe, who gave me the strength and courage to complete my thesis. May peace be upon our prophet Muhammad (PBUH), his household, companions, and followers. Completing this thesis would not have been possible without the support, encouragement, and advice of many individuals who provided me throughout my doctoral study.

I sincerely thank the Faculty of Business and Law, Curtin University, and the Australian Government for awarding me the Research Training Program (RTP) scholarship that enabled me to conduct my PhD candidature at this prestigious University. I would also like to acknowledge the FoodAgility Top Scholarship for its generosity.

I want to especially thank my supervisors, Associate Professor Vidy Potdar, Professor Mohammed Quaddus, and Dr Wendy Hui, for helping me along this beautiful journey and for their supervision and guidance. I would also like to thank my parents, Mr Yusuf Mohammed and (my late Mother) Mrs Adama Mohammed (May her soul rest in peace), and my siblings for their love and support during the programme.

Finally, I express my sincere gratitude to everyone who contributed in various ways to this thesis.

Dedication

This thesis is dedicated to my family.

List of Publications

The chapters of this thesis contain contents from papers published in refereed journals and conferences during the entire candidate's PhD research. The candidate contributed between 80% and 90% to every research paper, and the co-authors contributed to the thesis's concept development, writing, reviewing, and editing. Parts of this thesis have been published in peer-reviewed journals (*IEEE ACCESS, FOODS*) and the International Conference on Big Data and Security (ICBDS).

Journal Papers

1. A. Mohammed, V. Potdar, M. Quaddus and W. Hui, "Blockchain Adoption in Food Supply Chains: A Systematic Literature Review on Enablers, Benefits, and Barriers," in *IEEE Access*, vol. 11, pp. 14236-14255, 2023, https://doi.org/10.1109/ACCESS.2023.3236666. **Q1 Journal Impact Factor: 3.476.** Parts of this paper are relevant to chapters 2 and 4.

2. Mohammed, A.; Potdar, V.; Quaddus, M. Exploring Factors and Impact of Blockchain Technology in the Food Supply Chains: An Exploratory Study. *Foods* **2023**, *12*, 2052. https://doi.org/10.3390/foods12102052. **Q1 Journal Impact Factor: 5.5616.** Parts of this paper are relevant to Chapters 2, 3, and 4.

Conference

1. Mohammed, A., Potdar, V., Yang, L. (2020). Key Factors Affecting Blockchain Adoption in Organizations. In: Tian, Y., Ma, T., Khan, M. (eds) Big Data and Security. ICBDS 2019. Communications in Computer and Information Science, vol 1210. Springer, Singapore. https://doi.org/10.1007/978-981-15-7530-3_35. Part of this paper is relevant to Chapters 1 and 5.

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Abbreviations

BCT	Blockchain Technology
FSC	Food Supply Chain
IDC	International Data Corporation
PwC	PricewaterhouseCoopers
US	United States
UK	United Kingdom
RFID	Radio Frequency Identification
QSDSS	Quality Sustainability Decision Support System
IBM	International Business Machines
IoT	Internet of Things
HACCP	Hazard Analysis and Critical Control Points
SLR	Systematic Literature Review
EBSCO	Business Source Complete
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
TOE	Technology Organization Environment
HREC	Human Research Ethics Committee
P2P	Peer-to-Peer
APIs	Application layer
PoW	Proof of Work
COVID-19	Pandemic
EMR	Electronic Medical Record
CMI	Custom Market Insights
UTAUT	The Unified Theory of Acceptance and Use of Technology
DOI	Diffusion of Innovations
RBV	Resource-Based View
DC	Dynamic Capability
TAM	Technology Adoption Model

IT	Institutional Theory IT
ISS	Information Success Model
TPB	Theory of Planned Behaviour
IPT	Information Processing Theory
ST	Sensemaking Theory
TRI	Technology Readiness Index
KBV	Knowledge-Based View
SMEs	Small Medium Sized Businesses
SN	Subjective Norms
WSN	Wireless Sensor Networks
TRA	Theory of Reasoned Action
TBA	Planned Behaviour
BCTeSCS	BCT-enabled supply chain system
IS	Information Systems
RoI	Return on Investment
BRC	Business Research Company

Chapter 1. Introduction

1.1 Introduction

This chapter presents the research background, problem definition, research questions, and study objectives on blockchain technology adoption within the food supply chains. In addition, an overview of the research method used in the study is provided, as well as details of the research contributions and how the chapters of the thesis are presented. Parts of this chapter have been published in a Conference[1].

1.2 Research Background

The recent advent of the BCT is foretold as the next revolution in transforming the structure of organizations, including size, shape, and how corporate dealings are executed (K. Behnke & M. Janssen, 2020; Cermeño, 2016; Janssen et al., 2020). According to Crosby et al. (2016), the BCT is a set of blocks that records data in a hash function using a time stamp and a linkage to the previous block (Janssen et al., 2020). A BCT is a digital, decentralized, and distributed ledger that stores data in an irreversible and immutable form, which allows transaction flows without needing a third party (Mohammed et al., 2019; Stranieri et al., 2021). This eliminates the significant vulnerabilities that cybercriminals can exploit.

The fundamental components of BCT include distributed computation, decentralized consensus techniques, and cryptography (such as public key infrastructure and hashing) (Salviotti et al., 2018). Blockchain offers a paradigm of trust based on a

[1] Parts of this chapter have been published in the following publication:

a. Mohammed, A., Potdar, V., Yang, L. (2020). Key Factors Affecting Blockchain Adoption in Organizations. In: Tian, Y., Ma, T., Khan, M. (eds) Big Data and Security. ICBDS 2019. Communications in Computer and Information Science, vol 1210. Springer, Singapore.

collection of consensus, which provides transactions and allows chaining (Trautman, 2016). Yunsen Wang and Kogan (2018) present a blockchain-based enterprise transaction processing system that would significantly increase the efficiency and effectiveness of accounting and auditing practices.

Gartner predicted that the market value generated by BCT will hit $176 billion by 2025 and $3.1 trillion by 2030 (Gartner, 2019). Similarly, WinterGreen stated that it would reach $60.7 billion by 2024 (WinterGreen, 2019). By 2025, the global market for BCT adoption is anticipated to increase from $4.6 billion to $20.3 billion (Tractica, 2018). The International Data Corporation (IDC) estimated that blockchain solutions would grow by 75% by 2022 (Seth, 2019). A report from the multinational corporation PricewaterhouseCoopers (PwC) (PwC, 2019) indicated that “600 executives from 15 territories, 84% said their organizations have at least some involvement with blockchain technology". This outcome demonstrates that the financial services sector continued to lead to the adoption of BCT. PwC also discovered blockchain technology has potential applications in various industries, including energy, utilities, healthcare, etc. The country with the most advanced BCT is the United States (US). The Chinese President made a statement in 2019 (Wood, 2019) promoting the adoption of blockchain in China, and as a result, it is anticipated that China will soon take the lead (PwC, 2019). Blockchain has greatly impacted internationally. BCT can also improve an organization's competitive performance by making transactions more traceable and verifiable; additionally, wider usage of BCT signals awareness among organizations (Werner et al., 2021). BCT is also considered in supply chain management (SCM) (Bumblauskas et al., 2020b; Hughes et al., 2019; Köhler & Pizzol, 2020), signifying substantial interest in BCT adoption in the FSC. BCT is regarded as revolutionary and promising for the food industry, making it feasible to overcome existing supply chain difficulties (Bumblauskas et al., 2020b; Hughes et al., 2019; Köhler & Pizzol, 2020). Several studies have demonstrated the potential of blockchain applications in FSC in real-world settings. The global market value of BCT in the food and agriculture sector was expected to increase from $32.2 million in 2017 to $1.4 billion by 2028. It is also anticipated to increase by 42.85% in Europe between 2018 and 2028, by 40.42% in North America, by 7.85% in the Asia-Pacific region, and by 48.33% annually in the rest of the world (Damoska Sekuloska & Erceg, 2022). Blockchain has received increasing attention in scholarly studies. However, the acceptance of BCT in FSC is scarce (Gurtu & Johny, 2019; Shoaib et al., 2020). This study examined the factors and impacts of BCT adoption within the FSC by using a qualitative case study approach based on data collected from literature reviews, interviews, and digital contents.

1.3 Problem Definition

It is anticipated that there will be 8.5 billion people on Earth by 2030, 9.7 billion by 2050, and 10.9 billion by 2100. (Dorling, 2021; V. Pandey et al., 2022). Globalization of the FSC has contributed to several significant challenges in the food systems, such as food fraud and food security, due to information asymmetry (Chen et al., 2020; John G. Keogh et al., 2020).

Folkerts and Koehorst (1997) define FSC as a "set of interdependent companies that work closely together to manage the flow of goods and services along the value-added chain of agricultural and food products to realize superior customer value at the lowest possible cost.” The FSC is a complex system comprising several stakeholders: consumers, farmers, industries, manufacturers, distributors, retailers, and the government. These stakeholders have different roles in the FSC processes (F. Casino et al., 2020; Kayikci et al., 2020; D. Mao et al., 2018), from farmed crops to consumer's forks. However, food security has become a dominant global issue and has received increasing attention in recent years due to limited concerns in the food industry. Today, FSCs are becoming more complex because of globalization, and it is common for companies to outsource trade, manufacturing, logistics, and other tasks. However, the extent and intricacy of the supply chain increase the chances of product scams and loss of trust among supply chain stakeholders (Sarpong, 2014). Consequently, traceability is a crucial prerequisite in the supply chain industry, particularly the FSC industry (Chen et al., 2020; John G. Keogh et al., 2020). Consumers demand knowledge of a product's origin to confirm food quality. There have been several food scandals around the world, such as the Chinese milk scandal in 2008 (Xin & Stone, 2008) and India’s immense "food theft" scandal (G. Pandey, 2011). In 2013 there was a horsemeat scandal in the United Kingdom (UK) (Madichie & Yamoah, 2017). The same year, an egg contamination scandal affected 15 European countries and Hong Kong (Boffey & Connolly, 2017). These issues affect consumers’ beliefs about the food market and their attitudes toward it (Chen et al., 2020). This has resulted in a lack of trust, transparency, and inefficient food traceability (Costa et al., 2013; Trace, 2007); thus, an effective food traceability system is required (Guido et al., 2020; Hayati & Nugraha, 2018; Madumidha et al., 2019; Samal & Pradhan, 2019).

In recent years, academics and professionals have investigated technologies that could solve traceability issues in the FSC. For example, radio frequency identification (RFID) tag (Manzini & Accorsi, 2013), which allows for tracking a product’s history (Grunow & Piramuthu, 2013) to achieve the traceability and visibility of a particular product (Bernardi et al., 2008). Ting et al. (2014) present a “quality-sustainability decision support system (QSDSS)” approach, a solution that could provide quality and safety assurance for food products. Similarly, Manzini and Accorsi (2013) developed a conceptual framework to address food product quality, safety, sustainability, and logistics efficiency throughout the supply chains.

The emergence of BCT will likely transform the supply chains based on its potential benefits and advantages (Yingli Wang, Han, et al., 2019). This promises to improve traditional supply chain processes (Chen et al., 2020), which are more central (Fosso Wamba et al., 2020; Nir Kshetri, 2018). Blockchain has already been used in finance, education, healthcare, mining, supply chains, and the government (Dutta et al., 2020; Mohammed et al., 2019). For example, some large companies such as IBM, Walmart, and Tsinghua University have explored BCT to address food safety issues in China in order to improve food traceability across the whole supply chain (Aitken, 2017).

Several studies have provided significant views on how blockchain could improve the FSC. Tian (2017) proposed a food traceability system by combining blockchain and the Internet of Things (IoT) "for real-time food traceability based on HACCP (Hazard Analysis and Critical Control Points)", which records all products around the supply chain. In addition, Bumblauskas et al. (2020a) developed an integrated system for tracking eggs from farms to forks using blockchain and IoT. Cocco et al. (2021) proposed a system that provides actors with the ability to verify the quality of products. Their results showed that the participants confirmed the quality of the products. A. Tan and Ngan (2020) developed a food safety and traceability framework for the Vietnamese dairy industry. Chan et al. (2019) also developed a traceable and transparent supply chain management framework. Other related studies (Balamurugan et al., 2021; Grecuccio et al., 2020; P. W. Khan et al., 2020; Pal & Kant, 2019; Ronaghi, 2020) used blockchain and IoT to track food. Adopting new technology relies on several factors (Chen et al., 2020; Ghode et al., 2020; Nath et al., 2022). Despite blockchain's exceptional and valuable elements, its feet in the food industry are yet to be discovered, and this study aims to fill this gap, by exploring the factors, impacts, and challenges of BCT in FSC.

1.4 Research Objectives and Questions

This study aimed to conduct an in-depth exploratory study of the factors influencing BCT adoption within the FSC and its impact. Based on this, the following research objectives were formulated:

1) To explore the factors influencing blockchain technology adoption in the food supply chains.
2) To examine the impact of blockchain technology on food supply chains.
3) To identify the significant challenges of adopting blockchain technology in the food supply chains.

This study investigated the following research questions, considering the research objectives:

1) What factors influence the adoption of blockchain technology in food supply chains?
2) What are the impacts of blockchain technology on the food supply chains?
3) What are the significant challenges to adopting blockchain technology in the food supply chains?

1.5 Overview of Methodology

One of the main paradigms employed in information system research, the interpretivist approach, was applied in this study (Klein & Myers, 1999; Orlikowski & Baroudi, 1991). The decision to choose an interpretivist perspective is influenced by the study's goal of comprehending how organizations' actions and activities contribute to the development of the theory (Orlikowski & Baroudi, 1991). This study focused on identifying the factors, impacts, and challenges of blockchain technology adoption within the food supply chains. The interpretivist perspective also encourages using pre-existing theories and earlier research to create initial frameworks for this study (Geoffrey Walsham, 1993). Consequently, the qualitative case study method (Yin, 2009) was conducted under the guidance of relevant theories and current BCT literature. This study was conducted in three stages.

- Systematic Literature Review (SLR) – A SLR, following the standards from Kitchenham and Charters (2007) and Tranfield et al. (2003), and in line with the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" system as described by Liberati et al. (2009), was undertaken. Two prominent databases were selected for the source literature: "Scopus and Business Source Complete (EBSCO)," repeating the methodological approach (Bhimani et al., 2019; Olanrewaju et al., 2020). As detailed in Chapter 2, this study systematically reviews and synthesizes prior studies that have explored the adoption of BCT within the FSC.

- Qualitative study – Interviews were conducted to gather information about blockchain technology adoption within the food supply chains. Twenty-one participants from various food supply chains and agricultural levels were interviewed. An interview guide was developed based on the study questions to ensure that correct data were obtained from each participant. The candidates for the interviews were chosen based on specific criteria.

- Digital Contents – Content analysis was conducted based on a review of 40 digital content (white papers, news reports, social media reports, etc.) of BCT within the FSC. This study used publicly available data from Internet sources, which significantly advanced the understanding of the research.

1.6 Research Contributions

This study significantly contributes by evaluating theories and analyzing the synthesis of the literature on BCT that has already been published. This study offers perceptions of the strategies of BCT adoption in the food supply chain, which prior studies have largely overlooked. To the researcher's knowledge, highlighting crucial blockchain capabilities for food systems has not yet been examined in previous literature, which lacks an understanding of how BCT affects the food supply chain. The study also provides empirical support by applying the "Technology Organization Environment (TOE) framework" by L. Tornatzky and Fleischer (1990) and the resource-based view as the theoretical lenses for understanding the factors, impacts, and challenges of BCT adoption within the FSC. This study also proposes a conceptual framework that furthers the knowledge of the factors influencing BCT adoption in FSC.

This study undertook a systematic literature review (SLR) to understand the current knowledge on blockchain adoption within the FSC. This work was published in 2023 in the IEEE ACCESS journal, and according to the SCImago Journal Rank (SJR), this journal is ranked 0.926. The references are as follows:

A. Mohammed, V. Potdar, M. Quaddus and W. Hui, "Blockchain Adoption in Food Supply Chains: A Systematic Literature Review on Enablers, Benefits, and Barriers," in IEEE Access, vol. 11, pp. 14236-14255, 2023, https://doi.org/10.1109/ACCESS.2023.3236666

The findings of this research have also been published in Foods, a reputable journal that currently holds the SCImago publication rank (SJR) of 0.771. The references are as follows:

> Mohammed, A.; Potdar, V.; Quaddus, M. Exploring Factors and Impact of Blockchain Technology in the Food Supply Chains: An Exploratory Study. Foods 2023, 12, 2052. https://doi.org/10.3390/foods12102052

The study uses an exploratory review of texts from the public media because academic research in BCT is still in its infancy. This study makes the following contributions. First, the study contributes to the field of information systems research, which is still developing. Second, the study contributes to BCT research, which has so far concentrated on the phenomena and BCT adoption. The study's results provide an understanding for researchers and practitioners to develop their BCT strategies. Another peer-reviewed paper was presented at the International Conference on Big Data and Security ICBDS in China 2019. The references are as follows:

> Mohammed, A., Potdar, V., Yang, L. (2020). Key Factors Affecting Blockchain Adoption in Organizations. In: Tian, Y., Ma, T., Khan, M. (eds) Big Data and Security. ICBDS 2019. Communications in Computer and Information Science, vol 1210. Springer, Singapore. https://doi.org/10.1007/978-981-15-7530-3_35

The results of this study also offer new perspectives on BCT adoption in the food industry. Consequently, it provides enterprises with a basis to examine their adoption policies by outlining the variables that could facilitate or hinder adoption.

1.7 Ethical Considerations

Because this study included a qualitative element involving human participation, formal ethics approval was obtained from the Curtin University Human Research Ethics Committee (approval number: HRE2019-0230).

1.8 Thesis Structure

This study is divided into six chapters.

Chapter 1 presents the research background, problem definitions, objectives, and questions. It also outlines research methods, contributions, and ethical considerations. Chapter 2 provides a literature review of the fundamental concepts of BCT. It introduces BCT, its applications, food supply chains, and a theoretical foundation. A systematic review of BCT in the FSC is presented. Chapter 3 summarizes the chosen research methodology. It looks at how this study was organized and how a suitable research method was determined. The results of the qualitative investigation, which was conducted via interviews, are discussed in Chapter 4. It investigates the factors that influenced BCT adoption inside the FSC and covers the impact and challenges of BCT under the three main headings of technology, organization, and environment. Chapter 5 presents content analysis results based on the digital content of publicly available data on blockchain technology within food supply chains. Chapter 6 presents the findings of this study. A summary of this study is provided at the outset of this research. The research issues were then addressed while considering the body of the literature. This chapter discusses the study's contributions, limitations, and opportunities for further investigation.

1.9 Summary

This chapter provides an overview of this study. This highlights the importance of these factors and the impact of adopting blockchain technology within the food supply chains. The following chapter systematically reviews the literature and synthesizes prior studies on blockchain technology adoption in food supply chains.

Chapter 2. Literature Review

2.1 Introduction

This chapter reviews related literature on BCT within FSCs. The current chapter introduces BCT, its characteristics, and the different types of BCT. It then examines BCT applications. An SLR of BCT within food supply chains and the theoretical foundation for this thesis are presented. Parts of this chapter have been published in the Journals[2].

2.2 Blockchain Technology

The core concepts behind blockchain were anticipated in the late 1980s and the early 1990s. The Turing Award-winning Leslie Lamport established the Paxos protocol in 1989 as a consensus model for achieving a treaty in computer networks, where both the computer and networks may be untrustworthy (Lamport, 1998). This paper was published after an almost ten-year delay. A series of articles written between 1990 and 1997 presented the idea of a signed information chain that forms an electronic ledger (Bayer et al., 1993; Haber & Stornetta, 1990). This ledger comprised documents with a digital signature, which made it easy to prove that these signed documents had not been altered. These authors were acquainted with some further developments to make this data structure more effective, including 1) using faster computable hashes instead of signing document links, 2) grouping documents into blocks in place of processing

[2] Parts of this chapter have been published in the following publication:

a. Mohammed, V. Potdar, M. Quaddus and W. Hui, "Blockchain Adoption in Food Supply Chains: A Systematic Literature Review on Enablers, Benefits, and Barriers," in *IEEE Access*, vol. 11, pp. 14236-14255, 2023.
b. Mohammed, A.; Potdar, V.; Quaddus, M. Exploring Factors and Impact of Blockchain Technology in the Food Supply Chains: An Exploratory Study. *Foods* **2023**, *12*, 2052.

them separately, and 3) inside the respective block, connecting them with a binary Merkle tree structure as a substitute for linear document linking transaction hash indicators.

Satoshi Nakamoto introduced the idea of the BCT in 2008 (Nakamoto & Bitcoin, 2008), and it was developed as an open-source project in 2009 (Mohammed et al., 2019). The first use of BCT in the real world was Bitcoin (Nakamoto & Bitcoin, 2008); one well-known application of blockchain is the decentralized peer-to-peer network for cryptocurrencies known as Bitcoin. It is regarded as the technological invention of the word "blockchain."

2.3 Definition

Several attempts have been made to define BCT. A BCT is defined as "a blockchain as a distributed database, which is shared among and agreed upon by a peer-to-peer network. It consists of a linked sequence of blocks, holding time-stamped transactions secured by public-key cryptography and verified by the network community. Once an element is appended to the blockchain, it cannot be altered, turning a blockchain into a permanent record of past activity" (Seebacher & Schüritz, 2017, p. 14).

Medeiros and Chau (2016) defined BCT as defined BCT as "a decentralized peer-to-peer network of nodes recording authenticated, encrypted transactions as a distributed public ledger, thereby providing a trust and verification system by using programmed rules to govern the replication of the ledger across the computing nodes of the networks" (Medeiros & Chau, 2016, p. 305). Halaburda (2016) in their work described BCT as "a ledger that can be freely distributed (i.e., decentralized) and that relies on cryptographic tools to allow all users of the network to verify its consistency and preclude them from making unilateral changes" (Halaburda, 2016, p. 4). Preuveneers et al. (2017) give a more thorough explanation of BCT, claiming that "a distributed ledger with Byzantine fault-tolerant consensus, i.e. a highly resilient peer-to-peer database architecture maintaining blocks of transactions that contain each a timestamp and a reference to a previous block" (Preuveneers et al., 2017, p. 2308). Data stored in a blockchain cannot be permanently altered or manipulated (Lakhani & Iansiti, 2017).

2.3.1 Blockchain Technology Characteristics

Fundamentally, a blockchain is a connected database distributed and managed among the nodes in P2P networks. Figure 2.1 shows the elementary hierarchical structure of a four-layer blockchain (Paulavičius et al., 2019).

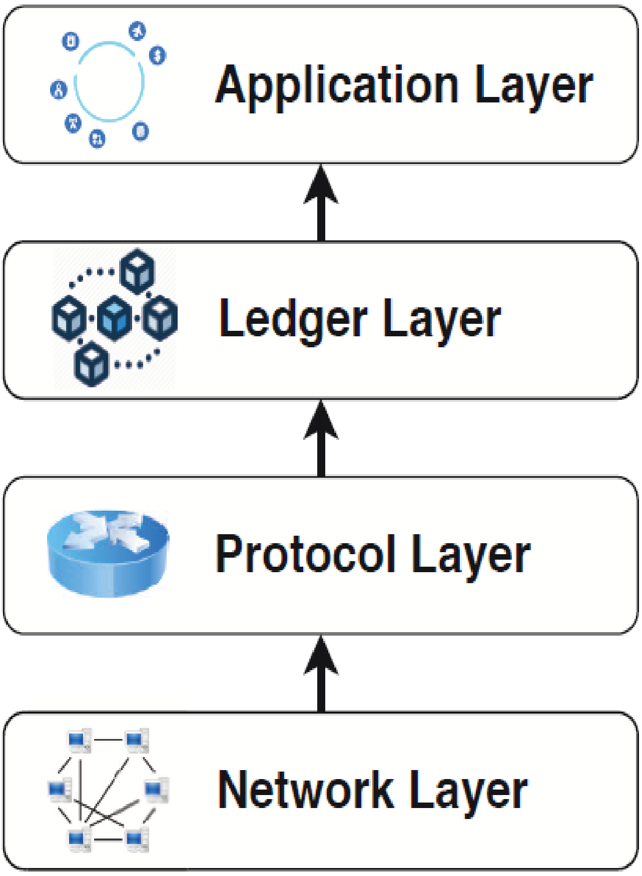

Figure 2.1: Basic hierarchical structure of blockchain technology (Paulavičius et al., 2019)

- ***Network layer:*** The computing node's bottom layer ensures the structure's functionality. P2P networks are vital for ensuring that blockchain nodes communicate with each other in a decentralized manner.

- ***Protocol layer:*** This is the second bottom layer and consists of the basics of the blockchain, such as consensus procedures and cryptographic techniques. This layer guarantees the proper operation of the structure.

- ***Ledger layer:*** The global ledger is the third layer from the bottom and is accountable for the reliable and secure transmission of transactions (including Smart Contracts), which is the mission of the main blockchain. This ensures that the system works correctly.

- ***Application layer:*** This top layer offers programming interfaces (APIs) for numerous applications. This layer oversees interactions with the blockchain when a business needs to call for it.

2.3.2 Types of Blockchain Technology

BCT is an underlying technology that powers bitcoin and other cryptocurrencies. Blockchain follows a distributed approach in which multiple nodes are interconnected without a central control node. The following section focuses on various types of BCT, as shown in Figure 2.2 (Hiremath, 2019; Mohammed et al., 2019; Sheth & Dattani, 2019).

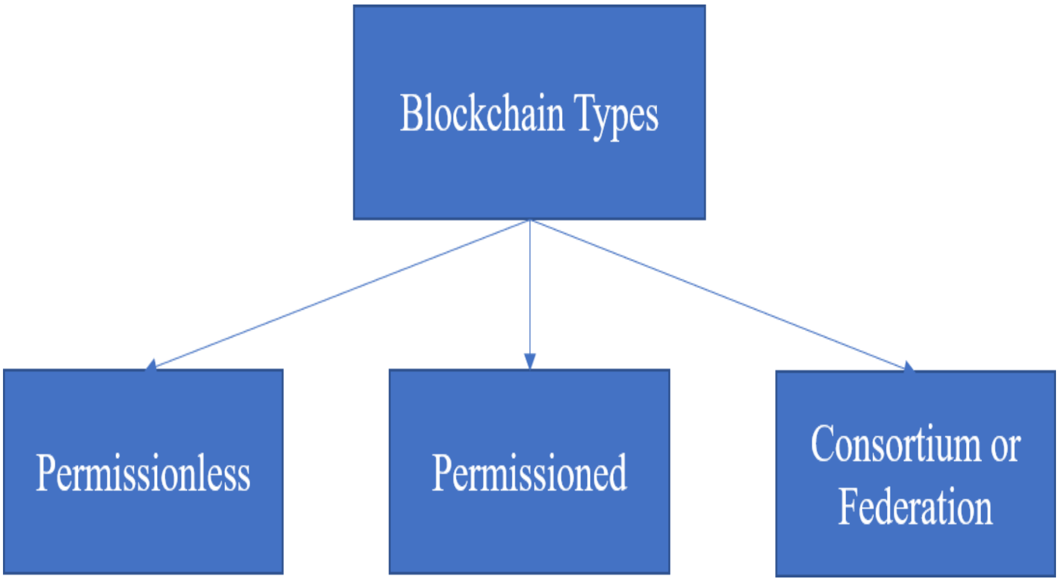

Figure 2.2: Types of blockchain technology

2.3.2.1 Permissionless

The best example of a permissionless blockchain is Bitcoin, which powers most digital currencies, such as Bitcoin, Ethereum, and Litecoin (Hiremath, 2019; Mohammed et al., 2019; Sheth & Dattani, 2019). There were no barriers to who could use them. Node-mining software was used for analysis. Anybody following the blockchain rules can access the wallet and write data to the transaction. These blockchains are open and translucent and can be reviewed by anyone. It has also been recognized as a public blockchain system.

2.3.2.2 Permissioned

This is generally called a "private blockchain." It acts as a closed ecosystem in which individuals cannot quickly join the blockchain network, view history, or issue transactions that require permission. This belongs to an individual or organization with centralized authority to process permits. The consensus mechanism can be similar to a public blockchain or a tool such as Ripple, Hyperledger, or R3 Corda (Hiremath, 2019; Mohammed et al., 2019; Sheth & Dattani, 2019).

2.3.2.3 Consortium or Federation

This type of blockchain deprives individuals of power. Instead of empowering a single unit, it is delegated to a group of people or individuals that form a group known as an association or federation, such as Quorum, Hyperledger, or Corda (Hiremath, 2019; Mohammed et al., 2019; Sheth & Dattani, 2019).

2.3.3 Blockchain Technology Platforms

This study also highlighted different blockchain platforms, as described by Sheth and Dattani (2019). A comparison of existing blockchain platforms is summarized in Table 2.1.

- ***Ethereum*** is an open-source public distribution system of blockchain that permits inventors to construct and install software applications and utilizes a unique cryptocurrency token called Ether. It also offers users an Ethereum virtual machine that sets up Ethereum-based "smart contracts.”

- ***A Hyperledger*** is an open-source technology platform built for enterprises using distributed ledgers. The first distributed ledger allows "smart contracts" to be written in common programming languages such as Java, Google Go, and Node JS. Therefore, enterprises do not require additional domain-specific language training. The core difference between this platform and other platforms is that it supports a pluggable consensus and makes it more resourceful for specific use cases.

- ***R3 Corda*** was designed to be associated with the world's top bank. This is the platform for a distributed ledger. This depends on a structure where nodes are accountable for applying smart contracts. It is a fully licensed network.

- ***Ripple*** is an open-source protocol designed for economic and swift transactions, which uses a general ledger controlled by a network of independent nodes. Interestingly, the Ripple Token XRP, such as Bitcoin or other cryptocurrencies, cannot be mined but is distributed from the beginning.

- ***The Quorum*** was established using JP Morgan Chase. This is the initial stage of blockchain application in the financial division. It is a licensed blockchain designed for economic use based on Go Ethereum. This is meant to protect the privacy of records, which is an essential aspect of financial organizations.

Table 2.1: Blockchain platforms

Parameter		**Blockchain**	**Platform**		
	Ethereum	**Hyperledger**	**R3**	**Ripple**	**Quorum**
Industry-focus	Cross-industry	Cross-industry	Financial service	Financial service	Cross-industry
Governance	Ethereum developers	Linux Foundation	R3	Ripple Labs	Ethereum dev and JP Morgan
Ledger Type	Permissionless	Permissioned	Permissioned	Permissioned	Permissioned
Consensus Algorithm	Proof of Work (PoW)	Pluggable framework	Pluggable framework	Probabilistic voting	Majority voting
Industry Focus	Ether	No currency	No currency	XRP	-
Smart contract functionalities	Yes	Yes	Yes	No	Yes

**Adapted from Sheth and Dattani (2019)*

2.4 Review of Blockchain Technology Applications

This section reviews the applicability of blockchain in different industrial sectors. Yli-Huumo et al. (2016) provided a comprehensive overview and cataloguing of the prevailing literature on BCT. Existing blockchain applications include energy (Andoni et al., 2019; Sedlmeir et al., 2020, 2021), supply chain (Dutta et al., 2020; Queiroz et al., 2019; Saberi et al., 2019), Internet of Things (IoT) (Panarello et al., 2018; Tian, 2017; Viriyasitavat et al., 2019), government (Alketbi et al., 2018; Datta, 2019), and healthcare (Dimitrov, 2019; Siyal et al., 2019). In addition, this section includes a summary of blockchain applications according to the most dominant evolving areas.

2.4.1 Finance

Research has been devoted to improving performance and dealing with transactions (Hazari & Mahmoud, 2019; Peters & Panayi, 2016), safety, privacy, and confidentiality (Singh & Singh, 2016), business economics (Momtaz et al., 2019), and financial contracts (Egelund-Müller et al., 2017). The market for blockchain-based financial services was predicted to rise from $1.17 billion in 2021 to $1.89 billion in 2022 at a cumulative annual growth rate (CAGR) of 61.9%. The COVID-19 pandemic-related global economic recovery was hindered by the Russia-Ukraine conflict, at least initially. The dispute between these two countries has affected many markets worldwide by imposing financial penalties on other countries, driving up the price of commodities, and disrupting the supply chains (BRC, 2022). According to Statista (2020), the global blockchain market, which has grown rapidly over the past years, is expected to reach 39 billion USD by 2025.

2.4.2 Healthcare

The healthcare industry has adopted blockchain technology at an increasing rate. Early adopters of health ecosystem technologies also do so advantageously. The blockchain strategy to transform the healthcare industry in the following years will include addressing issues affecting the current structure. This makes it possible for doctors, patients, and pharmacists to access all information at any time conveniently. Medical businesses are researching, testing, and learning about blockchain technology for health records. Decentralizing patient health history records, improving payment options, and implementing pharmaceuticals are essential healthcare industry tools. Along with other cutting-edge technologies, such as machine learning and artificial intelligence, the medical industry relies extensively on blockchain. The healthcare industry is being transformed by blockchain in several legitimate ways.

Blockchain applications have broad applicability, including biomedicine (Kuo et al., 2017; Mytis-Gkometh et al., 2017); assurance claims (Thenmozhi et al., 2021; Zhou et al., 2018); electronic medical record (EMR) management (Gordon & Catalini, 2018; Stafford & Treiblmaier, 2020; A. Zhang & Lin, 2018); and pharmaceutical supply chains (Mattke et al., 2019; Tseng et al., 2018). According to a recent analysis by BIS Research, by 2025, the healthcare sector may save up to $100 billion annually by implementing BCT. Cost savings will be seen in decreased operational costs, IT costs, fraud connected to counterfeit goods, and insurance fraud. According to this analysis, worldwide blockchain applications in the healthcare sector are anticipated to expand at a compound annual growth rate of over 64% between 2018 and 2025. In 2025 it will be worth approximately $6 billion (Research, 2018).

2.4.3 Internet of Things

IoT applications require a reliable mechanism that ensures the integrity and transparency of the data gathered and their interactions (Sicari et al., 2015). The research community has put blockchain into various features (Brody et al., 2015), including safety (M. A. Khan & Salah, 2018), device management (Samaniego & Deters, 2016), identification (Gan, 2017), confidentiality (Huh et al., 2017). According to Custom Market Insights (CMI), the Global Blockchain IoT Market was valued at USD 138.78 million in 2021 and was also projected to grow to USD 152.8 million by 2022 and USD 22189 million by the end of 2030 at a CAGR of almost 73.5% over the forecast period 2022-2030 (Marketplace, 2022).

2.4.4 Government

Blockchain in government is intended to be implemented in e-government (Sullivan & Burger, 2017), electronic voting (Pawlak et al., 2018), price archives (Ramya et al., 2018), and virtual identification (Dunphy & Petitcolas, 2018). In an intelligent city, blockchain might be a secure communication platform for linking economic, social, and physical infrastructures. The goal of decentralized and effective blockchain governance is to deliver the same services as those offered by the state and its equivalent public bodies while maintaining the same legitimacy (Fran Casino, Dasaklis, et al., 2019). Examples of these services include “voting, attestation, identification, marriage contracts, taxation, and registration.” The World Citizen Project is an illustration of a decentralized passport service to identify residents worldwide. BCT can also be used to deliver other public services such as income tax systems, patent administration, and marriage registration. Other campaigns emphasize democracy, which substitutes delegate voting for parliamentary representation.

2.4.5 Supply Chain Management

The blockchain supply chain market is anticipated to grow at a compound annual growth rate (CAGR) of 81.7% from 2021 to 2026. The significant growth drivers of the market include an increasing need for supply chain transparency and a rising desire for increased supply chain transaction security (Mordorintelligence, 2018). Implementing BCT in the supply chains is anticipated to advance environmental, social, and economic sustainability (Min, 2019; Saberi et al., 2019). To successfully deploy BCT, supply chain partners must also identify and address the hurdles to their adoption (Saberi et al., 2019). However, designing and identifying such barriers is challenging due to blockchain research in the supply chain's early stages (Blossey et al., 2019; Kouhizadeh et al., 2021). Chinese government research institutes have developed supply chain tracking policies for blockchain services. This development has helped track products throughout the supply chain and contributed to the country's development (Mohanta et al., 2019). The following section discusses BCT in food supply chains because there is an increasing need for more sustainable supply chain management in the food industry.

2.5 Review of Blockchain Technology in Food Supply Chains

Several studies have provided significant views on how blockchain can improve the FSC. Tian (2017) combined IoT and blockchain to suggest a system for tracking food and determining real-time food traceability using HACCP, which keeps track of every food security chain. Similarly, using blockchain and IoT, Bumblauskas et al. (2020a) developed an integrated system for tracking eggs from farms to forks. Cocco et al. (2021) also proposed a system that could provide actors with the ability to verify product quality. Their results showed that participants could confirm the quality of a particular product. A. Tan and Ngan (2020) developed a food safety and traceability framework for the Vietnamese dairy industry. This indicates that a food traceability framework is essential. Chan et al. (2019) also developed a traceable and transparent supply chain management framework. Other areas that use blockchain as a service include e-commerce JD in China, which tracks beef imports using blockchain platforms. Walmart used blockchain for distribution (Mohanta et al., 2019). Previous studies have also indicated that BCT has not been sufficiently evaluated in the food industry and that future effects, outcomes, and associated problems have not yet materialized (Yew et al., 2020; X. Zhang et al., 2020).

In contrast, BCT is entering the market with high hopes and promises but with knowledge heavily influencing adoption (Wong et al., 2020). Food supply chains may undergo a revolution, which might modify the equipment and circumstances used, and provide customers with information about food (Bumblauskas et al., 2020b). Although it is a relatively new technology, it offers a potential solution to some problems in food supply chains (Ronaghi, 2020; Saurabh & Dey, 2021; V. S. Yadav et al., 2020; Vinay Surendra Yadav et al., 2020). A recent study by Alba J Collart and Canales (2022) summarized a list of food industries that have adopted blockchain-based platforms, as shown in Table 2.2. The IBM Food Trust, created in 2017 in conjunction with Nestlé Unilever and Walmart, has embraced the BCT for traceability within food supply chains (Alba J Collart & Canales, 2022).

Table 2.2: Several food industries have implemented blockchain-based traceability software

Industry	**Blockchain platform**	**Products**	**Use cases**	**Information accessibility to consumers**
Walmart and its subsidiary Sam's Club	IBM Food Trust	Leafy greens	Food traceability and safety	-
Albertsons Companies	IBM Food Trust	Romaine lettuce	Food safety, traceability (Pilot phase)	-
Carrefour (European grocery chain)	IBM Food Trust	Cheese, eggs, Tomatoes, oranges, salmon, and milk	Food safety, transparency	QR code scanning
Cargill	Hyperledger Grid	Turkey	Food provenance transparency traceability	-
Dole	IBM Food Trust	Fresh vegetable salads	Traceability	In progress, planned by 2025
Bumble Bee Foods	SAP Cloud Platform Blockchain	Fair Trade Yellowfin tuna	Traceability, food safety, provenance	QR code scanning
Nestlé	IBM Food Trust and other platforms pilots	Palm oil, Coffee, and dairy	Provenance, Traceability	QR code scanning

Golden State Foods (Supplier for fast food industry)	IBM Food Trust	Produce of Beef	Traceability	-
Folgers	IBM Food Trust in partnership with Farmer Join	Coffee	Traceability, supplier insight	QR code scanning
Certified Origin's Group (Bellucci brand)	Oracle Blockchain	Extra virgin olive oil	Traceability, transparency, provenance	Code entered in the app (Blockchain not yet deployed)
Starbucks	Microsoft's Azure Blockchain Service	Coffee	Food traceability	QR code

**Adapted from Alba J Collart and Canales (2022)*

2.5.1 Prior Reviews

Because BCT is still in its early stages, researchers and practitioners have recently explored blockchain applications in FSC. Table 2.3 presents existing review studies on BCT within the FSC.

Table 2.3: Summary of recent reviews on BCT within the FSC

Authors	**Aim**
(Rocha et al., 2021)	To review the application of blockchain in agribusiness.
(W. Liu et al., 2021)	Its goal was to examine how blockchain technology and information communication technologies have been used in agriculture.
(Vu et al., 2021)	It aimed to review blockchain adoption in FSCs.
(J. Duan et al., 2020)	It aimed to investigate how BCT has been used in the FSC.

(H. Feng et al., 2020)	It aimed to review the benefits and barriers of development methods in agri-food traceability.
(Chen et al., 2020)	Its goal was to investigate whether the FSC would use blockchain technology.
(Mirabelli & Solina, 2020)	It aimed to investigate current research trends and possible future challenges of blockchain in agriculture.
(John G Keogh et al., 2020)	It aimed to review blockchain GS1 standards in the FSC.
(Rejeb et al., 2020)	To examine possible issues with blockchain in the food business.
(Kayikci et al., 2020)	To review BCT in the FSC
(Antonucci et al., 2019)	It aimed to review BCT applications in the food sector.

Jiang Duan et al. (2020) investigated blockchain's current research, benefits, and challenges in the FSC between 2008 and 2019. They performed content analysis and suggested four benefits and five barriers to blockchain adoption within an FSC. In a review of blockchain applications in agri-food from 2013 to 2018, Antonucci et al. (2019) indicated the need for more remarkable real-world case studies. Likewise, research from 2013 to 2019 investigated the future challenges of blockchain in agricultural supply chains (Mirabelli & Solina, 2020) and discussed potential future blockchain challenges (John G Keogh et al., 2020). W. Liu et al. (2021) combined information and communications technologies with blockchain technologies in agriculture using bibliometric and content analysis. Their findings provide a fundamental understanding of information, communication technologies, BCT in agriculture, possible challenges, and blockchain applications in agribusiness (Rocha et al., 2021). Kayikci et al. (2020) reviewed blockchain-based people, processes, and performance models to improve the food supply chain performance. In H. Feng et al.

(2020), blockchain was investigated to enhance agri-food traceability by reviewing the methods, benefits, and challenges.

Similarly, Chen et al. (2020); Zhao et al. (2019) used thematic analysis to examine the procedures, advantages, and barriers of implementing blockchain in the FSC and suggested how blockchain could enhance food supply chains. Vu et al. (2021) reviewed blockchain implementation in an FSC. They provided a conceptual framework for decision-makers to determine whether blockchain would fit their company well. Similarly, Rejeb et al. (2020) proposed a conceptual framework for blockchain technology in the food industry.

However, there is a scarcity of comprehensive literature reviews that can teach researchers and practitioners the state-of-the-art, as well as few studies on the deployment of BCT in the FSC. The factors, impacts, and challenges are the subjects of this scant body of knowledge. Only a few studies have examined other blockchain use cases. Figure 2.3 shows the overall outline of the article process from start to finish. This study conducted a systematic review of the literature to fill this research gap and answer the following research questions:

What is the current research on BCT adoption by FSC?

What are the BCT factors, impacts, and challenges in the FSC?

What are the research gaps and directions for future research?

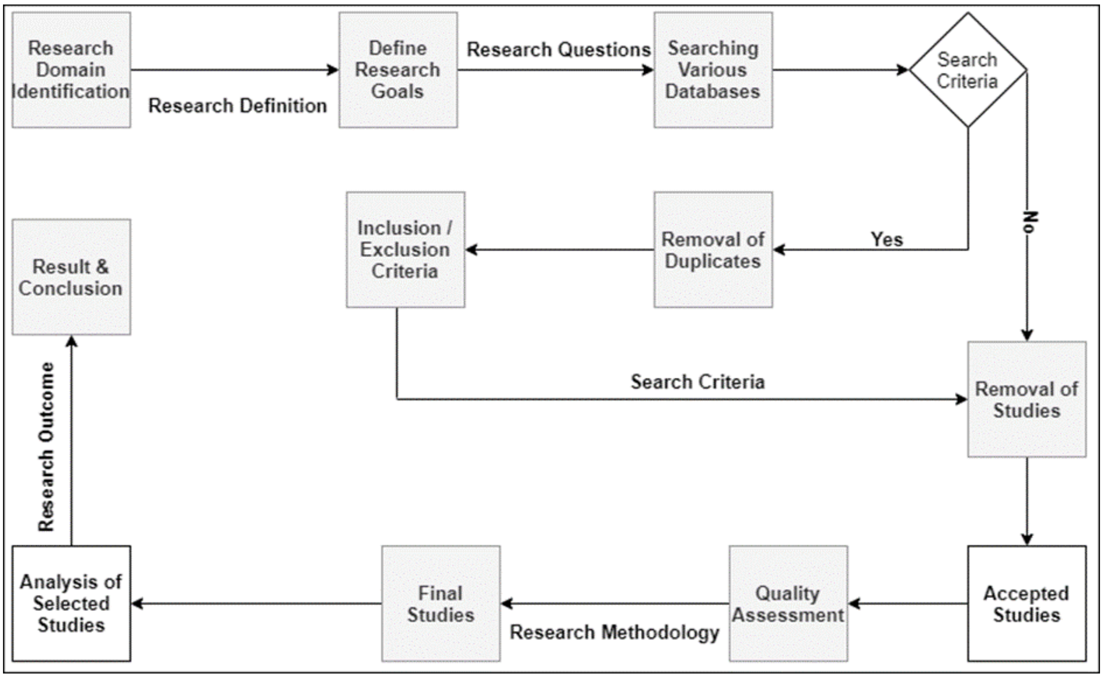

Figure 2.3: Outline of the article process, *Adapted from Baviskar et al. (2021)*

2.5.2 Method

To answer the research questions, an SLR was conducted using the standards of Kitchenham and Charters (2007) and Tranfield et al. (2003) in; conducting this research, in line with the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)," as it was used in Liberati et al. (2009).

The following sections summarize the results of a comprehensive literature review on BCT and FSC. It began by reading about how blockchain can enhance the food supply chain. The two prominent databases used in this systematic literature review were Scopus and Business Source Complete (EBSCO), replicating the methodological approach adopted in other research (Bhimani et al., 2019; Olanrewaju et al., 2020). These databases have an extensive journal index and are focused on business management. Because they reflect cutting-edge research outputs with significant effects, journal papers in these databases have received the highest priority and consideration. The search was conducted between 2016 and 2021.

A broad statement was initially used (blockchain and food supply chain) to identify keywords searched to investigate blockchain in the food supply chain. However, this has resulted in limited results. Hence, the search was expanded with different terms, which included "blockchain" "blockchains", "block chain", "block chains", "blockchain technology", "distributed ledger", "distributed ledger technology", "shared ledger", "decentralized ledger", "smart contracts", "smart contract", "hyper ledger", "Hyperledger", and "Ethereum." Alternate terms for food and agriculture were also used, including "food", "food supply", "food supply chain", "food security", "food fraud", "food quality", "food safety", "food scandal", "food trust", "food waste", "food traceability", "food transparency", "food supply chain management", "agriculture", "agri-food", and "agrifood". Boolean operators "AND" and "OR" were used for search strings. The final search strings were as follows.

> **Keyword** ("blockchain" OR "blockchains" OR "block chain" OR "block chains" OR "blockchain technology" OR "distributed ledger" OR "distributed ledger technology" OR "decentralized ledger" OR "shared ledger" OR "smart contracts" OR "smart contract" OR "hyper ledger" OR "hyperledger" OR "Ethereum") AND ("food" OR "food supply" OR "food industry" OR "food supply chain" OR "food security" OR "food fraud" OR "food quality" OR "food safety" OR "food scandal" OR "food trust" OR "food waste" OR "food traceability" OR "food transparency" OR "food supply chain management" OR "agriculture" OR "agricultural" OR "agri-food" OR "agrifood" OR "agri*" OR "agro*")

2.5.3 Inclusion and Exclusion Criteria

Table 2.4 presents the inclusion and exclusion criteria, and Table 2.5 is the quality assessment for this study, replicating the approach taken by Taylor et al. (2020).

Table 2.4: Criteria for inclusion and exclusion

Inclusion	**Exclusion**
The paper must present an empirical study. Case studies papers presented blockchain and food or agricultural supply chains.	Papers that were focused on building blockchain technology were excluded.
The paper must be a peer-reviewed article published in a journal.	Conference papers, book chapters, white papers, technical reports, news/magazines, master's and PhD dissertations.

2.5.4 Quality Assessment

A quality assessment checklist was used to check the relevance of the articles in this study based on this approach (Hosseini et al., 2017; Taylor et al., 2020). The checklist consisted of five stages, as shown in Table 2.5.

Table 2.5: Quality assessment criteria

#	**Statements**
Stage 1	Blockchain – The article must be focused on blockchain technology within the food supply chain or agriculture.
Stage 2	Context – The article must have sufficient context for the research to help interpret the results.
Stage 3	BCT and FSC – To answer RQ1, the article must detail blockchain adoption within the FSC or agriculture.
Stage 4	The article must explain blockchain's factors, impacts, and challenges in the food supply chain or agriculture to answer RQ2.
Stage 5	Data – A detail of how the data was acquired must be presented in the research.

2.5.5 Search Results

The initial search was limited to titles and abstracts. Based on the search criteria, 322 articles were identified from the two databases. A total of 168 duplicate papers were identified and removed, leaving a total of 154. Titles and abstracts were reviewed, and potential articles focusing on blockchain and food or agricultural supply chains were identified. This resulted in 85 papers. Full articles were then read to determine which were relevant and where full texts were unavailable. This resulted in 43 papers. Nine (9) papers were added based on snowballing techniques (Kitchenham & Charters, 2007), resulting in a final sample of 52 papers for further analysis. The flowchart of PRISMA (Kitchenham & Charters, 2007) (Kitchenham & Charters, 2007) is shown in Figure 2.4.

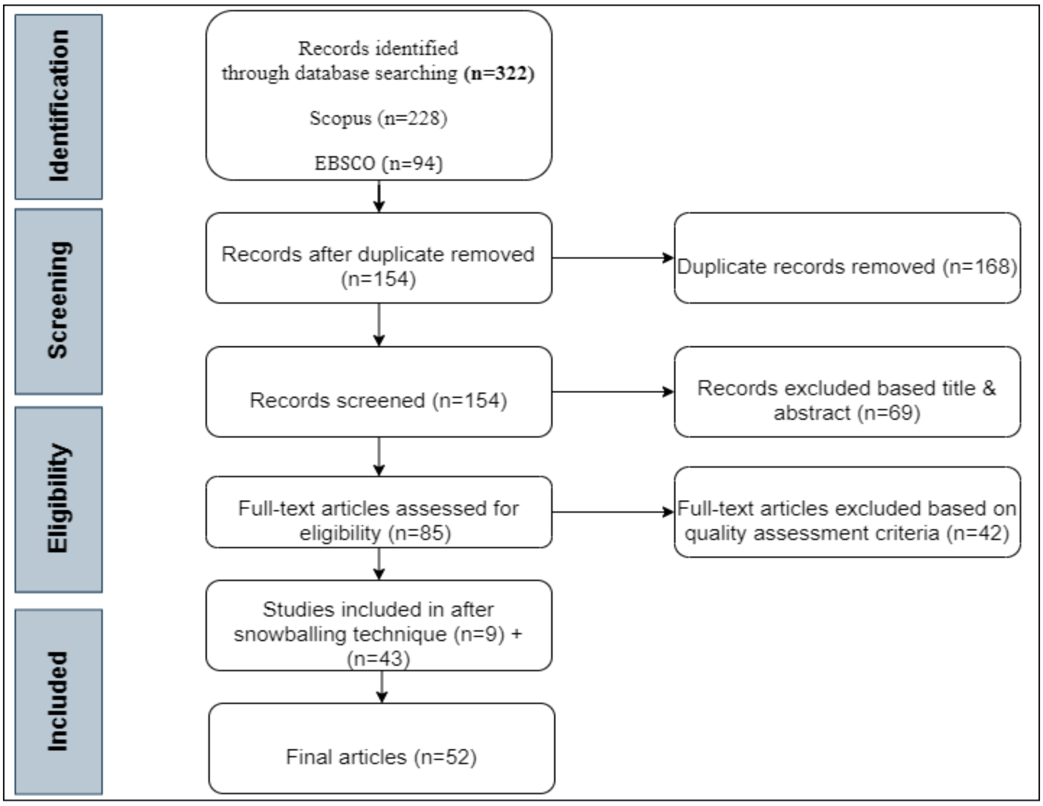

Figure 2.4: PRISMA flowchart for the selected articles

2.6 Analysis and Results

The distribution of selected studies related to BCT in the FSC in terms of publication year is illustrated in Figure 2.5. The findings indicate an increase in studies in this space in recent years, as seen from 2016 to 2021, even though the BCT first appeared in 2008 (Nakamoto & Bitcoin, 2008). However, most articles were published in the financial sector. The first study was published in 2016. It was also found that the highest number of articles was published in 2020, with 19 articles, whereas the lowest number was published in 2016, with only one article. Figure 2.5 further indicates that most studies were conducted from 2018 to 2021, indicating that publications will continue to grow in this area. The following section analyses the articles identified in the literature after confirming 52 articles as the final sample for this study.

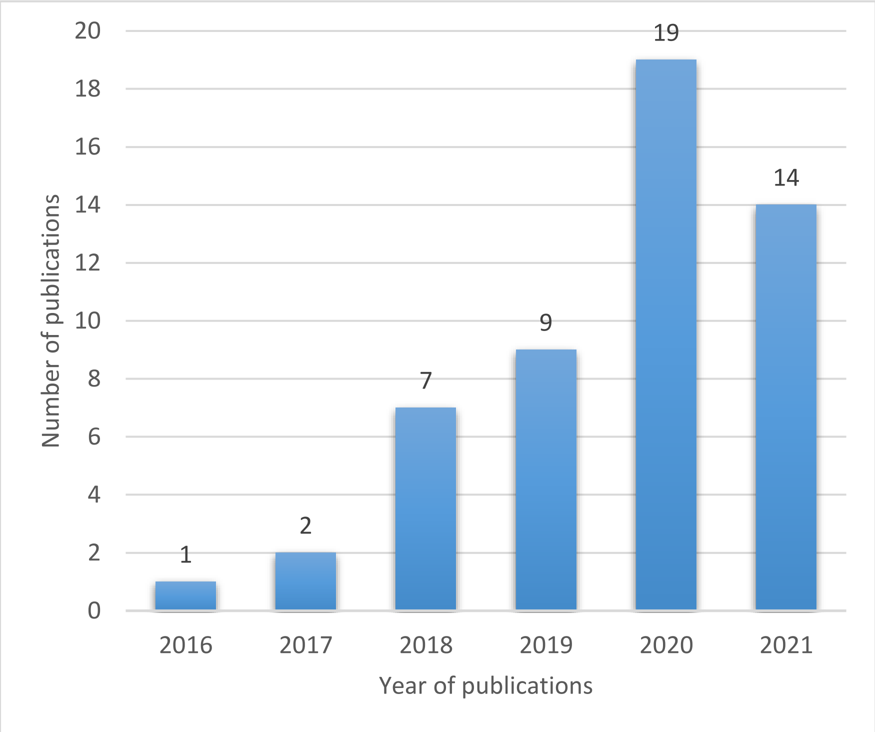

Figure 2.5: Publications by year

2.6.1 State of BCT in the FSC

This section analyses the articles identified in the literature. It starts with a summary of the primary studies, as shown in Table 2.6, according to the research focus, methods, and product. However, not all studies mention specific products and methods. This analysis helps develop an integrative framework for blockchain adoption within an FSC.

Table 2.6: Summary of previous studies of BCT in the FSC

Source	**Summary**	**Focus**	**Methodology**	**Products**
(Krzyzanowski Guerra & Boys, 2021)	The paper demonstrates blockchain adoption and its implications in the agri-food sector.	Adoption	Not specified	Not specified
(Vivaldini, 2021)	An operation of blockchain for food service.	Benefits	Qualitative – Case study	Food (General)
(Saurabh & Dey, 2021)	The study discusses adoption factors for blockchain in the FSC	Adoption Benefits Architecture Sustainable	Quantitative - Survey	Grape wine
(Tayal et al., 2021)	This paper introduced a novel 3-stage methodology to integrate blockchain into the food supply chain.	Challenges Benefits	Proof of concept	Not specified
(Aldrighetti et al., 2021)	The authors examined how blockchain could change the agri-food sector.	Benefits	Qualitative - Interview	Not specified
(Shew et al., 2021)	The use of blockchain in food traceability for beef in the USA is investigated in this study.	Benefits Adoption	Quantitative - Survey	Beef
(Lin et al., 2021)	It examines consumers' intentions toward blockchain food traceability.	Adoption	Quantitative	Organic food
(Stranieri et al., 2021)	It explores the impact of blockchain on the perforation of the FSC	Benefits Performance	Qualitative - Interview	Not specified

(Alba J. Collart & Canales, 2021)	How blockchain adoption could impact the fresh produce supply chain in the USA.	Challenges Adoption	Conceptual	Fresh fruit and vegetables
(Balamurugan et al., 2021)	This research suggested a blockchain employing IoT to track and prevent the introduction of illegal commodities along the supply chain.	Benefits	Proof of concept	Food (General)
(P. Katsikouli et al., 2021)	It explores the benefits and challenges of blockchain for managing FSC.	Benefits Challenges	Qualitative – Case study	Food (General)
(Hong et al., 2021)	Public cognition of the application of blockchain in food safety management.	Adoption	Quantitative	Food (General)
(Cao et al., 2021)	Based on a supply chain implementation using blockchain technology, this study sought to increase consumer confidence in the Australia–China cross-border beef supply chain.	Benefits Adoption	Qualitative – Focus group	Beef
(Sander et al., 2018)	The adoption of blockchain technology for transparent and traceable beef supply chains.	Adoption	Quantitative - Survey	Meat
(Garaus & Treiblmaier, 2021)	The influence of blockchain-based food traceability in retail.	Benefits	Quantitative - Survey	Food (General)
(Iqbal & Butt, 2020)	For more openness, it suggested supply chain	Benefits	Proof of concept	Crops (General)

	management based on blockchain.			
(Hew et al., 2020)	This study investigates blockchain-based Halal traceability.	Adoption	Quantitative - Survey	Halal food
(Köhler & Pizzol, 2020)	Assessment of blockchain-based technologies in FSC	Benefits	Qualitative	Food (General)
(Ronaghi, 2020)	They have developed a model for assessing the adoption of blockchain in the agri-food supply chain, which could help guild organizations and individuals to plan their blockchain adoption and achieve a higher level.	Adoption Benefits	Quantitative	Not specified
(Bumblauskas et al., 2020a)	They have developed an integrated system for tracking eggs from farm to fork using blockchain and IoT to achieve food traceability.	Benefits	Case study Proof of concept	Eggs
(A. Tan & Ngan, 2020)	This paper developed a food safety and traceability framework in the Vietnamese dairy industry.	Benefits	Qualitative	Dairy (General)
(L. Hang et al., 2020)	The paper designed a blockchain fish system to ensure data integrity in agriculture.	Benefits	Proof of concept	Fish
(Iftekhar et al., 2020)	It explores the application of blockchain and IoT to ensure	Benefits Challenges	Proof of concept	Food (General)

	tamper-proof data availability for food Safety.			
(A. Tan et al., 2020)	It proposed a traceability framework using blockchain for the halal food supply chain.	Benefits Challenges Adoption	Qualitative - Case study	Halal Food (General)
(F. Casino et al., 2020)	Demonstrate blockchain for dairy products.	Benefits	Proof of concept	Dairy (General)
(Rogerson & Parry, 2020)	Demonstrates how blockchain could enhance visibility and trust in FSC.	Benefits Challenges	Qualitative - Case study	Food (General)
(Vinay Surendra Yadav et al., 2020)	It explores blockchain adoption barriers in the agricultural supply chain	Benefits Challenges Adoption	Quantitative	Food (General)
(Patelli & Mandrioli, 2020)	The study examined blockchain's effects	Challenges Benefits	Not specified	Food (General)
(K. Behnke & M. F. W. H. A. Janssen, 2020)	It identifies boundary conditions for sharing information to ensure traceability.	Challenges Benefits	Qualitative - Case study	Food (General)
(Prashar et al., 2020)	A blockchain-based solution for agricultural product visibility and traceability was suggested in this study.	Benefits	Proof of concept	Food (General)
(Rijanto, 2020)	This paper explores patterns of business financing and the adoption of BCT in the agri-industry	Adoption Benefits	Qualitative - Case study	Not specified
(Grecuccio et al., 2020)	Integrated blockchain and IoT device food chain traceability	Benefits challenges	Proof of concept	Fish

(Longo et al., 2020)	This study designed an Ethereum blockchain for traceability and monitoring of transactions of fresh milk from dairy farms to end consumers.	Benefits	Proof of concept	Fresh milk
(S. S. Kamble et al., 2020)	This study identifies thirteen enablers that could influence the adoption of BCT in the agri-supply chain.	Adoption Benefits	Quantitative - Survey	Not specified
(Chan et al., 2019)	The supply chain for the agri-food industry is developed in this article as a framework for traceability and transparency.	Benefits	Conceptual	Peppers
(George et al., 2019)	It designed a reliable prototype for food traceability using blockchain.	Benefits	Proof of concept	Food (General)
(Jarka, 2019)	It explores the importance of blockchain in FSC.	Benefits	Conceptual	Not specified
(Sengupta et al., 2019)	This study investigates how blockchain technology is used in Canadian agriculture and food.	Adoption	Not specified	Not specified
(Fran Casino, Kanakaris, et al., 2019)	It created automated food traceability based on smart contracts and blockchain technologies.	Benefits	Proof of concept	Food (General)
(A. Kamilaris et al., 2019)	This article examines the impact of blockchain technology on agriculture and the FSC.	Challenges	Not specified	Not specified

(Maghfirah, 2019)	Indonesian food and agriculture supply chains will use blockchain technology.	Benefits	Qualitative - Case study	Rice
(Krzyzanowski, 2019)	Putting Food on the Blockchain	Not specified	Not specified	Not specified
(Pal & Kant, 2019)	Using blockchain for provenance and traceability for food logistics	Not specified	Not specified	Not specified
(Nir Kshetri, 2018)	Explored the benefits of blockchain in supply chain management by conducting multiple case studies in achieving supply chain objectives. Blockchain could reduce cost and risk and increase the supply chain's flexibility, quality, speed, and sustainability.	Benefits	Qualitative - Case study	Not specified
(Lucena et al., 2018)	It analyzed the implementation of blockchain for grains for quality assurance in Brazil.	Benefits	Qualitative- Case study	Grains
(Dianhui Mao et al., 2018)	To enhance management oversight in FSC, this study suggested a blockchain-based credit evaluation method.	Benefits	Proof of concept	Not specified
(Kamath, 2018)	IBM partners with Walmart's Pork and Mango Pilots	Challenges Benefits	Qualitative - Case study	Pork and Mango
(Galvez et al., 2018)	This study investigated the future challenges of using blockchain in FSC	Challenges	Conceptual	Food (General)

(Kniepert & Fintineru, 2018)	In order to accommodate this new technology while maintaining the goal of an overall economic optimum, the study then analyses the function of institutions in the food system as it has been structured.	Not specified	Not specified	Not specified
(Kumar & Iyengar, 2017)	The authors proposed a blockchain framework for the rice supply chain, ensuring safety throughout the supply chain.	Benefits	Conceptual	Rice
(T. Feng, 2017)	This study proposes a food traceability system enabling real-time safety, dependability, and security of food goods among supply chain participants. It is built on HACCP blockchain technology and IoT.	Benefits Challenges	Proof of concept	Food (General)
(T. Feng, 2016)	For the agri-food supply chain, this study presented a traceability system based on RFID and blockchain.	Benefits	Proof of concept	Fresh fruit and vegetables

2.6.2 Research Methods Used in the Literature

The study also examined the research methods used in the selected articles, summarized in Table 2.7. The findings showed that qualitative (N = 15) and proof-of-concept (N = 15) were the most employed methods, followed by quantitative (N = 9). There were a small number of conceptual studies (N = 5), and finally, (N = 8) did not specify any methods in the article.

Table 2.7: Methods used in the previous studies

References	**Frequency**
Qualitative (Nir Kshetri, 2018), (Lucena et al., 2018), (Aldrighetti et al., 2021), (A. Tan & Ngan, 2020), (A. Tan et al., 2020), (Rogerson & Parry, 2020), (Maghfirah, 2019), (Vivaldini, 2021), (K. Behnke & M. F. W. H. A. Janssen, 2020), (Rijanto, 2020), (Stranieri et al., 2021), (Kamath, 2018), (P. Katsikouli et al., 2021), (Cao et al., 2021), (Köhler & Pizzol, 2020)	15
Proof of Concept (Bumblauskas et al., 2020a), (L. Hang et al., 2020), (T. Feng, 2017), (T. Feng, 2016), (Iftekhar et al., 2020), (F. Casino et al., 2020), (Tayal et al., 2021), (Prashar et al., 2020), (Grecuccio et al., 2020), (Dianhui Mao et al., 2018), (Longo et al., 2020), (George et al., 2019), (Balamurugan et al., 2021), (Fran Casino, Kanakaris, et al., 2019), (Iqbal & Butt, 2020)	15
Quantitative (Ronaghi, 2020), (Vinay Surendra Yadav et al., 2020), (Shew et al., 2021), (Lin et al., 2021), (S. S. Kamble et al., 2020), (Hong et al., 2021), (Sander et al., 2018), (Hew et al., 2020), (Garaus & Treiblmaier, 2021)	9
Conceptual (Kumar & Iyengar, 2017); (Chan et al., 2019); (Jarka, 2019); (Galvez et al., 2018); (Alba J. Collart & Canales, 2021)	5
Not Specified	8

(Krzyzanowski Guerra & Boys, 2021), (Patelli & Mandrioli, 2020), (A. Kamilaris et al., 2019), (Kniepert & Fintineru, 2018), (Krzyzanowski, 2019), (Pal & Kant, 2019)	
Total	52

2.6.3 Theories and Frameworks Used in the Literature

A review of most theories and frameworks is shown in Table 2.8.

Table 2.8: Theories used in the reviewed articles

Theory	**References**
The Unified Theory of Acceptance and Use of Technology (UTAUT)	Queiroz and Wamba (2019)
Technology, Organization, and Environment Framework (TOE)	Wong et al. (2020); Rijanto (2020)
Diffusion of Innovations (DOI)	Wamba and Queiroz (2020); Hew et al. (2020)
Resource-Based View (RBV)	Wamba and Queiroz (2020); Martinez et al. (2019)
Dynamic Capability (DC)	Wamba and Queiroz (2020);
Technology Adoption Model (TAM)	Wamba and Queiroz (2020);
Institutional Theory (IT)	Wamba and Queiroz (2020); Hew et al. (2020)
WARA Method	Ronaghi (2020)
ISM-DEMATEL-Fuzzy MICMAC	Vinay Surendra Yadav et al. (2020); S. S. Kamble et al. (2020)
Information Success Model (ISS)	Lin et al. (2021)
Theory of Planned Behaviour (TPB)	Lin et al. (2021); S. Kamble et al. (2019)
Information Processing Theory (IPT)	Martinez et al. (2019)

Sensemaking Theory (ST)	Yingli Wang, Singgih, et al. (2019)
Technology Acceptance Model (TAM)	S. Kamble et al. (2019)
Technology Readiness Index (TRI)	S. Kamble et al. (2019)
Knowledge-Based View (KBV)	Caldarelli et al. (2020)

Frameworks to explain the adoption of blockchain in the supply chain have been proposed in earlier studies. For instance, Queiroz and Wamba (2019) employed the unified theory of acceptance and use of technology (UTAUT) and theory of acceptance to comprehend blockchain adoption. They built a blueprint for deploying blockchain in the U.S.–India supply chain. This study demonstrates the enabling circumstances, social influence, and performance expectations and how these elements may affect blockchain adoption. Based on the TOE Framework, Wong et al. (2020) conducted a survey to assess the adoption of blockchain by small- to medium-sized businesses (SMEs) in Malaysia. Their findings demonstrate how the behavioural intention to adopt blockchain is significantly influenced by cost, relative advantage, complexity, and competitive pressure.

Meanwhile, Wamba and Queiroz (2020) incorporated numerous theories, such as the diffusion of innovation theory (DOI), resource-based view, dynamic capability, technological adoption model, and institutional approach, to present a multi-stage model for blockchain diffusion. Martinez et al. (2019) applied a resource-based perspective (RBV) and information processing theory (IPT). A research model based on the fusion of three theories, the theory of planned behaviour (TPB), technology readiness index (TRI), and technology acceptance model (TAM), was proposed by empirical research by S. Kamble et al. (2019). They discovered that subjective norms (SN) and perceived ease of use (PEOU) influenced perceived usefulness (PU).

In a case study, Nir Kshetri (2018) identified critical fundamental factors for adoption, such as speed, risk mitigation, flexibility, cost, quality, and sustainability, and created a framework for supply chain performance dimensions. In contrast, Morkunas et al. (2019) developed a model based on the Osterwalder and Pigneur business framework. The knowledge-based approach and Gold et al.'s 2015 model were used, similar to Caldarelli et al. (2020), to investigate a single case study of an Italian agri-food company that launched a blockchain-based traceability project.

2.6.4 Initial Framework

Based on the analysis results, an initial framework was developed that brings together the factors, impacts, and challenges of BCT adoption in the FSC, as shown in Figure 2.6. The following section discusses the core elements of the framework.

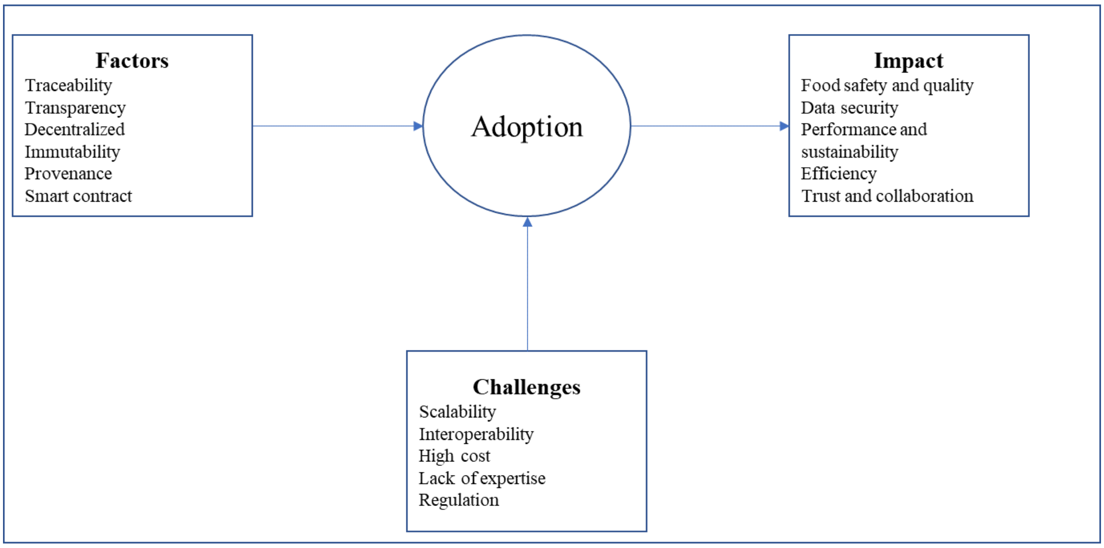

Figure 2.6: Initial Framework

2.6.5 Factors for BCT Adoption

The literature identifies the factors influencing BCT adoption in FSC. These factors are discussed in detail below:

2.6.5.1 Traceability

Food traceability is a logistics management tool (Rejeb et al., 2020). Food traceability involves tracking and tracing food processes throughout the FSC (Chen et al., 2020; Vu et al., 2021). Information can be tracked and organized using IoT devices such as QR codes, wireless sensor networks (WSN), and radio frequency identification (RFID). Blockchain can improve food supply chain traceability (Aldrighetti et al., 2021; J. Xu et al., 2020). This shows that blockchain can also enhance the security and quality of agri-food. Researchers have proposed blockchain-based traceability systems using other emerging technologies. T. Feng (2016) combined BCT and RFID to propose an agri-food value chain traceability system to guarantee food safety and quality throughout production. T. Feng (2017) later built a supply chain traceability system for real-time food tracing based on HACCP, providing supply chain members with real-time safety, reliability, and security. Their proposed system showed that RFID could be utilized for sharing and acquiring data in the agri-food value chain.

Similarly, Balamurugan et al. (2021) proposed traceability techniques to improve food safety using the blockchain and IoT. The proposed system avoids entering illegal food products into the supply chain. Tan et al. (2020) proposed a traceability framework for halal food supply chains. Walmart and IBM conducted a pilot study on Blockchain traceability systems in 2016. These companies provide a blockchain traceability system for seven-day tracking of the origins of mangoes (Kamath, 2018). Walmart intends to invest $ 25 million in this technology over five years, beginning in 2017 (Kamath, 2018).

2.6.5.2 Transparency

Transparency is a potential enabler of blockchains in FSC. Food quality can be affected by a lack of transparency, and using blockchain in the FSC improves food transparency

(Panagiota Katsikouli et al., 2020; N. Kshetri, 2019; Vu et al., 2021). Despite being in its infancy, Tian (2017) refers to BCT as a ground-breaking innovation that can enhance supply chains by creating openness, transparency, and dependability.

Decentralization, which enables authorized users to conduct transactions and directly access history without the involvement of a centralized authority, is thus a vital characteristic of the blockchain. Every duly registered user can review a transaction and obtain a copy of its history. This feature can reduce information imbalance between stakeholders, remove significant authority over information flow, and increase supply chain transparency (Baralla et al., 2018; Andreas Kamilaris et al., 2019). The records are also made permanent once the data are uploaded to the blockchain. Running the blockchain mining process enables immutability. The transaction details are saved whenever most miners or users decide to validate a particular transaction, and these are never modified without alerting all users. As a result, the history of a product's movements in a supply chain can be recovered and examined whenever necessary without any concerns that it has been altered (Menon & Jain, 2021).

Additionally, product information includes its movement and specific certifications that may be changed digitally, making it accessible at any moment to individuals with appropriate permissions. Verification is required for food goods to demonstrate a company's eligibility for production or sale. The manual paper inspection process can be sped up by digitizing records and documents and removing the possibility of data tampering and mistakes. Walmart and Tsinghua University followed pork production in China, from farm to table, in 2016 (Yiannas, 2018). The results demonstrated the blockchain's capacity to increase information trustworthiness, decrease errors, and improve information authenticity.

2.6.5.3 Decentralized

Decentralization is the transfer of control and authority from a centralized entity to a distributed network (which can be an individual, organization, or group of similar entities). Decentralized networks are designed to prevent users from interfering with one another in ways that would harm the network's functionality and reduce the amount of trust that participants must invest in one another. Blockchain communication metadata is dispersed throughout the ledger and cannot be gathered at a single location. Accordingly, the blockchain database is distributed. The data are simultaneously stored on numerous computers, referred to as "nodes," rather than on a single server (MacDonald et al., 2016; Wright & De Filippi, 2015). Because the database is distributed, blockchain users can trust one another more. Decentralization is not a novel concept. The three basic network structures–centralized, decentralized, and distributed–are typically considered when creating a technology arrangement. Although decentralized networks are a common feature of blockchain technology, blockchain applications cannot be categorized as centralized. All parts of a blockchain program can apply decentralization to varying degrees. Decentralization often has some disadvantages, such as lower exchange. Such setoffs are worthwhile, however, given the improved security and services they provide.

2.6.5.4 Immutability

Immutability implies that an object does not change over time. Immutability makes it possible to create an audit trial of all actions performed on the registry. This makes it possible to track any record at a given time. Blockchain provides an audit trail that cannot be changed (Weber et al., 2016), and because it is decentralized, it is more difficult for hackers to change or fake data in the blockchain network (Nir Kshetri, 2017).

2.6.5.5 Provenance

Kim and Laskowski (2018) state that BCT makes it easier to find where things come from in the supply chain. Several industries obtain the value of their goods based on the location from which they are sourced (Yingli Wang et al., 2018).

2.6.5.6 Smart Contract

Stakeholders must agree to conduct digital supply chain transactions and document changes. Consequently, a smart contract is helpful because it contains agreed-upon terms for stakeholders (X. Xu et al., 2016). Electronic contracts significantly impact business processes, particularly in the context of BCT (Scott et al., 2017). A smart contract digitally transfers an asset or currency to a BCT application.

2.6.6 Impact of BCT Adoption

2.6.6.1 Food Safety and Quality

Blockchain can help solve some of the biggest problems in food supply chains, such as food waste, recalls, inefficiency, traceability, and fraud. The transparency and traceability of blockchain make it possible to determine the origin of food and improve its safety and quality. For example, Walmart tracked the packages of sliced mangoes using a blockchain. The tracking was conducted in Mexico. Nestlé tracks milk from farms and production facilities to the factories. According to Stranieri et al. (2021), more knowledge of a product and process results in a better understanding of quality, which raises the perception of food quality.

2.6.6.2 Data Security

Blockchain can be used to accelerate transactions in food supply chains. Retaining every digital transaction record can eliminate errors caused by traditional paper-based recordkeeping. The distributed database, consensus mechanism, and cryptographic parts of the blockchain make it impossible for changes to be made to data.

2.6.6.3 Performance and Sustainability

The performance of the food supply chain can be enhanced by better matching the supply and demand. Blockchain delivers real-time data regarding the ongoing activities of supply chains, such as data on stocks, demand, supplies, dwell time, and production dates. This helps food supply chains keep track of inventory. Blockchain makes food supply chains more sustainable for the environment, the economy, and society (K. Li et al., 2021).

2.6.6.4 Efficiency

The BCT can enhance the efficiency of FSC during food operations. Blockchain provides the real-time availability of food products (B. Tan et al., 2018). For instance, Walmart collected real-time information to monitor food procedures from cultivation, production, processing, and sales (Lucas, 2018). This means that one can always see the origin and quality of the food (Schwarzbaum, 2018). For example, if food is mistreated or expired, Walmart identifies it before it reaches customers (Korpela et al., 2017; Mohanta et al., 2018; Risius & Spohrer, 2017; B. Tan et al., 2018). Walmart's Global Responsibility Report Walmart (2018) states that a company wants to reduce or eliminate food waste. It plans to achieve zero food waste in Japan, the US, the UK, and Canada by 2025 (Mondal et al., 2019).

2.6.6.5 Trust and Collaboration

The introduction of the BCT is a superlative model for Walmart to achieve the supportive effect of calculated alliances by developing collaboration in the food industry (B. Tan et al., 2018). Supply chain partners can benefit from blockchain by increasing trust and cooperation (Cartier et al., 2018; Liang et al., 2018; Ølnes et al., 2017).

2.6.7 Challenges to BCT Adoption

Although blockchain benefits FSCs, some problems still need to be addressed, such as scalability, complexity, lack of expertise, high costs, and regulations (Astill et al., 2019; K. Behnke & M. F. W. H. A. Janssen, 2020).

2.6.7.1 Scalability

BCT has gained popularity in recent years, and because of the rapid uptake of technology, the transaction volume of a network is also increasing. The block size is restricted due to the increasing importance of the transactions. In addition, as the number of users and transactions increases, the number of nodes required to process them increases. Minimal scalability can simultaneously lead to many transactions, thereby slowing the network down (Jiang Duan et al., 2020; Lei Hang et al., 2020). The energy consumption of blockchain cannot be considered a disadvantage but is an essential attribute in dealing with public blockchain security and overspending issues.

2.6.7.2 Interoperability

Interoperability means that different blockchains can share and communicate with one another. Several blockchain projects are currently in progress. These projects were written in different programming languages and on different run-on platforms; thus, various blockchain networks could not connect because they could not communicate with each other. This results in network isolation and information asymmetry. Therefore, as suggested by other researchers (Y. Liu et al., 2020; Nurgazina et al., 2021), the communication protocol should be able to work with other systems. Privacy is an important and sensitive issue in blockchain applications. All data related to transactions in the public blockchain are publicly accessible. However, transparency in blockchain should be harmonized with sensitive and personal data protection. Consortium and private type blockchains solve this problem, but the users' access is limited, thereby decreasing the level of decentralization. Thus, for specific use cases, an optimal trade-off is applicable. The consensus protocol determines blockchain security.

2.6.7.3 High Costs

The adoption of BCT may be hampered by the expenses associated with its acquisition, customization, and learning curve, particularly for small- and medium-sized firms in the food supply chain (K. Li et al., 2021; Yingli Wang, Singgih, et al., 2019). Building infrastructure and management capabilities for blockchain requires significant investments (K. Li et al., 2021). Businesses worry that the advantages of investing in blockchain outweigh the costs and that technology may not be able to offset these costs. Large companies such as Walmart and Carrefour were early adopters of blockchain because they had the financial wherewithal to engage in price initiatives with the hope of long-term gains.

2.6.7.4 Lack of Expertise

BCT is still in its infancy, and most stakeholders are unaware of its economic consequences (Ge et al., 2017). Many organizations are concerned about their lack of understanding and experience with BCT. Blockchain implementation is a complex process that requires considerable technical expertise and infrastructure for businesses (Y. Chang et al., 2020; Helo & Hao, 2019; Wong et al., 2020). The lack of standardization among data models, privacy mechanisms, and different consensus protocols of various platforms has led to an interoperability problem, namely, the limitation of sharing information across other blockchains. Notary schemes, sidechains, standardization, and hash locking are potential solutions.

2.6.7.5 Regulations

Another crucial aspect of deploying blockchain is the establishment of policies and regulatory environments (Pearson et al., 2019; Zhao et al., 2019). Blockchain applications are a topic on which policy and technical experts disagree, creating regulatory hurdles that have prevented the widespread adoption of BCT. Additionally, there is no precise guidelines and requirements for applying BCT to FSC. Developing laws and standards to deploy BCTs in FSCs effectively is vital. It is necessary to thoroughly investigate how the BCT affects governance (Krzyzanowski Guerra & Boys, 2021).

Fulmer (2019) stated that numerous problems are created for regulators due to the nature of the blockchain. There should be regulations for finance-oriented blockchain-based solutions, such as cryptocurrency and other financial activities. However, the decentralized blockchain paradigm is not in line with the centralized regulation scheme, especially for public network problems that are bound to occur in territorial regulations (Cermeno, 2016). Cong and He (2019) found that smart contracts could demand different treatment than traditional contracts. Hence, close collaboration between the blockchain industry and its regulators is required to ensure compliance with policies, regulations, and rules. Furthermore, Dewey (2019) reported that countries such as Japan, Switzerland, Malta, Estonia, Liechtenstein, and Singapore are already preparing for blockchain-friendly laws. However, international standards must be established because there is a lack of central administration for each distributed ledger.

2.7 Theoretical Foundation

Ajzen and Fishbein (1975) presented the Theory of Reasoned Action (TRA) to understand behavioural intent. Attitudes in the direction of behaviour represent individual factors, and subjective norms characterize social factors. The TRA is a widely studied model in social psychology that deals with the elements of intentional behaviour (Ajzen & Fishbein, 2004). The theory includes attitude, social impact, and intentions to predict behaviour. The TRA assumes that the behavioural intent of individual actions is mutually resolved by somebody's attitude toward executing the action and subjective norms.

The founding idea of planned behaviour (TBA) is that some predeterminations in the direction of behaviour lead to planned behaviour (Ajzen, 1991). The intent is understood as apprehending the motivating elements that stimulate behaviour by showing how strongly willing a person is and how much effort they intend to carry out the behaviour. The more robust the intent to act, the more likely a person will execute that action (Godin & Kok, 1996). This relationship between intention and succeeding behaviour has been established by a universal meta-analysis and a new entrepreneurship explicit meta-analysis (Conner, 2020).

TAM is introduced to predict technology usage and acceptance (Davis, 1989). The TAM states that perceived usefulness and perceived ease of use are two primary factors that explain the adoption intention of individual users (Dasgupta et al., 2002; Pierce, 2014). Perceived usefulness is the degree to which an individual believes that using a technology optimizes its performance, while perceived ease of use is the level at which an individual believes that using a system will be free of effort. Many scholars have repeatedly validated TAM since it was first published, and it has been widely adopted in studies on technology adoption in the past few decades. However, TAM is a relatively simple model that can be extended and modified in different ways; therefore, the literature has reported many other extensions integrating this theory.

The UTAUT has been used continuously in technology management studies (A. Chang, 2012; Venkatesh et al., 2011). Generally, UTAUT focuses on a cause-and-effect relationship between individual attitudes towards using a system, a personal tendency towards using technology, the identification of the performance expectancy of a technology, and the actual use of a system. Venkatesh et al. (2003) mentioned that the facilitating conditions in this model are the primary determinants in the use of technology and strategy.

TOE is considered an informing and relevant theory in BCT as it focuses on a firm's technology, where environmental, organizational, and technological factors influence adoption (L. G. Tornatzky et al., 1990). However, a single theory might not adequately explain a blockchain's complexity and interdependent technologies. The TOE framework can be extended by considering the impact of actors other than the focal organizations as parts of the "environmental context" in an enterprise ecosystem of the blockchain (Chittipaka et al., 2022; Malik et al., 2021). Depending on the actor's degree of influence and opinion on the focal organization, each actor might positively or negatively affect an organization’s BCT adoption.

RBV theory, as rooted in the literature on management strategy, predicts, describes, and explains how a firm achieves sustainable competitive advantage through controlling and acquiring its "unique" capabilities and resources. These sets of unique abilities and resources that lead to a firm's competitive advantage are rare, valuable, difficult to imitate, heterogeneously distributed among firms, and non-substitutable by other resources within an industry (Lockett et al., 2009). Lockett et al. (2009) added that a firm's resources are assets acquired by a firm to enable the production and delivery of goods and services, whether intangible (such as process knowledge and information) or tangible (such as information technology infrastructure). Table 2.9 describes the advantages and disadvantages of the theories of technology adoption.

Table 2.9: Advantages and disadvantages of the theories of technology adoption

Theories	**Advantages**	**Disadvantages**
Theory of Reasoned Action	It explains why certain background circumstances are connected (or not connected) to a particular behaviour.	Risk of significant confusion between norms and attitudes
Planned Behaviour	Making predictions using the model is beneficial.	Additional behavioural elements, such as emotions, are not considered by the model.
Technology Acceptance Model	TAM is simple to understand while also displaying a high level of predictiveness in numerous situations	TAM supplies very general information about ease of usefulness
The Unified Theory of Acceptance and Use of Technology (UTAUT)	Combining eight different models into one to provide the most comprehensive acceptance model.	More external elements in many technology areas need to be considered by this model.
Technology Organization Environment	The TOE framework's adaptability to many contexts	It could be extremely vague and broad, making it challenging to apply in certain situations.

Resource-Based View	It gives the firm's strategic direction.	It can be challenging to choose the correct analytical level.

2.7.1 Justification for Using Two Frameworks

Therefore, this study combines the TOE and resource-based views to investigate blockchain adoption in food supply chains. As TOE is a theory that examines the factors that drive adoption, it provides a framework for examining the factors that may influence blockchain adoption within food supply chains. However, this study also explored the impact of blockchain on food supply chains. Thus, this study must combine the TOE and resource-based views as underpinning theories. Mayer and Sparrowe (2013) gave four unique motivations for utilizing two different speculations for making sense of a solitary peculiarity according to an alternate point of view, homogenizing two assorted surges of examination, tending to relate peculiarities in light of a connection arrangement of anticipating factors and managing to various exceptions yet producing new experiences when utilized together. Therefore, this study proposes that using TOE alongside the resource-based view will enable further understanding of the adoption of BCT within the FSC. The initial framework (see Section 2.6.4) describes how a framework's factors, impacts, and challenges are related. This study proposes TOE alongside the resource-based view will enable further understanding of the adoption of BCT within the FSC (see Section 6.2).

2.8 Review Summary

This study summarizes the present knowledge of blockchain's factors, impacts, and challenges in FSC. The SLR findings highlight the relevance of blockchains in FSC. The results of the SLR analysis indicate that blockchain is a promising technology for transforming FSCs and can potentially solve some of the issues inherent in FSCs.

Blockchain can improve product traceability and speed up determining the origin of products linked to recalls due to concerns about contamination, falsification, or other violations of food safety regulations. Blockchain also provides end-to-end product traceability and tracks food products at every stage of the food supply chain. The study's findings identify traceability, transparency, decentralized databases, provenance, and smart contracts as the most significant factors that drive blockchain adoption. The results also discussed the benefits of BCT and how it can enhance food quality, safety, data security, trust, collaboration, performance, and sustainability in FSC processes. The results also show how helpful blockchain can be for FSC collaboration. Blockchain allows the FSC stakeholders to work together more efficiently and effectively. The findings also suggest that this could improve the performance and sustainability of food supply chains. This study proposed a conceptual framework for BCT adoption in an FSC. This framework integrates the factors, impacts, and challenges of BCT adoption and can further explore blockchain adoption within other industry contexts to understand the impacts and advantages of BCT.

2.8.1 Limitations of Review

Although this review provides details on BCT adoption within an FSC, future research should consider some limitations. First, this review is limited to food supply chains. Second, because peer-reviewed journal papers were the only ones that met the inclusion criteria, the findings showed that there were not many journal articles in the literature. Therefore, it is suggested that it might be helpful to add conference proceedings, white papers, reports, and newspapers, for example, to avoid overlooking information. Third, the findings revealed few published articles on blockchain adoption.

2.8.2 Future Research Directions

This study suggests that despite the potential benefits of BCT, specific challenges, such as scalability, high cost, lack of expertise, and regulation, were identified as the main issues that need to be addressed.

Additional obstacles and pressures that can result from the deployment of BCT should be understood through management. The literature review framework thoroughly examined blockchain's factors, impacts, and challenges in FSC. The following future research directions are suggested.

- Future studies should develop practical solutions to address organizational and technical challenges.
- Researchers must determine why blockchain is used (or not used) in the food industry.
- Researchers should provide examples of how blockchain influences people's lives and how they perceive it.
- Future research should examine how forensic testing and blockchain can be used together to ensure that food is safe, from the right location, and correct.
- Future studies should examine the potential applications of blockchain in FSC as a whole.

2.9 Conclusion

It is clear from the review of past studies that blockchain applications in FSC are still evolving and nascent. Similar to many other technological innovations, the hype around blockchain has outgrown its potential benefits and opportunities. This study synthesizes the significant characteristics of blockchain, different platforms, applications of blockchain, blockchain in FSC, and the challenges posed in FSC. The main review findings were evident factors, impacts, and challenges to BCT adoption in the FSC, which later helped to propose an initial framework for BCT adoption in the FSC and will provide a helpful basis for future research. In general, to understand the research dilemma and propose the initial framework (see Section 2.6.4). The following chapter discusses the research methods used in this study.

Chapter 3. Research Methodology

3.1 Introduction

This section introduces and explains the conceptual framework, theoretical underpinnings, empirical research methodology, and design. As stated in Chapter 1, this study explores the factors and impacts of blockchain adoption in food supply chains. This chapter consists of seven sections: a process that emphasizes the selected research, followed by the research paradigm, approach, and design. This is followed by a section on the data collection procedure, presenting information on the collection and analysis of data, data analysis, and an ethical examination of the thesis. The concluding section offers the practical design and a summary of this chapter. Parts of this chapter have been published in the Journals[3].

3.2 Research Paradigm

A research paradigm is a collection of guiding philosophical presumptions for examination (Collis & Hussey, 2003; Guba & Lincoln, 1994) involving the researcher's claims and beliefs about what constitutes reality (ontology), the researcher's conception of what constitutes knowledge (epistemology), and the method used to perform the inquiry (Collis & Hussey, 2003). This paradigm is frequently used across several academic disciplines. According to Schwandt (2001), a paradigm is a shared worldview that characterizes a discipline's beliefs and values and directs resolving issues. Research design and clarification of questions can benefit from this

[3] Parts of this chapter have been published in the following publication:

a. Mohammed, A.; Potdar, V.; Quaddus, M. Exploring Factors and Impact of Blockchain Technology in the Food Supply Chains: An Exploratory Study. *Foods* **2023**, *12*, 2052.

paradigm. The knowledge claims, theoretical perspective of the researcher, techniques of inquiry, and procedures for gathering and analyzing data were the three components of the research design identified by Creswell (2003).

Research paradigms come in various forms and are observed in many different fields. The four paradigms recognized by Creswell as the foundations of qualitative research were post-positivist, constructivist/interpretivism, transformative, and pragmatist. Similarly, Guba and Lincoln (1994) positivism, post-positivism, critical theory, and constructivism are the four main paradigms identified as the foundation of qualitative research. According to Orlikowski and Baroudi (1991), these categories are positivism, interpretive realism, and critical realism. The dominant paradigms are compiled in Table 3.1 based on their philosophical components. The following section describes three commonly used research paradigms in information systems (IS) research.

Table 3.1: Differences in qualitative research paradigms

Philosophical elements	**Positivist**	**Interpretivist or Constructivist**	**Critical Realism**
Ontology	Only one reality or truth exists	Reality is shaped by society	Facts are produced socially and constantly influenced inside
Epistemology	Since knowledge can be quantified, it emphasizes valid and dependable techniques to get it.	Subjectivism	Revisable objectivism
Purpose	Test propositions, hypothesis, and measurement variables	Analyzing actions and activities towards theory building	Focus on uncovering contradictions and

			seeks to be emancipatory
Methodology	Research methods include qualitative, experimental, survey, quantitative, and randomized control studies.	Quantitative research methods, such as survey, correlational, causal-comparative, and quasi-experimental designs	Mixed method - the combination of qualitative and quantitative methods

Adapted from Orlikowski and Baroudi (1991)

3.2.1 Positivism

According to this perspective, science is the only path to actual knowledge, and the ideal framework for studying the social world is provided by scientific methods, techniques, and procedures (Chilisa & Kawulich, 2012; McGregor & Murnane, 2010). In the 19th century, Auguste Comte's critique of metaphysics claimed that only scientific knowledge could disclose the unchanging truth, leading to the emergence of the positivist paradigm (Kaboub, 2008; Lenzer, 2017). A positivist researcher holds that knowledge can be obtained only through observations and measurements. A positivist's ontological assumption is realism, which holds that reality exists apart from the researcher. In contrast, the positivist's epistemological assumption is based on objectivism, which holds that the researcher has absolute knowledge of objective reality. By closely following established ethics, the researcher maintains separation from the research and is value-driven from an axiological perspective (Wahyuni, 2012). A positivist holds that knowledge is absolute and without value. Typically, their claims are true and detailed (Scotland, 2012). They contend that truth comprises immutable laws and norms of causality and that there are complications that reductionism can resolve (Aliyu et al., 2014). By adhering to the recommended processes, a researcher can avoid altering the research’s conclusion because of prejudice and values, and the results should be repeatable (Guba & Lincoln, 1994). A positivist paradigm approach aims to test theories, explain relationships to create laws and use these laws as a foundation for predictions and generalizations (Bhattacherjee, 2012).

3.2.2 Interpretivism

According to interpretivism theory, knowledge is constructed socially and culturally and is hence arbitrary. According to interpretivism, reality is socially created because it depends on how people perceive the outside world (Heinze, 2008). The positivist perspective of realism or objectivism contrasts with that of interpretivism. It asserts that various legitimate realities are created socially. They believe that knowledge is arbitrary and value-based. Consequently, researchers frequently draw from the perspective of numerous individuals. The researcher and participants co-created findings based on their dialogue and interpretation (Ponterotto, 2005; Geoff Walsham, 1995). They contend that, although there are multiple ways to interpret knowledge, these interpretations all contain the desired scientific understanding.

3.2.3 Critical Realism

The ontologically critical realist claims that different types of knowledge exist and function separately from our understanding of them (Guba & Lincoln, 1994). According to critical realism, power structures within society influence reality and knowledge, and both are socially produced. This is similar to Crotty's (1998) argument Crotty (1998)that knowledge is created rather than passively noting nature's laws. The participants in a study are interactively linked by their values, which can change reality through the researcher's activities. This can impact the findings of this study. Communication transforms ignorance into informed knowledge because research is a transactional process between the investigator (the researcher) and the subjects (the participants) (Guba & Lincoln, 1994).

3.2.4 Choosing a Research Paradigm

There are many different study paradigms, each with its advantages and disadvantages, as discussed (see Section 3.2). Typically, a research paradigm is chosen based on the research problem. Participants in the food sector were consulted as part of this study to understand better the factors and impacts of adopting BCT in the food supply chain. This study aimed to gather expert comments on the factors and effects of adopting BCT. The interpretive paradigm, in which knowledge is acquired interactively from human perception and social experience, serves as the foundation for the fundamental assumptions of this research. The interpretive research paradigm has a subjective point of view of the world; instead of focusing on the action's objective observer, it looks to the participant for an explanation (Johnson & Onwuegbuzie, 2004; Slade, 1991). Because it focuses on understanding a phenomenon through the meaning assigned to it by others, an interpretive paradigm approach is most appropriate for this study because it provides deeper meanings that reflect many facets of the research subject. In addition, it offers helpful frameworks for comprehending blockchain adoption in the food supply chain.

3.3 Research Strategy

The research objectives should determine the research approach, as each methodology has a unique way of gathering and analyzing data (Yin, 2009). There are three reasons why a qualitative approach was used in this study. First, qualitative research is helpful when exploring a new field (Creswell, 2003). Second, qualitative analysis best serves exploratory research in which the crucial variable is still developing (Creswell, 2003).

Third, qualitative research, in line with the interpretative stance used in the study's design and execution, may shed light on and explain blockchain adoption in the food industry.

3.4 Research Method and Design

Case studies in IS research are prevalent (Tsang, 2014). Significant advancements have been made in interpretive research over the past few decades. A case study allows the evaluation of a research issue in actual situations (Wieringa, 2013). According to Leedy and Ormrod (2019), a case study aims to explore a person or a scenario thoroughly. It provides multiple data sources, thus making it a flexible research method. Because it offers a thorough investigation and description of a single unit or system, which is limited by time and space, case study research differs from other types of research. This is helpful when looking into a new or developing field of study. A case study technique was selected for the development and execution of the research strategy. Two reasons for using the case-study approach are described below.

First, case studies are one of the main methods used in qualitative research because they are suitable for answering "how" questions (Yin, 2009). According to Yin, the "how" inquiries encompass contextual factors because they are considered pertinent to the studied phenomena. As a result, this study uses a case study approach to explore blockchain adoption in food supply chains. Second, Yin notes that case studies are designed to be adaptable so that insights may be gained using data gathered from real-world contexts, such as the activities of established food industries. Furthermore, the case study is also appropriate when the boundaries between the phenomena under inquiry and circumstances are unclear.

3.5 Data Collection

This section describes the procedure used to obtain the data for this investigation. To better understand blockchain adoption, this study employs a qualitative strategy to address the research questions. The qualitative technique used in this thesis makes it possible to gather precise information and generate fresh insights into the phenomenon (Patton, 1987; Peshkin, 1993; Sofaer, 1999). Qualitative studies use a variety of data-collection methods. This study used interviews and digital content for the data collection. Interviews with digital content were combined to minimize shortcomings and maximize the advantages of the two data collection methods. The following subsections provide a general overview of the data-collection methods used in this study.

3.5.1 Interviews

Research interviews can be broadly divided into three types based on how their questions are framed: unstructured, semi-structured, and structured. Structured interviews employ a series of predefined queries, provide no room for exploration, and lose depth. Unstructured interviews were those in which there were no pre-planned questions or topics. Semi-structured interviews pursue a medium path, requiring the development of a list of pre-planned questions to be investigated (G. Li et al., 2008).

The primary data were gathered through semi-structured interviews, in which certain questions were prepared beforehand to support and direct the interviewee while maintaining the conversation on the topic. Contrary to a positivist interview, no set format was required, allowing the dialogue to progress and new questions to be produced as the interview progressed (Collis & Hussey, 2014). A viable substitute for using the selected sample approach in a qualitative study is to collect primary data through semi-structured interviews (McIntosh & Morse, 2015). Additionally, this interview form is appropriate for an interpretivist survey because its flexible structure enables researchers to obtain in-depth responses (Collis & Hussey, 2014).

Several sites were explored to identify and contact potential interview specialists. These were social networking websites and apps like Facebook, Twitter, and LinkedIn. Other Internet venues were also utilized, such as ResearchGate. The most popular platform, however, was LinkedIn, the largest professional online network in the world and a prime location to find potential sector experts.

The list of open-ended interview questions and documentation approving the ethics were emailed to the 21 experts who agreed to participate. The 21 experts signed and returned the participant consent form after some follow-ups. With the experts' permission, the interviews were performed online using Zoom software, even though face-to-face interviews were preferred. The COVID-19 pandemic necessitated conducting online interviews using the zoom platform. This had benefits in protecting the health of the researcher and participants but drawbacks because it is preferable to conduct in-person interviews to enable observation of facial expressions and body language (McIntosh & Morse, 2015). Samples of interview questions can be seen in Appendix A.

3.5.2 Snowballing Sampling Method

Another non-probability sampling technique is snowballing sampling, in which individuals who fit specific criteria for the study's topic are asked to help find more potential participants. However, the researcher must know the qualifications, including knowledge and abilities, that the initial volunteers must meet. This approach, sometimes called chain sampling or chain referral sampling, has historically been used in qualitative research. When the qualitative researcher builds a social connection with the initial participant after obtaining their agreement to engage in the study, a reference to another potential subject will likely be forthcoming. For instance, a researcher interested in emotional intelligence behaviour may ask potential volunteers to suggest members of their social network who might be able to contribute to the study.

3.5.3 Digital Contents

Another technique involves the use of background information from study-related papers. It consists of inspecting current data in databases, reports, or any other record type. Various researchers have defined it as the systematic study of printed or electronic documents (Bowen, 2006; Davidson et al., 2016). These documents include attendance records, meeting minutes, manuals, background papers, books and brochures, diaries and journals, organizational or institutional reports, survey results, and various public records (Bowen, 2006; Hand & Hillyard, 2014). The document analysis method is typically used with other qualitative approaches and is particularly appropriate for a qualitative approach. Particularly for case study research, documents offer helpful, rich background information and historical insight. Additionally, documents provide insight into inquiries that must be made during the study and provide a way to monitor any progress or change (Bowen, 2006).

3.5.4 Data Processing

Data processing involves examining the gathered data and generating an informative output. Checking entails ensuring the data's accuracy, completeness, and anonymity and transforming it into a format that can be preserved and disseminated (Bernard, 1996). Contextual data were added to the data during the conversion process, such as labelling audio recordings of the interviews. The main objective of the output produced during processing is to enable users to select the data-gathering components most pertinent to their research (Bernard, 1996). Data for this study were gathered from digital documents and interviews. The data are subjected to several operations or procedures to be verified, organized, transformed, integrated, and extracted in the proper output format for later use to ensure accuracy and usefulness and to prepare the data for analysis.

3.5.5 Data Analysis

The various methods and techniques used to turn the facts gathered into an explanation, understanding, or interpretation of the people and circumstances under investigation are known as qualitative data analyses (Taylor & Gibbs, 2010). Interpreting the primary qualitative unstructured data gathered through interviews and digital content was the primary goal of data analysis in this study. Numerous techniques have been used to analyze qualitative data. Constant comparative analysis, narrative, theme analysis, discourse, ethnography, and others are commonly utilized analyses.

Since qualitative research frequently generates massive amounts of data, its analysis is often more difficult and time-consuming than quantitative data (Collis & Hussey, 2014). Thematic analysis, a typical coding technique for qualitative research, was used to conduct qualitative data analysis in this study (Braun & Clarke, 2006). Handling and comprehending the vast quantity of data using this technique was achieved by recognizing, deciphering, and presenting themes derived from empirical data.

Inductive and deductive methods are the two primary methods used in thematic analyses. The inductive method entails open data coding and classifying the newly emerged code categories into themes. Open coding is a type of analysis in which unprocessed research material is methodically assessed and categorized. This approach involves creating code from the dataset and offers a platform for developing new theories (Javadi & Zarea, 2016). By contrast, the deductive technique, also known as deductive coding, starts with pre-established code classifications or topics of interest before assigning these codes to fresh qualitative data or changing them. In addition, this method entails first undertaking data coding and then identifying and sketching code categories based on earlier theories or studies (Alhojailan, 2012).

In this study, open data coding was performed, and newly emergent code classifications were formed into themes. This method determined the significance of phrases, themes, or ideas in experts' judgements. Open coding was performed using NVivo 12 software, which was used to code the interview transcripts. NVIVO was used to support the researcher rather than automatically coding or replacing the analytical thought process. All the transcripts were coded and reviewed to ensure the data references were accurate. The data were then analyzed using a six-step theme analysis procedure outlined by Braun and Clarke (2006) in conjunction with Gioia et al.'s (2013) systematic inductive method, as shown in Table 3.2.

Table 3.2: Data analysis process

Phase	**Description**
Familiarisation of data	Transcription, repeated reading, and taking down initial thoughts
Generating initial codes	Systematic coding of essential elements throughout each data collection
Search for themes	Putting together all the data relevant to each potential theme and
Reviewing themes	Figuring out if the themes have anything to do with the coded extracts. Examining how well the themes relate to the complete set of data
Defining and Naming themes	Ongoing review to enhance the narrative analysis as a whole and the specifics of each subject
Product report	The final examination of chosen extracts and the selection of vivid, engaging extract samples. Lastly, create a scholarly summary of the

	analysis by connecting the analysis to the research question and the literature.

Adapted from Braun and Clarke (2006)

3.5.5.1 Familiarization with the Data

The crucial initial step in the thematic analysis is properly comprehending the interview transcripts to familiarize them with the data (Belotto, 2018; Javadi & Zarea, 2016). The transcripts from the 21 interviews were used to analyze the interview data. There was no need for translation because every interview was conducted in English. The interview lasted 739 minutes, with a total of 130 pages.

3.5.5.2 Generating Initial Codes

This study systematically analysed coding the data in phase two after becoming familiar with the interview data. Traditional techniques, such as hand coding of paper transcripts, have been employed by researchers. Additionally, this technique uses coloured cards, labels for identifying the codes, and highlighted text to show the codes that accompany it (Tuckett, 2005).

3.5.5.3 Searching for Themes

A theoretical evaluation was prepared while generating the sub-themes to determine whether they supported the phenomena being studied and were consistent with the methodology of Gioia et al. (2013). Using this method, the codes created were categorized based on similarities in the language used by the informants. According to Gioia, Corley, and Hamilton (2013), the initial grouping of codes is the process of creating abstract codes or first-level notions that roughly define all codes initially formed. Reliability is necessary for qualitative investigations to establish internal and external consistencies (Neuman, 2013). The research also used external consistency checks to ensure that the concepts at the second and third levels aligned with the literature, which served as its primary source of information.

3.5.5.4 Reviewing Potential Themes

The potential themes across the entire dataset were closely examined during this stage. It is necessary to reread the data during this phase to see whether the themes effectively represented the dataset as a whole or just a portion of it (Vaismoradi et al., 2013). The objective was to ensure that the collection of themes accurately represented the relevant data points concerning the study questions. This assessment aimed to confirm that the themes conveyed a distinct and clear interpretation of the data (Maguire & Delahunt, 2017). A few themes were completely dropped during this assessment process, while others were split into many themes, and some were amalgamated.

3.5.5.5 Defining and Naming Themes

This phase aimed to identify and label themes; therefore, each concept was subjected to a critical study. This entails determining each theme's fundamental significance and key insights and applicability to the entire body of information (Javadi & Zarea, 2016). However, sub-themes are also helpful in connecting to research questions (Braun et al., 2016; Maguire and Delahunt, 2017). These themes represented broad patterns in the data. During this phase, themes were identified, and the essence of each theme was distilled.

3.5.5.6 Producing the Report

The final step of thematic analysis. The themes were thoroughly discussed, and many points of view were developed to address the study objectives. This indicates that a thorough interpretation of the interview conversations based on the analysis was included in the report.

3.5.6 Ethical Considerations

The conduct of research and how the findings and conclusions are shared are the two main areas of concern in research ethics (Collis & Hussey, 2014). It is crucial to consider ethical considerations when conducting future studies. Conducting social research requires careful ethical considerations (Babbie 2015), and ethical issues are of utmost importance throughout the interview process for this investigation. This process began with the research design and continued to report on the interview findings. The study was approved by the Curtin University Human Research Ethics Committee (HREC Approval Number: HRE2019-0230) and was exclusive to the qualitative data collection phase.

3.5.7 Anonymity

The option of retaining anonymity must be provided to everyone participating in a study (Collis & Hussey, 2014). Individual participants in the qualitative element of this thesis chose to remain anonymous but agreed to let the researcher know the study's sponsor. The importance of the organizations that decided to participate became increasingly evident when they could be identified. However, as it is the researcher's responsibility to ensure that respondents cannot be recognized, personal information such as names cannot be disclosed (Collis & Hussey, 2014). Revealing the interviewee's precise position in an organization might also be problematic because it could allow for the identification of personal data (Bell & Bryman, 2007). Table 3.3 describes the criteria used to achieve reliability and validity.

Table 3.3: Data truthfulness standards

Quality Elements	Criteria	Description of Strategy

Continuity	Transferability	Details on the participants, the method, and the setting of the current study
Truthfulness	Credibility	Method Triangulation: Multiple data collecting triangulation, interviews, and digital contents.
	Dependability and Confirmability	Ensuring consistency in the questions requested of the participants and using qualitative data analysis software NVivo.

3.5.8 Credibility

Concerns about credibility include whether the study's topic has been honestly and appropriately recognized and reported (Collis & Hussey, 2014). It is crucial to consider credibility because it contributes to dependability (Lincoln & Guba, 1985; Shenton, 2004). As a result, to ensure credibility, the researcher actively contributed to all aspects of the thesis by sharing work and jointly participating in all meetings with external contacts.

3.5.9 Transferability

Transferability is the ability of research findings to adapt to a different setting in which the environment, time, and population are similar (Collis & Hussey, 2014; Malterud, 2001). This thesis adopts a qualitative methodology and features such as small sample sizes that produce rich, subjective data that permit transferability (Shenton, 2004). This necessitates presenting clear information and thoroughly describing the phenomenon (Curtin & Fossey, 2007; Shenton, 2004). Thus, a detailed explanation of the phenomena and the study procedure is offered to aid in the transferability of this thesis. In particular, the sampling strategy, selection criteria, and interview participants were thoroughly detailed.

3.5.10 Dependability

Dependability demonstrates reasonable, consistent, well-recorded, and accurate research procedures (Collis & Hussey, 2014). It would be simpler for others to comprehend how conclusions are reached by properly documenting processes (Shenton, 2004). As a result, several procedures were carefully documented, including data collection, interview reports, analysis, and interpretation of obtained data. Consequently, reliability increases because an audit trail may be created (Lincoln & Guba, 1985). Additionally, stepwise replication, used in this study by allowing the author and a second researcher to assess the data independently, improves dependability.

3.5.11 Confirmability

Confirmability is attained when the study's methodology is transparent, and it is feasible to determine whether the conclusions are pertinent to the collected information (Collis & Hussey, 2014). Writers should maintain objectivity throughout the study to guarantee confirmability (Shenton 2004). Confirmability may also be attained by an audit trial, which relates to data reduction, analysis, and coding material, in addition to the recorded content (Lincoln & Guba, 1985). This thesis ensures neutrality while outlining the coding procedure and theme development in simple visual terms to enable confirmability. This implies that information is offered to support every interpretation and that the audit trail may be used to examine it.

3.6 Summary

This chapter examines the general research strategy used in this study. The discussion of the many philosophies applied in the research in the first part resulted in choosing an interpretative viewpoint as the best one for this thesis. As the researcher was interested in investigations that entailed interpreting and describing social contexts, interpretivism was the method of choice (Walsham, 1995). The use of qualitative research methodologies is justified.

Chapter 4. Qualitative Analysis Findings

4.1 Introduction

This chapter summarizes the findings from interviews with experts from the FSC and BCT backgrounds. The interviews were the primary source of data in this study. The data were analyzed using NVivo 12 software, as described in chapter three, and the data were thematically interpreted. The interpretation of responses to the open-ended questions posed to the study participants is essential for achieving the goals of the research study. Parts of this chapter have been published in the Journals[4].

This study used Braun and Clarke (2006) as a guide and employed the thematic analysis method. This method was chosen because the thematic analysis is renowned for flexibility in encompassing the researcher's interests and necessitates a methodical process to ensure consistency and rigour (Braun & Clarke, 2012; Guest et al., 2011). The ability to recognize themes deductively and the flexibility that encourages the inductive development of unexpected insights are the foundations for the acceptance of thematic analysis. The method's adaptability is perhaps its greatest asset because it is effective beyond adhering to the original "themes" and enables research to reflect on reality by identifying new areas of interest (Braun & Clarke, 2006). An inductive method was applied in this study to provide the best possible interpretation of the data.

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[4] Parts of this chapter have been published in the following publication:

a. Mohammed, V. Potdar, M. Quaddus and W. Hui, "Blockchain Adoption in Food Supply Chains: A Systematic Literature Review on Enablers, Benefits, and Barriers," in *IEEE Access*, vol. 11, pp. 14236-14255, 2023.
b. Mohammed, A.; Potdar, V.; Quaddus, M. Exploring Factors and Impact of Blockchain Technology in the Food Supply Chains: An Exploratory Study. *Foods* **2023**, *12*, 2052.

This chapter presents the data gathered from the qualitative analysis following Yin (2009) approach.

4.2 Demographics

This study gathered empirical data from interviews. The sample of the population used for qualitative data collection is described in this section. The participants were chosen based on their specialist knowledge and expertise in the BCT and supply chain. All interviewees identified to participate in the study have also worked on blockchain projects in the food sector and come from countries worldwide, including Australia, New Zealand, India, Canada, and the US.

4.2.1 Participant Demographics

Popular news items, websites, personal industry connections, and media communications were used to identify the participants. In addition to professional social media platforms such as LinkedIn, emails were utilized to contact senior managers and secure their consent to participate in the study interview email sample (see Appendix B). Each participant was asked several questions regarding the factors and impact of BCT adoption in the FSC. Table 4.1 outlines the interview participants' demographics, and Table 4.2 the participant’s profiles.

Twenty-one (21) interviews were conducted, each lasting between 30 and 50 minutes (see Table 4.2). No translation was required for the interviews, and all were in English. The interviews lasted for a total of 739 minutes, and 130 pages of transcription were produced. The researcher produced the transcription. Data were summarized and sorted into categories as part of the coding process based on observations drawn from the data (Bryman & Burgess, 1994). NVivo 12 was used to code the text files from each transcribed interview and to support the researcher in ensuring that coding was not performed automatically without analytical thought. These coding strategies allowed the researcher to remain receptive to the participants' stories and to identify themes. These themes were subsequently identified, given names, and separated into ten sub-themes, which assisted the researcher in providing somewhat broad concepts and creating more structures.

Table 4.1: Participant's demographics

Position	Senior Management	12
	Project Manager	5
	Developer	4
Gender	Male	15
	Female	6
Interview Time	Minimum Minutes	21
	Maximum Minutes	48
	Mean Minutes	36.24
Nationality	Australia	11
	USA	4
	Canada	1
	India	2
	New Zealand	3

Table 4.2: Participant's profile

Code	**Position**	**Gender**	**Experience**	**Length**
P1	Project Manager	Male	10+years	31mins
P2	Solution Architect	Male	5+years	40mins
P3	Chairman	Male	10+years	48mins
P4	Management Scientist	Male	5+years	42mins
P5	CEO & Founder	Male	15+years	27mins

P6	Software Engineer	Male	4+years	27mins
P7	Product Management Advisor	Female	5+years	44mins
P8	Solution Architect	Male	5+years	37mins
P9	CEO & Founder	Female	15+years	21mins
P10	CEO & Founder	Female	10+years	48mins
P11	CEO & Founder	Male	10+years	36mins
P12	CEO & Founder	Female	10+years	44mins
P13	Founder	Male	15+years	36mins
P14	CEO	Male	20+years	32mins
P15	Technical Analyst	Male	15+years	30mins
P16	Supply Chain Manager	Male	10+years	23mins
P17	CEO	Male	20+years	41mins
P18	Solution Architect	Male	5+years	32mins
P19	CEO	Female	5+years	37mins
P20	Director	Male	10+years	29mins
P21	Project Supervisor	Female	3+years	34mins
	Total			739mins

4.2.2 Code Analysis

NVivo 12 software was used for code analysis. The analysis adhered to the framework for thematic analysis and the steps of analysis proposed by Yin (2009): examining, categorizing, tabulating, and testing. The data reliability for each stage of the analysis is shown in Table 4.3.

Table 4.3: Data reliability for data analysis

Process	**Thematic Analysis**	**Trustworthiness**	**Description**
Examining	Get acquainted with your data.	Audit Trials	Organizing all data in archives

Categorizing	Create an initial code and describe the content. Examine the codes across the several interviews for trends or themes	Dependability	Triangulation Documentation of code generation through NVivo
Tabulating	Themes review and defines.	Credibility	Triangulation
Testing	Produce the report	Confirmability and Transferability	A detailed explanation of every step in the research process

Adapted from Yin (2009)

This section presents the findings of the study's themes and subthemes. The expert statements, which were obtained directly from the interview transcripts, provided support for the conclusions. Italics were used to display the data extracts. Table 4.4 shows themes and sub-themes.

Table 4.4: Themes and sub-themes

Theme One	**Blockchain Technology Adoption Factors**
Sub-Theme 1	Technological factors
Sub-Theme 2	Organizational factors
Sub-Theme 3	Environmental factors
Theme Two	**Impact of Blockchain Technology**
Sub-Theme 1	Visibility
Sub-Theme 2	Performance
Sub-Theme 3	Operational efficiency
Sub-Theme 4	Trust
Theme Three	**Challenges of Blockchain Technology**

Sub-Theme 1	Interoperability
Sub-Theme 2	Privacy
Sub-Theme 3	Infrastructure conditions
Sub-Theme 4	Lack of knowledge

4.3 Blockchain Technology Adoption Factors

This section presents the answers to the initial research question regarding the factors affecting BCT adoption in FSC. Themes and subthemes were extracted from the thematic analysis of the transcribed responses. The factors and impacts of adopting BCT were then organized using theme analysis. The question posed to respondents was, 'What factors encouraged the adoption of blockchain technology?'. Responses were analyzed using the TOE framework, and themes and discussions were based on technological, organizational, and environmental aspects, as shown in Table 4.5.

Table 4.5: TOE framework

Technological Factors	**Organizational Factors**	**Environmental Factors**
Complexity Compatibility Cost	Resource Organization size Knowledge Management support Attitude	Government support Competitive pressure Standardization Compliance

4.3.1 Technological Factors

The study explores participants' views on the technological factors in adopting BCT in the FSC (L. G. Tornatzky & Klein, 1982). This study found that complexity, compatibility, cost, trust, disintermediation, and relative advantage can influence BCT's adoption in FSCs. The following subsection explains the identified factors based on the responses of study respondents.

This study explores participants' views on the technological factors in adopting BCT in the FSC (L. G. Tornatzky & Klein, 1982). This study finds that complexity, compatibility, cost, trust, disintermediation, and relative advantage can influence BCT's adoption of BCT in FSCs. The following subsection explains the factors identified based on the respondents' responses. Table 4.6 illustrates the example of codes.

Table 4.6: Example of coding for technological factors

Illustrative quotes	**Examples**
Complexity	*What, I think, you know, is our role is to provide an excellent application to our supplies and to make users interact with that application rather than interacting directly with the blockchain. So, it is just not user-friendly technology for our broad group of the supply chain (P16)* *How to get beyond the complexity of the food ecosystem is the first obstacle facing the food supply chain, which is just entering the market (P2)*
Compatibility	*So that is an essential question because many of these companies might be using some software, maybe an ERP or some other software, which they might have already spent a lot of money to get into work (P12)* *I think our system will be capable enough to pull and push the data from that existing engine, provide an update to the farmers (P4)*
Cost	*We must be very, very mindful of the cost structure and the dynamics of physical environments and the industry to decide on what the most appropriate technology interventions need to be (P9)*

Complexity is *"the degree to which an innovation is seen as relatively hard to understand and apply"* (Rogers, 1995). The degree of complexity reflects how challenging the innovation or new technology is to comprehend, implement, and use (Rogers, 1995). An established factor for technology adoption is the perceived complexity of the innovation. The likelihood that an organization will accept innovation decreases as its complexity increases. This factor is also one of the three elements of the DOI theory, "(i.e., relative advantage, compatibility, and complexity)", which are the most relevant factors for the examination of technology adoption (L. G. Tornatzky & Klein, 1982). Previous studies found that complexity (Espadanal & Oliveira, 2012; Isma'ili et al., 2016; Picoto et al., 2014) is negatively related to technology adoption (Ruivo et al., 2014).

The responders emphasized the need for enterprises to exercise caution while implementing blockchain technology. There is a lot of friction in blockchain regarding users being able to access it directly. This is evidenced by the responses P16 stated, *"What, I think, you know, our role is to provide an excellent application to our supplies and to make users interact with that application rather than interacting directly with the blockchain. So, it is not user-friendly technology for our broad supply chain group"*.

The complexity of the ecosystem and the range of stakeholders means that collaboration is necessary to produce value from the technology: P11 mentioned, *"Not all supply chain equipment is suitable for or ready for rapid digitalization. And even digitalized technologies, in terms of the information they collect, may not be in a cloud-ready state that would enable ready access from a blockchain point of view"*. P5 stated further: *"I think spreading literacy about technology will help food supply chain partners to come on board, try, and implement new solutions, that will reduce their perception on the complexity of blockchain"*. One participant supported this view P9 said: *"We discovered that scaling up the solution in a sustainable fashion was one of the main hurdles with blockchain technology"*.

Complexity may result from several factors, including the fact that blockchain is problematic. P2 mentioned, *"How to get beyond the complexity of the food ecosystem is the first obstacle facing food supply chain, who are just entering the market".* The complexity of blockchain, as well as the potential difficulties associated with it, might lower the adoption to the targeted food sectors.

Compatibility *"is the extent to which an innovation is viewed as consistent with the existing values, past experiences, and needs of potential users"* (Rogers, 1995). The perception of BCT is how blockchain can be compatible with an organization's needs, goals, infrastructure, and processes (Premkumar & Roberts, 1999). Compatibility is critical in accepting innovation (Cooper & Zmud, 1990). High compatibility has been viewed as an enabler for the uptake of innovations (Cooper & Zmud, 1990). According to adoption diffusion research, where potential adopters view suitable innovation as "less unclear," it is more likely to be adopted quickly. Premkumar et al. (1994) similarly demonstrated how a compatible innovation increases integration within a company, such as with supply chain partners. P17 expressed, "To consider the business cases and determine what the beneficial business case may or may not be to understand an existing technological implementation, "how BCT can be compatible with the company's existing technology. That is, whether blockchain solutions can connect with the company's existing food supply chain systems.

P12 respondent said: *"So that is an important question because many of these companies might be using some software, maybe an ERP or some other software, which they might have already spent a lot of money to get into work.* So, the first question is, will blockchain replace that software, or is blockchain credible enough to replace that? P12 added, "*So, my answer to that is blockchain is not replacing any software. Blockchain adds credibility to the information generated by this software".*

P4 voiced the same opinion on blockchain compatibility, stating: *"I think our system will be capable enough to pull and push the data from that existing engine, provide an update to the farmers"*, Interacting with the system and making that data transfer happen.

Cost is a significant factor in adopting innovation (L. G. Tornatzky & Klein, 1982). Cost can be categorized into two aspects: direct and indirect cost. The direct cost is related to obtaining the technology, while indirect costs are created by maintenance, implementation, and use. The cost is essential for technology adoption, so it is hardly considered a roadblock. The cost has always had an impact on adoption. As also stated in (L. G. Tornatzky & Klein, 1982) to be considered in an organization's decision before adopting the technology (Iansiti & Lakhani, 2017).

Blockchain is relatively affordable from a commercial and development perspective. Blockchain, however, comes with additional charges. There are processing expenses, for instance, if you wish to run an application against the blockchain. One interviewee mentioned that blockchain development platforms had hidden costs P9 stated: *"We must be very, very mindful of the cost structure and the dynamics of physical environments and the industry to decide on what the most appropriate technology interventions need to be"*.

According to another participant, blockchain has no cost-effectiveness issues, as highlighted by these comments P15 mentioned, *"I know that certain blockchain solutions have become cripplingly expensive. We provide super low-cost digital infrastructures for food suppliers, and data is accessible. Accessing our API is open like we are trying to be as open source as possible. The only thing where we encounter a challenge around costs is making payments. And that is because now, we must move* *on to traditional payment rails. So, we encounter the same costs you would have with any other payment provider, but that becomes like an additional layer when delivering finance and making payments. So, it is still reasonably low cost".*

P3 found, *"The blockchain solution's price must be competitive to attract users like farmers. The company has seen significant cost savings because of this"*. Blockchain allows businesses to comply with financial regulations in real-time.

4.3.2 Organizational Factors

Organizational factors describe the organization's qualities. The elements that have been thoroughly investigated for technology adoption are discussed below. **Resources** - BCT requires an organization to have a solid resource foundation because it is a complicated and expensive technological breakthrough. Resources are better able to manage risks and payoffs as a firm grows. Therefore, compared to smaller firms, large organizations are more ready to adopt developing technology to gain an advantage. The size of the business strongly influences the adoption of blockchain-based technology. As a result, it is defined as a determinant in the study model to examine the impact of organizational size on the corporate adoption of blockchain supply chains. Table 4.6 illustrates the example of codes.

Table 4.7: Example of coding for organizational factors

Illustrative quotes	**Examples**
Organization size	*If you are an industry leader, you can exploit market dominance without spending large amounts of capital to sustain that position (P14)*
Knowledge	*Indeed, as a new technology, there is just knowledge, a learning curve. So, you know, not everybody involved in blockchain has the level of expertise,*

	especially since the end users receiving the value may not have the most knowledge of blockchain (P13) *And then the other aspect is many pilots are still running in the supply chain. However, I would say it's still pretty early for them to say they're in full rollout mode (P7)*

Organization size: Size is an influential factor (Zhu & Kraemer, 2005). For example, large organizations are more willing to accept new technologies than small organizations due to their flexibility and ability to soak up the risk (Malak, 2016; Opala, 2012). P18 stated, *"Obviously, the bigger the organization, the more potential it must justify a significant capital cost implementation"*. In many supply chains, large incumbents resist applying new technologies such as blockchain until they are ready to roll over into a blockchain environment.

P14 gave an example *"If you are an industry leader, you can exploit market dominance without spending large amounts of capital to sustain that position"*. In this study, size is preferable to organization size. The number of cattle, the number of people working on the farm, or the farm's income can all be used to measure the size of a farm. Most studies concur that the most prevalent indicator of organizational size is the number of employees (Yao, Xu et al. 2003). P6 said, "*What they want to do, therefore, is delay the application of blockchain technologies until they are ready. And the reason they want to delay it is that should new players come on to this thing and smaller, more agile players within their industry with new technologies that can enable them to either get productivity benefits or value creation benefits, in particular, that could jeopardize the traditional incumbents market position".*

Knowledge: There is; generally, limited awareness of blockchains, and often the knowledge that people would have picked up in exposure to the discussions on the technology is misleading. P13 described, *“Certainly, as a new technology, there is just knowledge, a learning curve. So, you know, not everybody involved in blockchain has the level of knowledge, especially since the end users receiving the value may not have the most knowledge of blockchain”*.

Another participant, P7, said, *“The adoption is relatively low. We have been around for about two you plus years. So, people are becoming more familiar with it. They did not associate when we first came to market. Everyone was thinking of Bitcoin, or some cryptocurrency, is that dark side of the net. And so now we rarely get that type of question. Now we get different questions about how this technology enables sharing kind of what a permission blockchain means, so the questions have evolved so that people are becoming more familiar with Blockchain technology”* There's, quite frankly, more information published about the technology. So, people are reading more about it and becoming more educated”.

Furthermore, P7 added, *“And the other aspect is many pilots are still running in the supply chain. However, I would say it's still early for them to say they're in full rollout mode”*. Enterprises see BCT as an integrated technology, which means they see it as a complement to already-in-place technical solutions.

4.3.3 Environmental Factors

The environment is the physical and social aspects that directly influence how people behave while making organisational decisions (Yontar, 2023). Environmental factors can be classified as either internal or external environments. External environmental factors are those aspects of the environment outside the control of the organization's management that might endanger or benefit the organization (Callinan et al., 2022; Zoubi et al., 2023). The external environment consists of those "global" external elements beyond an organization's control yet is crucial to its operation and decision-making processes. In contrast, the internal environmental factors are organizational traits. As a result, this study considers explicitly the external environment rather than the "environment" (Dehghani et al., 2022). Table 4.7 illustrates the example of codes.

Table 4.8: Example of coding for environmental factors

Illustrative quotes	**Examples**
Government Support	*To my point before, there is some way where I think the government, you know, has... a role to play. And you know, it should not just be you, and I know the big guys at the banks have done some blockchain stuff to support some food industries (P11)* *I think there is an opportunity for the government to set up a blockchain task force. Scale the marketplace (P3)* *It is not just that we can take advantage of great technologies like blockchain, which have a lot of potential benefits, but also that we can agree on standards to have better governance across supply chains (P4)*
Competitive pressure	*There is a bit of peer pressure. This technology is fascinating, and everybody wants to implement that. Some people and the food industry can appreciate the value, and some companies do not see any immediate value (P2)*

Government Support can significantly impact the adoption of blockchain technology. Governments may also offer financial incentives and pilot programs to encourage technical innovation. The government can play a significant role in the adoption and diffusion of innovations through information provision, research and development policies and facilities, incentives, building and enhancing the infrastructure, running pilot projects, offering tax breaks, and providing consulting and counselling services (Gupta & Shankar, 2023; Krzyzanowski Guerra & Boys, 2022; C. Zhang et al., 2023). There are some external requirements that, through acting as dual-edged factors, have been discovered to influence food industries' decisions to implement BCT. It would be riskier for individual farmers to adopt new technologies and practises without government involvement. P11 stated, *"To my point before, there is some way where I think the government, you know, has... a role to play. And you know, it should not just be you, and I know the big guys at the banks have done some blockchain stuff to support some food industries.* P3 supported: "*I think there is an opportunity for the government to set up a blockchain task force. Scale the marketplace. Many people like me are doing projects with SMEs [small to medium enterprises]"*.

Blockchain is a technology that requires competitors to compete; P4 describes, "*It is not just that we can take advantage of great technologies like blockchain, which have a lot of potential benefits, but also that we can agree on standards to have better governance across supply chains.* This participant added that there is a lot of movement, and governments are interested in this.

P19 highlighted, *"I still think there is a lot of scepticism. So, I think the awareness is certainly growing. But I think there is a lot of scepticism in the agriculture industry. In part, that is because, for decades and decades, people have gone to the agriculture industry with new technologies and said, "implement this technology"* P14 recalled, *"I think we will see more and more interest over the next six months from state governments interested in expanding exports into Asian food sectors"* Looking at traceability technologies, some more of these will come out soon enough. But because governments are interested, *"I think that is also spurring even further interest in the agriculture industry. Things like the national blockchain roadmap, which came out earlier this year, are a big signpost for many industries that this is happening. But, of course, there are a lot of obstacles and challenges in adopting this technology" (P8)*.

Adopting the technology will not happen out of thin air but because of a rule or regulation.

Competitive pressure is *"the degree of pressure faced by the companies from competitors inside the industry"* (Ye et al., 2022). Organizations are encouraged to research to thrive and remain competitive in the market. Competitive pressure is a crucial factor influencing the adoption of new technologies. Blockchain-based solutions offer more efficiency and transparency, which give the food industry essential competitive benefits (Wong et al., 2020).

P9 shared, *"So because blockchain is getting gaining popularity, possibilities are that your competitor is contemplating using Blockchain, and you do not want to stay behind them. So, in that sense, you also want to go ahead and stay with them to stay in tune with what the market is doing".*

P2 "There is a bit of peer pressure from the participant's perspective*. This technology is fascinating, and everybody wants to implement that. Some people and the food industry can appreciate the value, and some companies do not see any immediate value. Still, everyone knows this technology has potential, and they are starting to get open to it".*

Standardization: In addition to controlling blockchain usage, it is essential to standardize the terminology. Standardization is necessary to increase the advantages of great technologies like blockchain, which have a lot of potential benefits. Still, also that agreement on standards ensures better governance across food supply chains. P17 emphasized, *"Blockchain has no regulation as such, and the law will come into the picture when there are smart contracts, and maybe there will be questions on the validity of smart contracts as legal documents. But most of the use cases have not* *reached that maturity level. And so it remains to be seen how that will shape up, but sooner or later, maybe the industry will have some framework standard that will become the standard for the* industry.

Further stated, to facilitate more collaborative effort across the supply chain more generally. The P13 said, *"So, it's not just so that we can take advantage of great technologies like blockchain, which have a lot of potential benefits, but also so that we can agree on standards so that we can have better governance across supply chains".*

Compliance: Another expectation is compliance in complex supply chains, particularly in the FSC. There is a need for extensive compliance for all sorts of things, ranging from animal safety, food safety, and human safety to environmental impacts. One participant commented on P7, "*Create new regulatory regimes that can be inadequate cost and data-driven, almost to a point where compliance becomes an automatic feature of ongoing operations*". The ability to achieve compliance and report on compliance cost-effectively is beneficial to those who must comply with something to be able to operate lawfully.

4.4 Impact of Blockchain Technology

Visibility - It is possible to define supply chain visibility as having *"access to high-quality information that explains diverse demand and supply elements"*. This concept is frequently enhanced by the capacity to recognize and validate a product's crucial data (such as identification, location, and status) as it moves through the supply chain. Others refer to the ability to determine a product's path as traceability. Despite some ambiguity in the terminology, researchers concur that supply chain visibility is linked to several advantageous operational and financial outcomes, such as decreased uncertainty and disruption risks, lower inventories, and improved responsiveness: (*"In* *general, supply chain management and logistics have several main objectives, but achieving supply chain visibility is one of them. It is, moreover, a significant outcome of essential supply chain procedures like external integration and knowledge sharing*" P12). The information would be more trustworthy, and there would be no information asymmetries, ultimately boosting food visibility. The participants argued that blockchain technology's primary reason is its visibility. As stated by P11, *"Businesses can deliver information to clients when they are visible, which gives them a chance to do so"*.

Performance - Blockchain improves supply chain quality management by lowering costs and sharing information with the right partner, impacting industry performance and sustainability. With the approval of other organizations in the supply chain network, information transparency enables individual organizations to track the flow of products. This improves industry performance by reducing the likelihood of corrupt practices and fake goods; as P20 described, *"I think that supply chain governance performance could be enhanced by blockchain technology"*. Managers and policymakers must take the initiative to establish a platform for fostering collaboration to improve performance. P18 supported, *"The requirement for improving the fresh food supply chain's performance is coupled with the technological aspects of the blockchain in several ways"*.

Efficiency - BCT has a significant and advantageous role in enhancing businesses' operational effectiveness since it solves various issues with data sharing and resource integration in multi-party collaboration. *"The capability to do this in the short term is to enhance operational efficiency within many organizations. But operational efficiency needs to be related to network efficiency"* P12. Blockchain is not necessarily the best technology to use if it's going to be internalized and solve internal problems.

P12 added: "But if we're looking at solving network problems across the whole *supply chain problems, then blockchain could be a great technology. But to solve those problems, it's not good enough to have great technology; you must have collaborative effort and the supply chain participants' leadership to want to be able to share enough information to benefit from implementing that technology"*.

Trust - transparency and traceability are correlated with firms' readiness to establish customer trust in their communications and foster an awareness of their business operations. P5 *"When one considers the numerous potentials of a blockchain, it is about acquiring better control and the capacity to enable the appropriate data"*. ***Value creation*****:** relates to business case propositions and different uses of information within complex ecosystems. Supply chains have other demands for information. P9 stated, *"What I would call productivity benefits. And they largely go towards the ability of somebody engaged in a value creation process in the supply chain to achieve that value creation with fewer inputs"*. Many agricultural producers are interested in improving the quality of their products because it will change the value and price of that product. According to *P14, "Value growth beneficiaries are related to the ability, through data, for the new value to be created and for more earnings from a supply chain activity"*. Furthermore, the results demonstrate that: (*"Added value through greater transparency and traceability is correlated with firms' readiness to establish customer trust in their communications and foster an awareness of their business operations"* P8).

4.5 Challenges of Blockchain Technology

The biggest obstacle to using blockchain is still comprehending what it can and cannot achieve. Its continued evolution as a technology presents another challenge. This indicates that it is still under development and not a complete solution. It should be more evident that blockchain should be used with other developing technologies as a solution. Even though the technology has already been around for ten years, there are still some adoption challenges in the industrial setting. Blockchain adoption is being hindered significantly by a lack of education and awareness. *What are the significant challenges of BCT adoption in the FSC?*

Interoperability: The demand for standards and protocols is heightened by the necessity of interoperability throughout the food supply chain. Blockchain-based solutions face difficulties in being adopted because there is no consensus protocol. P16 *"I think blockchain technology itself is it is still very young. And it is not a great surprise. I think it is held up to be something that was going to be this. This is a super ground-breaking solution"*. The food industry has been exposed because of the lack of visibility into the supply chain (*"So, one of the problems is the supply chain's lack of visibility and the incompatibility of visibility"* P18).

Privacy: Blockchain provides peer-to-peer data transfer via a decentralized network without needing any third party. This study found that privacy is another challenge in the food supply chain process. One participant noted this: *"So, for example, privacy solutions are not solved adequately in most blockchains or distributed ledgers"* 15). And further, P9 *"It is challenging to work with blockchain, and it is not like many solutions are solved with blockchain in the supply chain"*. **Infrastructure conditions** P10 described, *"So if you do not have good internet connectivity to areas, the cost of data communications is expensive. You must modify your approach to how you collect that information and how you transmit that data*". This participant P17 said: *"So even though the idea of having ear tags for cattle that can capture all the information you could imagine for cattle anywhere in Australia, theoretically, is fantastic, transmitting* *that data continually poses challenges. In addition, the ability to maintain energy [for] devices to send information poses data in remote locations"*. **Lack of knowledge:** Although BCT is unfamiliar to many people, some are knowledgeable and have recognised its significance. According to the respondents, the biggest obstacle to the widespread usage of blockchain is the general public's lack of understanding of it. "*People are still learning about it. They do not understand the difference between a blockchain ledger system in a database or how the technology can improve or provide value to the whole ecosystem"*. Although internal BCT knowledge is required, it may not be the only important component influencing the adoption rate. The results demonstrate the importance of comprehending the benefits of adopting BCT. Businesses should view BCT as a solution that adds value to their operations and yields results.

4.6 Summary

The findings are consistent with other studies on BCT adoption in food supply chains because several parameters corroborate those earlier studies. The results of this study classify and link these characteristics in various ways. The results of this study instead conclude that transparency and traceability are variables and benefits that can help achieve adoption, in contrast to other research that highlights them as the primary factors and advantages of BCT adoption. The study discovered complexity, compatibility, cost (technology), resource, size and knowledge, management support and attitude (organization), government support, competition pressure, standard, and compliance (environment) as the critical factors of BCT adoption in the food supply chain.

Chapter 5. Content Analysis Findings

5.1 Overview

In recent years, BCT has gained popularity and piqued the interests of practitioners and academics. BCT promises to overcome the current restrictions in the FSC. The adoption of BCT in the FSC is still in its infancy, and there is limited research on its adoption factors, impacts, and challenges within the FSC. This chapter discusses the analyses of 115 news stories, web pages, white papers, and social media reports on the BCT from 2016 to 21. The chapter also reports on studies of social media reports from LinkedIn, Facebook, and Twitter on the BCT. The study found 98 comments on adopting BCT on social media platforms. This analysis provides the first comprehensive assessment of the factors, impacts, and challenges associated with blockchain adoption. The remainder of this Chapter is organized as follows. The goals and significance of this research are discussed in Section 5.2. The methodology and analysis are presented in Section 5.3. Section 5.4 covers the results regarding BCT adoption. Section 5.5 contains the chapter summary. Parts of this chapter have been published in a Conference[5].

5.2 Introduction

BCT makes tracing data along the FSC more accessible and improves food quality. Additionally, it offers a secure method for managing and storing data, enabling the development and application of information-driven solutions for smart agriculture and

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[5] Parts of this chapter have been published in the following publication:

a. Mohammed, A., Potdar, V., Yang, L. (2020). Key Factors Affecting Blockchain Adoption in Organizations. In: Tian, Y., Ma, T., Khan, M. (eds) Big Data and Security. ICBDS 2019. Communications in Computer and Information Science, vol 1210. Springer, Singapore.

the reliance of agricultural insurance on intelligent indices. Additionally, it lowers transaction costs, facilitates farmers' access to markets, and opens new revenue streams. Despite its enormous potential benefits, there are still significant obstacles to using BCT in food and agriculture (David et al., 2022; V. Pandey et al., 2022).

5.3 Digital Content Methods

Company reports, news articles, and websites were used to generate strong support for adopting BCT. The search was restricted to these sources because it is believed that the published information has passed some level of information verification before publication. According to previous studies, mainstream media is crucial in promoting managerial concepts and practices (Mazza & Alvarez 2000; Zavolokina, Dolata, & Schwabe 2016). The value of practitioner literature in examining topics not covered in the academic literature has been observed in some studies (Deng et al., 2017). Two different data collections were used for document analysis.

5.3.1 First Data Collection

The study thoroughly searched for documents related to the BCT and FSC using publicly accessible information to answer the research questions. Based on this, the study decided to create a search string for a Google search to encompass a wide range of materials. The search string was adopted from Chapter (see Section 2.5.2) as follows:

> **Keyword** ("blockchain" OR "blockchains" OR "block chain" OR "block chains" OR "blockchain technology" OR "distributed ledger" OR "distributed ledger technology" OR "decentralized ledger" OR "shared ledger" OR "smart contracts" OR "smart contract" OR "hyper ledger" OR "hyperledger" OR "Ethereum") AND ("food" OR "food supply" OR "food

industry" OR "food supply chain" OR "food security" OR "food fraud" OR "food quality" OR "food safety" OR "food scandal" OR "food trust" OR "food waste" OR "food traceability" OR "food transparency" OR "food supply chain management" OR "agriculture" OR "agricultural" OR "agri-food" OR "agrifood" OR "agri*" OR "agro*")

The primary online search was conducted in 2019 using the string mentioned above. A batch of 103 documents was screened. Seventy-five (78) documents were selected from the filtered academic papers. The study proceeded to add documents for analysis until no new themes appeared, resulting in a final dataset of 40 documents. Table 5.1 shows a breakdown of the year and the types of sources analyzed. Then, a thematic analysis of 40 documents was conducted using NVivo 12 software, which helped highlight the factors, impacts, and challenges of BCT adoption.

Table 5.1: Document sources

Year	**Newspaper**	**web pages**	**Media**	**Reports**
2016	3	2	1	5
2017	7	1	1	3
2018	15	14	4	23
2019	8	10	0	6
2020	20	13	1	12
2021	12	9	2	19
Total	65	49	9	68

5.3.2 Second Data Collection

Netnography is designed to study online cultures and communities (Kozinets, 2002). This method allows using available online resources to obtain a public viewpoint on a specific topic or idea. The internet is filled with a large amount of information in various areas. It allows individuals to share their thoughts and opinions on various topics (Kaya et al., 2017). With the increasing relevance of social networks, online spaces are exceptional and productive for research. In Bowler Jr (2010), the authors state that "netnography is an excellent resource for seasoned qualitative researchers and a useful entry point for newcomers to qualitative research". This study adopted a non-participant form of netnography to understand experts' opinions on blockchain adoption by qualitatively analyzing social media posts on Facebook, Twitter, and LinkedIn.

This study gathered 98 comments discussing ideas related to BCT adoption. This study used these posts as secondary data on concepts associated with BCT adoption. This study used these posts as secondary data. Data screening was conducted to determine relevant posts, meaning that some posts (or comments) were unrelated to the research question and were omitted from the study. This study chose 44 of the 98 comments and categorized them accordingly. The following section discusses the findings based on the data collected from the two data collections.

5.4 Findings of Document Analysis

Based on content analysis, this study found that blockchain adoption was influenced by cost, awareness, and storytelling. This study also found that trust, transparency, and visibility impact the FSC processes. At the same time, the risk was considered challenging in blockchain implementation based on the analysis of the documents listed in Table 5.2.

Table 5.2: Analysis of the documents

Factors	**Impacts**	**Challenges**
Cost Awareness storytelling	Trust Transparency Visibility	Risks

5.4.1 Factors

Cost has been shown to be a powerful barrier to technology adoption and usage (L. G. Tornatzky & Klein, 1982).

Observation 1. Experts mentioned that blockchain could improve the Return on Investment (RoI), which most organizations want in their business. Experts have also highlighted that selling a solution rather than technology, is better. The answer may be to use blockchain as an underlying technology, but the idea is to provide a cost-effective solution that addresses business problems. As a D1 stated, "*Why do not sell solutions other than blockchain? Do folks care if you are implementing blockchain or only about how you can save 20% or more? If you cannot do the latter, will they buy what you sell?"*. While (D2) added: "*First, the current workflow must be understood. They can analyze how their systems can be beneficial to the blockchain. We need to provide them with actual data on how they can improve their customer base and increase their margins".*

Observation 2. Cost is a significant factor in blockchain adoption in any industry seeking blockchain implementation. Blockchain reduces operational costs (Nagy et al., 2016; Shen et al., 2010). The most important aspect is cost savings. As stated in (D3), “*There are two ways to make a business more emotional. You can either help them make money or save money”.*

Inference 1. These findings are consistent with those reported by Nagy et al. (2016); (Shen et al., 2010; Walsh et al., 2002), showing that cost plays a critical role in adopting new and disruptive technologies.

Awareness has been identified as a significant factor in technology adoption. Blockchain awareness among individuals and organizations is essential (Lee & Blouin, 2019). *Suppose we ensure that people understand blockchain and how it works. This will increase the overall knowledge of the technology. In this case, they are more likely to understand the benefits of blockchain, which will help increase adoption*.

Observation 3. Another thing to consider is the benefit obtained by providing workshops with real business use cases and examples because many people only see the one-use case of blockchain as a cryptocurrency. Thus, this perception must be changed. For instance, blockchain is a perfect solution for customers facing transparency problems in supply chains. As stated by one expert: “*Explain it simply in one sentence that even a child would understand and follow up with use cases” (D8)*

Observation 4. Creating awareness among individuals and organizations is essential for educating people about blockchain solutions and their potential benefits to industries. D10 said, “*Make it easy to understand. Break it down into pieces of the puzzle that are simpler to comprehend. Focus on identifying pain areas and highlighting how blockchain technology can solve these critical issues most efficiently and fully-proof. You will see a more favourable response and reaction*”.

Furthermore, D6 added: "*Do not talk about blockchain. It is just a new layer of a boring tech stack that the C suite already knows nothing about. Talk about the problems you are solving.*"

Observation 5. Once individuals and organizations realize what blockchain can do and how it can help grow businesses, they can adopt it. Otherwise, they will be sceptical. D11 said, "*You cannot sell something to people who do not understand its benefits. Therefore, putting your time and energy into educating business leaders would be best. Blockchain is here. We are already witnessing the potential benefit to many industries*".

Inference 2. These findings also align with research that has mentioned awareness as an influential factor in technology adoption (Quaddus & Hofmeyer, 2007; Sabah, 2016; Safeena et al., 2012).

Storytelling was identified as a factor leading to blockchain adoption (Ch'ng et al., 2019; Revythi & Tselios, 2019). Storytelling helps customers relate to and understand how technology can solve their business problems. When you take a customer through a storytelling journey, you can clearly describe their problems, show when and where technology can resolve them, and showcase the benefits of technology adoption. These comments came from experts such as directors and senior managers. The experts support the following statements:

Storytelling has been identified as a factor that leads to blockchain adoption (Ch'ng et al., 2019; Revythi & Tselios, 2019). Storytelling helps customers to relate to and understand how technology can solve business problems. When you take a customer through a storytelling journey, you can clearly describe their problems, show when and where technology can resolve them, and showcase the benefits of adopting technology. These comments came from experts such as directors and senior managers. The experts D13 supported the following statements: "*Outline a pain/risk-mitigating scenario in their world and do not mention blockchain until they have bought it as a viable solution. It is great to say, " What if I tell you that what I explained is possible using blockchain technology?"*

Observation 6. Storytelling works by giving examples that relate to people's mindsets and business models: D1 mentioned, "*They focus on their existing challenges and offer blockchain solutions that cannot be attained with their current systems. Important to emphasize the integration point of blockchain tech and its legacy systems"* D15 statement stated, "*Blockchain may only solve a fraction of the problem, which is okay. Blockchain purists may argue that this approach defeats the point of implementing blockchain technology altogether, but for the enterprise above executives, a gradual transition is the best way forward"*.

Inference 3. These findings align with Akgün et al. (2015), who stated that storytelling is crucial for adopting technology.

5.4.2 Impacts

The practitioner literature review was used with organization reports and websites, newspaper articles, and press releases to present solid evidence of FSC. The search was restricted to these sources because it is believed that the information published has passed some level of information verification before publication. BCT research is still in its infancy, and only a few scholarly papers exist. Literature from mainstream media outlets covering blockchain extensively can demonstrate practical knowledge of the subject. This section discusses the impact and challenges of adopting BCT.

Trust is an essential factor that affects technology adoption (AlAwadhi, 2019; Mendling et al., 2018). We know that people buy from those they "trust". For a business that offers a "digital trust machine, " blockchain first needs to build trust as an individual and an organization. The supporting statements from experts also recap this argument: “*Sell them the power and trust of blockchain and tell them that they can change the world. Confidence and experience play an important role. Note: Blockchain is not the answer to every question*” (D23). And: “*One's approach depends on relationships, trust, client openness, etc. The key is to take an incremental approach, take it slowly, and not try to suggest the complete flipping of legacy. However, augmenting legacy systems to modernize and make them more robust and secure*” (D26)

But as (D20) states, *“I would tell them that using a blockchain means having a mechanism that enables and "structures" the trust between the parties: each relevant participant keeps its copy, always updated, of the "ledger" of the transactions”.*

Observation 7. Most people do not care about the technology. They usually care about how to solve their problems and improve their lives. In one expert’s opinion, “*Give them basic examples, then explain to them how they can use blockchain to grow their business and do not have to trust intermediaries to run their business”* (D19)

Inference 4. The findings also confirm that trust is a vital component influencing innovation adoption (Alzahrani et al., 2017; Gao & Waechter, 2017; Lippert & Davis, 2006; Rouibah et al., 2016).

Efficiency (or business efficiency) is another crucial factor for technology adoption. Organizations usually consider technology that adds value to their business and makes it more efficient and accurate (Akroush et al., 2019). These findings suggest that efficiency is a crucial impact of BCT adoption. The experts support the following statements *“Like any sale, sell them the benefits they apply to them, not the underlying* *technology. Find the pain that their current solution is creating, and tell them how the new one solves it"* (D22)

Observation 8. Selling a solution to improve business efficiency is better than a blockchain. This was supported by D6 "*Customers demand trust, transparency, and efficiency. That is what you sell. Blockchain is the name of the technology"*.

Inference 5. These findings align with Galang (2012) study that efficiency is essential for adopting technology.

Transparency organizations can also enforce the intended level of transparency and prevent unintentional information leakage. Organizations are impacted in several ways by the transparency afforded by blockchain, as stated in the following statement "*To safeguard the privacy and the exchange of crucial data, organisations can predetermine the conditions and access privileges under which blockchain solutions will function"* (D11)

Supply chain resilience has benefited from improvements in information transparency made possible by blockchain technology. Supported by D19, "*Businesses can foresee and plan their operations more effectively because of blockchain transparency, which reduces supply and demand uncertainties"*.

Observation 9. Constant information poured into the blockchain by firms in the supply chain network is a significant difficulty in maintaining transparency. As backed by D14, "*Blockchain transparency reduces supply and demand uncertainty, enabling organizations to plan and forecast more effectively"* And "*The beginning of a good or service, together with every stop along the road, can be tracked and documented"* (D8)

Visibility is beneficial in risky and uncertain times by enabling more effective security measures against fraud and modification, improving forecasting through information sharing, and identifying visible and invisible dangers, such as cyberattacks, computer hacking, declined credit applications, and contract fraud. Blockchain requires organizations to have new information-sharing and information-processing skills to affect visibility. D18 presented, "*For enterprises to impact visibility, new information processing and information-sharing capabilities are required*".

5.4.3 Challenges

Risk is a fear for an organization; hence, any approach that can mitigate or reduce risk will be valued by organizations.

Observation 10. If BCT can help an organization manage risks better, they will consider it; otherwise, no. This is because organizations seek technology to reduce risks and increase the RoI. The following statements from one expert indicate that cost is an essential factor to be considered: "*You do not sell blockchain any more than you sell databases or backup archives. These are tools. You sell how to reduce the risk or increase the ROI"* (D4). **Observation 11.** Facilitating the value transfers (D7): "*Many financial risks, including financial losses, need to be considered while developing such blockchain applications".* Risk management is supported by D17 "*No technology, including the blockchain, is at risk. The long-time winners in the blockchain space know how to recognize the quantity of risk and manage the risk in a blockchain-based application?"*

5.5 Summary

The findings from this study identified relevant factors, impacts, and challenges of BCT based on social media reports. With the approval of other companies in the supply chain network, information transparency enables various entities to track the transit of goods. Because of this, there are fewer opportunities for fake products and dishonest business methods, which improves industrial performance. Improvements in efficiency, effectiveness and sustainability depend on managing disruptions, stakeholder collaborations, involvement, and sustainable performance. A lack of stakeholder collaboration and participation, privacy concerns, and intolerance of blockchain immutability may impact performance and sustainability. Although this relies on elements including product quality, store brand awareness and image, supplier supply fluctuation, and customer surplus, blockchain also has the potential to impact economic sustainability. Blockchain fosters industrial coordination by minimising fragmentation, discoordination, and ineffective operation. End-to-end digitisation requirements can be affected by blockchain to improve network visibility and communication. Blockchain can also assist traceability and transparency at the industry level by collecting and making supply chain data accessible to all stakeholders.

Chapter 6. Conclusion

6.1 Introduction

This Chapter discusses the findings of the three studies outlined in Chapters 2, 4, and 5. Section 6.2 presents a summary of the three studies and a discussion. Section 6.3 summarises the limitations, and Section 6.4 outlines future work. Parts of this chapter have been published in the Journals[6].

6.2 Discussions

As discussed in the previous chapters, the three studies included SLR, qualitative analysis, and digital content of BCT in the FSC. Table 6.1 outlines a summary of these studies.

Table 6.1 Summary of the three studies

Studies	**Key findings**		
SLR	**Factors**	**Impacts**	**Challenges**
	Traceability Transparency Decentralized Immutability Provenance Smart contract	Food safety and quality Data security Performance and sustainability Efficiency	Scalability Interoperability Lack of expertise Regulations

[6] Parts of this chapter have been published in the following publication:

a. Mohammed, A.; Potdar, V.; Quaddus, M. Exploring Factors and Impact of Blockchain Technology in the Food Supply Chains: An Exploratory Study. *Foods* **2023**, *12*, 2052.

		Trust and collaboration	
Qualitative Study	**Factors**	**Impact**	**Challenges**
	Complexity Compatibility Cost Resource Organization size Knowledge Management support Attitude Government support Competitive pressure Standardization Compliance	Visibility Performance Operational efficiency Trust Value creation	Interoperability Privacy Infrastructure conditions Lack of knowledge
Digital Contents	**Factors**	**Impact**	**Challenges**
	Cost Awareness Storytelling	Efficiency Visibility Transparency Trust	Risk

The results demonstrate that blockchain offers security, peer-to-peer authentication, smart contracts, and transparent information sharing, reducing the effects of technology integration and collaboration with participants in the network. The shared understanding of FSC data, the basic functionality of the current system embedded in the blockchain, standards for interoperability, and collaboration from FSC partners are crucial elements for facilitating successful blockchain-based inter-organizational integration. The rationale is that one supply chain actor's adoption and integration decision would cascade impact, other network participants. BCT can improve supply chain traceability and transparency. The transparency between organizations and supply chain traceability can be improved by using BCT. However, there are several requirements that the supply chain must first fulfil. These requirements include creating a shared platform, standardized interfaces, and regulations. BCT has been shown to impact enterprises by improving RoI and reducing transaction costs positively. Blockchain technology can also affect profitability by enabling trustworthy performance indicators and influencing price sensitivity through effective information exchange. Blockchain can potentially improve the supply chain's efficiency and reduce transaction costs and time. Such optimization reduces intermediary fees, the required number of operations, order processing time, operational and security risks related to intermediary involvement, privacy concerns, and other compliance-related issues. This study explores the adoption of BCT within the FSC. To do so, an extensive review of previous literature was conducted to create a frame of reference that served as the basis of this thesis. Twenty-one semi-structured interviews were conducted with relevant expectations in the food industry. Three proposed research questions were answered.

RQ1: What factors influence the adoption of BCT into the food supply chain?

RQ2: What are the impacts of BCT on the FSC?

RQ3: What are the significant challenges to BCT adoption in FSC?

These findings comply with previous research on BCT adoption in FSCs, as several factors were found in the SLR, qualitative study, and document analysis. However, the findings of this study categorize and connect these factors in different ways. Several other impacts of BCT adoption have been identified as challenges of BCT adoption. These factors, impact, and challenges were merged to develop a framework for BCT adoption in the food supply chain, as presented in Figure 6.1.

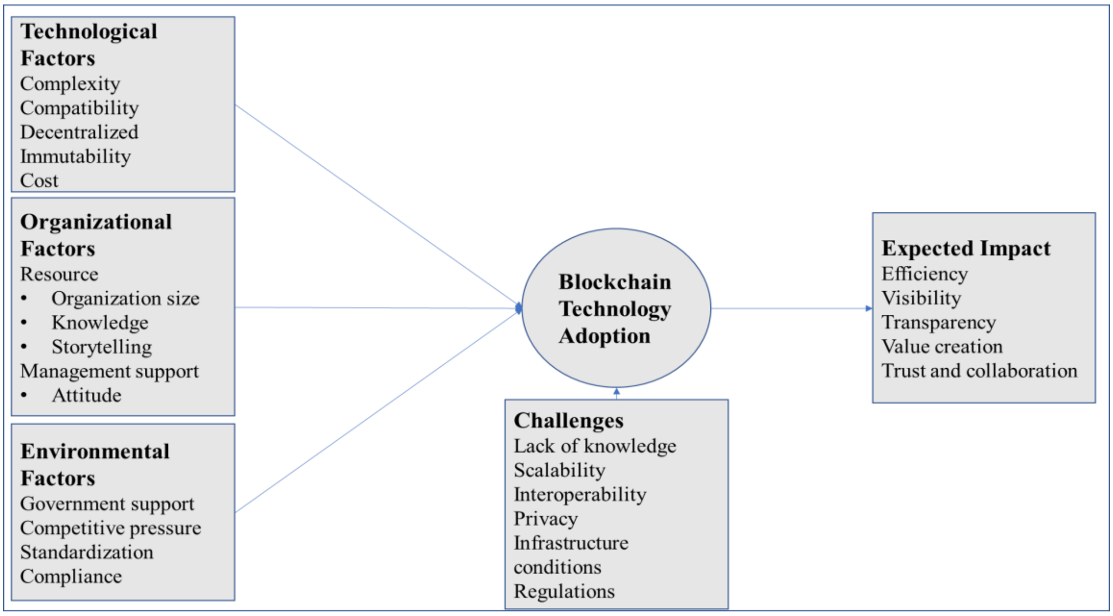

Figure 6.1: Framework of blockchain technology adoption in the food supply chain

Collectively, these three studies contribute to previous studies on BCT in the FSC, which are discussed as follows.

First, this study summarizes the knowledge of blockchain factors, impacts, and challenges in FSC. The SLR findings highlight the relevance of blockchains in FSC. The results of the SLR analysis indicate that blockchain is a promising technology for transforming FSCs and can potentially solve some of the issues inherent in FSCs. Blockchain can improve product traceability and speed up the determination of the origin of products linked to recalls due to concerns about contamination, falsification, or other violations of food safety regulations. Blockchain also provides end-to-end product traceability and tracks food products at every stage of the food supply chain. The study's findings identify traceability, transparency, decentralized databases, provenance, and smart contracts as the most significant factors driving blockchain adoption. The results also discussed the impact of BCT and how it can enhance food quality, safety, data security, trust, collaboration, performance, and sustainability in FSC processes. The results also show how helpful blockchain can be for FSC collaboration. Blockchain allows the FSC stakeholders to work together more efficiently and effectively. These findings also suggest that this could improve the performance and sustainability of food supply chains. This study proposed a conceptual framework for BCT adoption in an FSC. This framework integrates the factors, impacts, and challenges of BCT adoption and can further explore blockchain adoption within other industry contexts to understand the effects and advantages of BCT.

Second, the results of this study conclude that transparency and traceability are variables and benefits that can help achieve the primary goal of adoption, in contrast to other studies that highlight them as the primary factors and advantages of adopting BCT. The study discovered complexity, compatibility, cost (technology), resources, size and knowledge, management support and attitude (organization), government support, competition pressure, standards, and compliance (environment) as the critical factors of BCT adoption in the food supply chain. Several other BCT advantages were emphasized as elements that can aid organizations in achieving this objective and are therefore seen as secondary motivations for implementing the technology.

Third, based on social media reports, this study identified the relevant factors, impacts, and challenges of BCT. Information transparency allows different organizations to follow the movement of items with the consent of other organizations in the supply chain network. As a result, there are fewer opportunities for dishonest business practices and fraudulent items that boost industrial performance. Management of disruptions, stakeholder collaboration, involvement, and sustainable performance is necessary to improve efficiency, effectiveness, and sustainability. A lack of stakeholder cooperation and participation, privacy concerns, and intolerance of blockchain immutability may influence performance and sustainability. Blockchain also has the potential to impact economic sustainability, although it is dependent on factors such as product quality, retailer brand recognition and image, supplier supply fluctuation, and customer excess. Blockchain promotes industrial coordination by reducing fragmentation, discoordination, and inefficient operation. Blockchain can affect end-to-end digitalization requirements to enhance communication and network visibility.

6.3 Limitations

This study was constrained by the early stages of BCT adoption, making it more challenging to connect with food industries with sufficient background knowledge and experience with the phenomenon. As a result, the organizations participating in this study maintain varying degrees of BCT adoption experience and expertise, which forces researchers to engage with and thoroughly study the empirical data. The intention to concentrate on a particular supply chain was constrained by the absence of organisations with expertise and experience in BCT adoption and producing the same product, which is related to the immature stage of BCT adoption in the food industry. As a result, this study focuses on the food industry. The absence of academic studies on BCT adoption in general and those relevant to the food industry might be considered a limitation. First, we only covered the qualitative approach in this study. The literature lacks empirical studies, so a qualitative approach is ideal for our research. Second, only one case study has focused on the food supply chain. We did not focus on a specific food supply chain, such as the milk or grain supply chains.

However, our research sets the foundation for others to undertake future research that could focus on specific product supply chains or investigate a specific factor or factor(s). Third, all interviews were conducted online due to COVID restrictions. This might have impacted the quality of the interviews, as when interviews were face-to-face, people could be more engaged and provided additional details. However, we ensured that the interviews were engaged as much as possible to gather sufficient depth. Fourth, many companies have not yet implemented blockchain; therefore, many of their responses were based on their assumptions. In other cases, companies that had implemented blockchain only had the platform running for a short period as a pilot and hence, even explored the benefits and challenges of their implementation. However, the information they provided during the interviews was still very useful in understanding the benefits they perceived of using blockchain, the challenges they faced, and the impacts they observed.

6.4 Future Work

There are many future research directions that we identified based on this research. We list five future research directions that we consider promising for future research. First, one line of inquiry for future research is BCT's adoption of a particular product supply chain in the food business. This recommendation is supported by research that shows that product attributes and other supply chain circumstances influence firms' adoption decisions. Therefore, such a study would offer more detailed perceptions of the adoption process. Second, the additional research could strengthen, investigate, and test the BCT framework described in this study; for instance, undertaking a multiple case study that enables a more in-depth examination of the justifications for various firms' adoption choices and strategies. Third, we conducted quantitative studies to validate the findings presented here. There are still limited empirical studies in the literature, and it would be timely to undertake quantitative studies over the next two to three years. Fourth, in the food supply chain, current studies are still focused on the conceptual level, and some studies have developed and tested a pilot. Future studies can focus on a longitudinal study in which blockchain implementation and use can be researched over two or three years. This will provide additional insights into the challenges and benefits of using blockchain technology. Researchers can also investigate the real-time application of blockchain and assess it from technological, environmental, and organizational perspectives to understand its challenges and potential impacts (both positive and negative).

Fifth, another essential research direction is to evaluate the factors, challenges, and impacts in the light of technology fusion, that is, combining blockchain with other emerging technologies such as artificial intelligence, machine learning, big data, the Internet of things, cloud computing, and robotic process automation. Blockchains have technological limitations. For example, one area where blockchain can be challenging is when data are entered manually. It is possible that such data can be erroneous or lead to manual data entry errors. If Blockchain is combined with IoT, where IoT sensors capture data and directly store it on the blockchain, trust in the overall blockchain solution will be much higher. In such cases, researchers can explore new models and frameworks to integrate different technologies to obtain better results efficiently. Sixth, researchers can investigate the complete life cycle assessment of a particular crop or food product to understand the impact of carbon emissions during the growth cycle. Blockchain can record carbon emission-related information throughout the supply chain, from farm to fork. Several challenges would need to be resolved during this process; hence, this will be a promising future research direction.

Blockchain technology has shown promising potential for substantially improving transparency and traceability in the food supply chain. Building a transparent food supply chain improves trust among consumers calling for better transparency on how and where their food is grown. Consumers are becoming more sensitive to what they eat and what they feed to their families. Hence, any technology that can help to improve this situation would be beneficial. Blockchain has shown promise as a technology for meeting consumer expectations. In the future, as technology matures, these benefits will be realized, and consumers will be happy and confident.

6.5 Conclusion

This study investigates the factors that drive blockchain technology adoption in food supply chains. In addition, five impacts on BCT adoption were identified (efficiency, transparency, visibility, value creation, and trust and collaboration). This study also identified the significant challenges of BCT (scalability, interoperability, privacy, infrastructure conditions, and lack of knowledge). Based on this, this study develops a framework for blockchain adoption in FSCs. It is hoped that the food supply chain will benefit from blockchain technology.

This study contributes to the body of knowledge by providing insights into the adoption of BCT and its impact on FSCs while providing the industry with evidence-based direction to build its blockchain strategy. Furthermore, this study offers a thorough understanding and awareness of blockchain adoption issues among executives, supply chain organizations, and government bodies.

References

Aitken, R. (2017). IBM & Walmart Launching Blockchain Food Safety Alliance In China With Fortune 500's JD.com. *forbes.com*. https://www.forbes.com/sites/rogeraitken/2017/12/14/ibm-walmart-launching-blockchain-food-safety-alliance-in-china-with-fortune-500s-jd-com/?sh=279117a27d9c

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, *50*(2), 179-211.

Ajzen, I., & Fishbein, M. (1975). A Bayesian analysis of attribution processes. *Psychological bulletin*, *82*(2), 261.

Ajzen, I., & Fishbein, M. (2004). Questions raised by a reasoned action approach: comment on Ogden (2003).

Akgün, A. E., Keskin, H., Ayar, H., & Erdoğan, E. (2015). The influence of storytelling approach in travel writings on readers' empathy and travel intentions. *Procedia-Social and Behavioral Sciences*, *207*, 577-586.

Akroush, M. N., Zuriekat, M. I., Al Jabali, H. I., & Asfour, N. A. (2019). Determinants of purchasing intentions of energy-efficient products: The roles of energy awareness and perceived benefits. *International Journal of Energy Sector Management*.

AlAwadhi, S. (2019). A proposed model of trust factors for e-government adoption and civic engagement. Proceedings of the 52nd Hawaii International Conference on System Sciences.

Aldrighetti, A., Canavari, M., & Hingley, M. K. (2021). A Delphi Study on Blockchain Application to Food Traceability. *International Journal on Food System Dynamics*, *12*(1), 6-18. https://doi.org/10.18461/ijfsd.v12i1.72

Alketbi, A., Nasir, Q., & Talib, M. A. (2018). Blockchain for government services—Use cases, security benefits and challenges. 2018 15th Learning and Technology Conference (L&T).

Alzahrani, L., Al-Karaghouli, W., & Weerakkody, V. (2017). Analysing the critical factors influencing trust in e-government adoption from citizens' perspective: A systematic review and a conceptual framework. *International business review*, *26*(1), 164-175.

Andoni, M., Robu, V., Flynn, D., Abram, S., Geach, D., Jenkins, D., McCallum, P., & Peacock, A. (2019). Blockchain technology in the energy sector: A systematic review of challenges and opportunities. *Renewable and Sustainable Energy Reviews*, *100*, 143-174.

Antonucci, F., Figorilli, S., Costa, C., Pallottino, F., Raso, L., & Menesatti, P. (2019). A review on blockchain applications in the agri-food sector. *Journal of the Science of Food and Agriculture*, *99*(14), 6129-6138. https://doi.org/10.1002/jsfa.9912

Astill, J., Dara, R. A., Campbell, M., Farber, J. M., Fraser, E. D., Sharif, S., & Yada, R. Y. (2019). Transparency in food supply chains: A review of enabling technology solutions. *Trends in Food Science & Technology*, *91*, 240-247.

Balamurugan, S., Ayyasamy, A., & Joseph, K. S. (2021). IoT-Blockchain driven traceability techniques for improved safety measures in food supply chain. *International Journal of Information Technology (Singapore)*. https://doi.org/10.1007/s41870-020-00581-y

Baralla, G., Ibba, S., Marchesi, M., Tonelli, R., & Missineo, S. (2018). A blockchain based system to ensure transparency and reliability in food supply chain. European conference on parallel processing.

Baviskar, D., Ahirrao, S., Potdar, V., & Kotecha, K. (2021). Efficient automated processing of the unstructured documents using artificial intelligence: A systematic literature review and future directions. *IEEE Access*, *9*, 72894-72936.

Bayer, D., Haber, S., & Stornetta, W. S. (1993). Improving the efficiency and reliability of digital time-stamping *Sequences Ii* (pp. 329-334). Springer.

Behnke, K., & Janssen, M. (2020). Boundary conditions for traceability in food supply chains using blockchain technology. *International Journal of Information Management*, *52*, 101969.

Behnke, K., & Janssen, M. F. W. H. A. (2020). Boundary conditions for traceability in food supply chains using blockchain technology. *International Journal of Information Management*, *52*, 101969. https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2019.05.025

Bernard, H. R. (1996). Qualitative data, quantitative analysis. *CAM Journal*, *8*(1), 9-11.

Bernardi, P., Gandino, F., Lamberti, F., Montrucchio, B., Rebaudengo, M., & Sanchez, E. (2008). An anti-counterfeit mechanism for the application layer in low-cost RFID devices. 2008 4th European Conference on Circuits and Systems for Communications.

Bhimani, H., Mention, A.-L., & Barlatier, P.-J. (2019). Social media and innovation: A systematic literature review and future research directions. *Technological Forecasting and Social Change*, *144*, 251-269.

Blossey, G., Eisenhardt, J., & Hahn, G. (2019). Blockchain technology in supply chain management: An application perspective.

Boffey, D., & Connolly, K. (2017). Egg contamination scandal widens as 15 EU states, Switzerland and Hong Kong affected. *Support The Guardian*. https://www.theguardian.com/world/2017/aug/11/tainted-eggs-found-in-hong-kong-switzerland-and-15-eu-countries#:~:text=Europe's%20latest%20food%20scandal%20has,insecticide%20harmful%20to%20human%20health.

Bowen, G. A. (2006). Grounded theory and sensitizing concepts. *International journal of qualitative methods*, *5*(3), 12-23.

Bowler Jr, G. M. (2010). Netnography: A method specifically designed to study cultures and communities online. *The qualitative report*, *15*(5), 1270.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.

Braun, V., & Clarke, V. (2012). *Thematic analysis*. American Psychological Association.

BRC. (2022). *Global Blockchain In Banking And Financial Services Market*. Retrieved 10.10.2022, 2022, from https://www.thebusinessresearchcompany.com/report/blockchain-in-banking-and-financial-services-global-market-report#:~:text=The%20global%20blockchain%20in%20the,least%20in%20the%20short%20term.

Brody, P., Pureswaran, V., Panikkar, S., & Nair, S. (2015). Empowering the edge Practical insights on a decentralized Internet of Things. *IBM Institute for Business Value. Technical report*.

Bumblauskas, D., Mann, A., Dugan, B., & Rittmer, J. (2020a). A blockchain use case in food distribution: Do you know where your food has been? *International Journal of Information Management*, *52*, 102008. https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2019.09.004

Bumblauskas, D., Mann, A., Dugan, B., & Rittmer, J. (2020b). A blockchain use case in food distribution: Do you know where your food has been? *International Journal of Information Management*, *52*, N.PAG-N.PAG. https://doi.org/10.1016/j.ijinfomgt.2019.09.004

Caldarelli, G., Rossignoli, C., & Zardini, A. (2020). Overcoming the blockchain oracle problem in the traceability of non-fungible products. *Sustainability*, *12*(6), 2391.

Callinan, C., Vega, A., Clohessy, T., & Heaslip, G. (2022). Blockchain adoption factors, enablers, and barriers in fisheries supply chain: preliminary findings from a systematic literature review. *The Journal of The British Blockchain Association*, 32437.

Cao, S., Powell, W., Foth, M., Natanelov, V., Miller, T., & Dulleck, U. (2021). Strengthening consumer trust in beef supply chain traceability with a blockchain-based human-machine reconcile mechanism. *Computers and Electronics in Agriculture*, *180*, Article 105886. https://doi.org/10.1016/j.compag.2020.105886

Cartier, L. E., Ali, S. H., & Krzemnicki, M. S. (2018). Blockchain, Chain of Custody and Trace Elements: An Overview of Tracking and Traceability Opportunities in the Gem Industry. *Journal of Gemmology*, *36*(3).

Casino, F., Dasaklis, T. K., & Patsakis, C. (2019). A systematic literature review of blockchain-based applications: Current status, classification and open issues. *Telematics and informatics*, *36*, 55-81.

Casino, F., Kanakaris, V., Dasaklis, T. K., Moschuris, S., & Rachaniotis, N. P. (2019). Modeling food supply chain traceability based on blockchain technology. *IFAC-PapersOnLine*, *52*(13), 2728-2733. https://doi.org/https://doi.org/10.1016/j.ifacol.2019.11.620

Casino, F., Kanakaris, V., Dasaklis, T. K., Moschuris, S., Stachtiaris, S., Pagoni, M., & Rachaniotis, N. P. (2020). Blockchain-based food supply chain traceability: a case study in the dairy sector. *International Journal of Production Research*, 1-13. https://doi.org/10.1080/00207543.2020.1789238

Cermeño, J. S. (2016). Blockchain in financial services: Regulatory landscape and future challenges for its commercial application. *BBVA Research Paper*, *16*, 20.

Ch'ng, E., Cai, S., Leow, F.-T., & Zhang, T. E. (2019). Adoption and use of emerging cultural technologies in China's museums. *Journal of Cultural Heritage*, *37*, 170-180.

Chan, K. Y., Abdullah, J., & Khan, A. S. (2019). A framework for traceable and transparent supply chain management for agri-food sector in malaysia using blockchain technology. *International Journal of Advanced Computer Science and Applications*, *10*(11), 149-156. https://doi.org/10.14569/IJACSA.2019.0101120

Chang, A. (2012). UTAUT and UTAUT 2: A review and agenda for future research. *The Winners*, *13*(2), 10-114.

Chang, Y., Iakovou, E., & Shi, W. (2020). Blockchain in global supply chains and cross border trade: a critical synthesis of the state-of-the-art, challenges and opportunities. *International Journal of Production Research*, *58*(7), 2082-2099.

Chen, S., Liu, X., Yan, J., Hu, G., & Shi, Y. (2020). Processes, benefits, and challenges for adoption of blockchain technologies in food supply chains: a thematic analysis. *Information Systems and e-Business Management*, 1-27.

Chilisa, B., & Kawulich, B. (2012). Selecting a research approach: Paradigm, methodology and methods. *Doing social research: A global context*, *5*(1), 51-61.

Chittipaka, V., Kumar, S., Sivarajah, U., Bowden, J. L.-H., & Baral, M. M. (2022). Blockchain Technology for Supply Chains operating in emerging markets: an empirical examination of technology-organization-environment (TOE) framework. *Annals of Operations Research*, 1-28.

Cocco, L., Mannaro, K., Tonelli, R., Mariani, L., Lodi, M. B., Melis, A., Simone, M., & Fanti, A. (2021). A Blockchain-Based Traceability System in Agri-Food SME: Case Study of a Traditional Bakery. *IEEE Access*, *9*, 62899-62915, Article 9410538. https://doi.org/10.1109/ACCESS.2021.3074874

Collart, A. J., & Canales, E. (2021). How might broad adoption of blockchain-based traceability impact the U.S. fresh produce supply chain? *Applied Economic Perspectives & Policy*, 1. https://doi.org/10.1002/aepp.13134

Collart, A. J., & Canales, E. (2022). How might broad adoption of blockchain-based traceability impact the US fresh produce supply chain? *Applied Economic Perspectives and Policy*, *44*(1), 219-236.

Collis, J., & Hussey, R. (2003). Business research: A practical guide for undergraduate and postgraduate students.

Collis, J., & Hussey, R. (2014). Writing up the Research *Business Research* (pp. 297-330). Springer.

Conner, M. (2020). Theory of planned behavior. *Handbook of sport psychology*, 1-18.

Cooper, R. B., & Zmud, R. W. (1990). Information technology implementation research: a technological diffusion approach. *Management science*, *36*(2), 123-139.

Costa, C., Antonucci, F., Pallottino, F., Aguzzi, J., Sarriá, D., & Menesatti, P. (2013). A review on agri-food supply chain traceability by means of RFID technology. *Food and bioprocess technology*, *6*(2), 353-366.

Creswell, J. W. (2003). *Research design: qualitative, quantitative, and mixed methods approaches*. Sage Publications.

Crosby, M., Pattanayak, P., Verma, S., & Kalyanaraman, V. (2016). Blockchain technology: Beyond bitcoin. *Applied Innovation*, *2*(6-10), 71.

Crotty, M. J. (1998). The foundations of social research: Meaning and perspective in the research process. *The foundations of social research*, 1-256.

Damoska Sekuloska, J., & Erceg, A. (2022). Blockchain Technology toward Creating a Smart Local Food Supply Chain. *Computers*, *11*(6), 95.

Dasgupta, S., Granger, M., & McGarry, N. (2002). User acceptance of e-collaboration technology: An extension of the technology acceptance model. *Group Decision and Negotiation*, *11*(2), 87-100.

Datta, A. (2019). Blockchain in the government technology fabric. *arXiv preprint arXiv:1905.08517*.

David, A., Kumar, C. G., & Paul, P. V. (2022). Blockchain technology in the food supply chain: empirical analysis. *International Journal of Information Systems and Supply Chain Management (IJISSCM)*, *15*(3), 1-12.

Davidson, J., Paulus, T., & Jackson, K. (2016). Speculating on the future of digital tools for qualitative research. *Qualitative Inquiry*, *22*(7), 606-610.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

Dehghani, M., Popova, A., & Gheitanchi, S. (2022). Factors impacting digital transformations of the food industry by adoption of blockchain technology. *Journal of Business & Industrial Marketing*, *37*(9), 1818-1834.

Dimitrov, D. V. (2019). Blockchain applications for healthcare data management. *Healthcare informatics research*, *25*(1), 51-56.

Dorling, D. (2021). World population prospects at the UN: our numbers are not our problem? *The Struggle for Social Sustainability: Moral Conflicts in Global Social Policy*, 129.

Duan, J., Zhang, C., Gong, Y., Brown, S., & Li, Z. (2020). A Content-Analysis Based Literature Review in Blockchain Adoption within Food Supply Chain. *International Journal of Environmental Research and Public Health*, *17*(5), 1784.

Duan, J., Zhang, C., Gong, Y., Brown, S., & Li, Z. (2020). A content-analysis based literature review in blockchain adoption within food supply chain. *International Journal of Environmental Research and Public Health*, *17*(5), Article 1784. https://doi.org/10.3390/ijerph17051784

Dunphy, P., & Petitcolas, F. A. (2018). A first look at identity management schemes on the blockchain. *IEEE security & privacy*, *16*(4), 20-29.

Dutta, P., Choi, T.-M., Somani, S., & Butala, R. (2020). Blockchain technology in supply chain operations: Applications, challenges and research opportunities. *Transportation research part e: Logistics and transportation review*, *142*, 102067.

Egelund-Müller, B., Elsman, M., Henglein, F., & Ross, O. (2017). Automated execution of financial contracts on blockchains. *Business & Information Systems Engineering*, *59*(6), 457-467.

Espadanal, M., & Oliveira, T. (2012). Cloud computing adoption by firms. Proceedings of Mediterranean Conference on Information Systems (MCIS).

Feng, H., Wang, X., Duan, Y., Zhang, J., & Zhang, X. (2020). Applying blockchain technology to improve agri-food traceability: A review of development methods, benefits and challenges. *Journal of cleaner production*, *260*, 121031.

Feng, T. (2016, 24-26 June 2016). An agri-food supply chain traceability system for China based on RFID & blockchain technology. 2016 13th International Conference on Service Systems and Service Management (ICSSSM). https://doi.org/10.1109/ICSSSM.2016.7538424

Feng, T. (2017, 16-18 June 2017). A supply chain traceability system for food safety based on HACCP, blockchain & Internet of things. 2017 International Conference on Service Systems and Service Management. https://doi.org/10.1109/ICSSSM.2017.7996119

Folkerts, H., & Koehorst, H. (1997). Challenges in international food supply chains: vertical co-ordination in the European agribusiness and food industries. *Supply Chain Management: An International Journal*, *2*(1), 11-14. https://doi.org/10.1108/13598549710156312

Fosso Wamba, S., Queiroz, M. M., & Trinchera, L. (2020). Dynamics between blockchain adoption determinants and supply chain performance: An empirical investigation. *International Journal of Production Economics*, *229*, 107791. https://doi.org/https://doi.org/10.1016/j.ijpe.2020.107791

Galang, R. M. N. (2012). Government efficiency and international technology adoption: The spread of electronic ticketing among airlines. *Journal of International Business Studies*, *43*(7), 631-654.

Galvez, J. F., Mejuto, J. C., & Simal-Gandara, J. (2018). Future challenges on the use of blockchain for food traceability analysis. *TrAC Trends in Analytical Chemistry*, *107*, 222-232. https://doi.org/https://doi.org/10.1016/j.trac.2018.08.011

Gan, S. (2017). An IoT simulator in NS3 and a key-based authentication architecture for IoT devices using blockchain. *Indian Institute of Technology Kanpur*.

Gao, L., & Waechter, K. A. (2017). Examining the role of initial trust in user adoption of mobile payment services: an empirical investigation. *Information Systems Frontiers*, *19*(3), 525-548.

Garaus, M., & Treiblmaier, H. (2021). The influence of blockchain-based food traceability on retailer choice: The mediating role of trust. *Food Control*, 108082. https://doi.org/https://doi.org/10.1016/j.foodcont.2021.108082

Gartner. (2019). *Gartner predicts 90% of current enterprise blockchain platform implementations will require replacement by 2021*. Retrieved 30 July 2019, 2019, from https://www.gartner.com/en/newsroom/press-releases/2019-05-07-gartner-predicts-90--of-blockchain-based-supply-chain

Ge, L., Brewster, C., Spek, J., Smeenk, A., Top, J., van Diepen, F., Klaase, B., Graumans, C., & de Wildt, M. d. R. (2017). *Blockchain for agriculture and food: Findings from the pilot study*. Wageningen Economic Research.

George, R. V., Harsh, H. O., Ray, P., & Babu, A. K. (2019). Food quality traceability prototype for restaurants using blockchain and food quality data index. *Journal of Cleaner Production*, *240*, 118021. https://doi.org/https://doi.org/10.1016/j.jclepro.2019.118021

Ghode, D., Yadav, V., Jain, R., & Soni, G. (2020). Adoption of blockchain in supply chain: an analysis of influencing factors. *Journal of Enterprise Information Management*, *33*(3), 437-456. https://doi.org/10.1108/JEIM-07-2019-0186

Godin, G., & Kok, G. (1996). The theory of planned behavior: a review of its applications to health-related behaviors. *American journal of health promotion*, *11*(2), 87-98.

Gordon, W. J., & Catalini, C. (2018). Blockchain technology for healthcare: facilitating the transition to patient-driven interoperability. *Computational and structural biotechnology journal*, *16*, 224-230.

Grecuccio, J., Giusto, E., Fiori, F., & Rebaudengo, M. (2020). Combining blockchain and iot: Food-chain traceability and beyond. *Energies*, *13*(15), Article 3820. https://doi.org/10.3390/en13153820

Grunow, M., & Piramuthu, S. (2013). RFID in highly perishable food supply chains–Remaining shelf life to supplant expiry date? *International Journal of Production Economics*, *146*(2), 717-727.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of qualitative research*, *2*(163-194), 105.

Guest, G., MacQueen, K. M., & Namey, E. E. (2011). *Applied thematic analysis*. sage publications.

Guido, R., Mirabelli, G., Palermo, E., & Solina, V. (2020). A framework for food traceability: Case study-Italian extra-virgin olive oil supply chain. *International Journal of Industrial Engineering and Management*, *11*(1), Article 252. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85083581451&partnerID=40&md5=04379d8beb25ccf5491f74d92167d88d

Gupta, R., & Shankar, R. (2023). Managing food security using blockchain-enabled traceability system. *Benchmarking: An International Journal*.

Gurtu, A., & Johny, J. (2019). Potential of blockchain technology in supply chain management: a literature review. *International Journal of Physical Distribution & Logistics Management*.

Haber, S., & Stornetta, W. S. (1990). How to time-stamp a digital document. Conference on the Theory and Application of Cryptography.

Halaburda, H. (2016). Digital currencies: beyond bitcoin. *Available at SSRN 2865004*.

Hand, M., & Hillyard, S. (2014). *Big data?: qualitative approaches to digital research*. Emerald Group Publishing.

Hang, L., Ullah, I., & Kim, D.-H. (2020). A secure fish farm platform based on blockchain for agriculture data integrity. *Computers and Electronics in Agriculture*, *170*, 105251. https://doi.org/https://doi.org/10.1016/j.compag.2020.105251

Hang, L., Ullah, I., & Kim, D. H. (2020). A secure fish farm platform based on blockchain for agriculture data integrity. *Computers and Electronics in Agriculture*, *170*, Article 105251. https://doi.org/10.1016/j.compag.2020.105251

Hayati, H., & Nugraha, I. G. B. B. (2018, 21-22 Nov. 2018). Blockchain Based Traceability System in Food Supply Chain. 2018 International Seminar on Research of Information Technology and Intelligent Systems (ISRITI). https://doi.org/10.1109/ISRITI.2018.8864477

Hazari, S. S., & Mahmoud, Q. H. (2019). A parallel proof of work to improve transaction speed and scalability in blockchain systems. 2019 IEEE 9th annual computing and communication workshop and conference (CCWC).

Heinze, A. (2008). *Blended learning: An interpretive action research study*. University of Salford (United Kingdom).

Helo, P., & Hao, Y. (2019). Blockchains in operations and supply chains: A model and reference implementation. *Computers & Industrial Engineering*, *136*, 242-251.

Hew, J. J., Wong, L. W., Tan, G. W. H., Ooi, K. B., & Lin, B. (2020). The blockchain-based Halal traceability systems: a hype or reality? *Supply Chain Management*, *25*(6), 863-879. https://doi.org/10.1108/SCM-01-2020-0044

Hiremath, O. S. (2019). *Different types of blockchain and why we need them*. Retrieved 30 July, 2019, from https://www.edureka.co/blog/types-of-blockchain/#DifferenttypesofBlockchain

Hong, W., Mao, J., Wu, L., & Pu, X. (2021). Public cognition of the application of blockchain in food safety management—Data from China's Zhihu platform. *Journal of Cleaner Production*, *303*, 127044.

Hosseini, S., Turhan, B., & Gunarathna, D. (2017). A systematic literature review and meta-analysis on cross project defect prediction. *IEEE Transactions on Software Engineering*, *45*(2), 111-147.

Hughes, L., Dwivedi, Y. K., Misra, S. K., Rana, N. P., Raghavan, V., & Akella, V. (2019). Blockchain research, practice and policy: Applications, benefits, limitations, emerging research themes and research agenda. *International Journal of Information Management*, *49*, 114-129.

Huh, S., Cho, S., & Kim, S. (2017). Managing IoT devices using blockchain platform. 2017 19th international conference on advanced communication technology (ICACT).

Iansiti, M., & Lakhani, K. R. (2017). The truth about blockchain. *Harvard Business Review*, *95*(1), 118-127.

Iftekhar, A., Cui, X., Hassan, M., & Afzal, W. (2020). Application of Blockchain and Internet of Things to Ensure Tamper-Proof Data Availability for Food Safety. *Journal of Food Quality*, *2020*, Article 5385207. https://doi.org/10.1155/2020/5385207

Iqbal, R., & Butt, T. A. (2020). Safe farming as a service of blockchain-based supply chain management for improved transparency. *Cluster Computing*, *23*(3), 2139-2150. https://doi.org/10.1007/s10586-020-03092-4

Isma'ili, A., Li, M., He, Q., & Shen, J. (2016). Cloud computing services adoption in Australian SMEs: a firm-level investigation.

Janssen, M., Weerakkody, V., Ismagilova, E., Sivarajah, U., & Irani, Z. (2020). A framework for analysing blockchain technology adoption: Integrating institutional, market and technical factors. *International Journal of Information Management*, *50*, 302-309.

Jarka, S. (2019). FOOD SAFETY IN THE SUPPLY CHAIN USING BLOCKCHAIN TECHNOLOGY. *BEZPIECZEŃSTWO ŻYWNOŚCI W ŁAŃCUCHU DOSTAW Z WYKORZYSTANIEM TECHNOLOGII BLOCKCHAIN.*, *18*(4), 41-48. https://doi.org/10.22630/ASPE.2019.18.4.43

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational researcher*, *33*(7), 14-26.

Kaboub, F. (2008). Positivist paradigm. *Encyclopaedia of counselling*, *2*(2), 343.

Kamath, R. (2018). Food traceability on blockchain: Walmart's pork and mango pilots with IBM. *The Journal of the British Blockchain Association*, *1*(1), 3712.

Kamble, S., Gunasekaran, A., & Arha, H. (2019). Understanding the Blockchain technology adoption in supply chains-Indian context. *International Journal of Production Research*, *57*(7), 2009-2033.

Kamble, S. S., Gunasekaran, A., & Sharma, R. (2020). Modeling the blockchain enabled traceability in agriculture supply chain. *International Journal of Information Management*, *52*, N.PAG-N.PAG. https://doi.org/10.1016/j.ijinfomgt.2019.05.023

Kamilaris, A., Fonts, A., & Prenafeta-Boldu, F. X. (2019). The rise of blockchain technology in agriculture and food supply chains. *Trends in Food Science & Technology*, *91*, 640-652. https://doi.org/10.1016/j.tifs.2019.07.034

Kamilaris, A., Fonts, A., & Prenafeta-Boldύ, F. X. (2019). The rise of blockchain technology in agriculture and food supply chains. *Trends in Food Science & Technology*, *91*, 640-652.

Katsikouli, P., Wilde, A. S., Dragoni, N., & Høgh-Jensen, H. (2020). On the benefits and challenges of blockchains for managing food supply chains. *Journal of the Science of Food and Agriculture*, *n/a*(n/a). https://doi.org/10.1002/jsfa.10883

Katsikouli, P., Wilde, A. S., Dragoni, N., & Høgh-Jensen, H. (2021). On the benefits and challenges of blockchains for managing food supply chains. *Journal of the Science of Food and Agriculture*, *101*(6), 2175-2181. https://doi.org/10.1002/jsfa.10883

Kaya, S., Argan, M., & Yetim, G. (2017). From Experience to Summit or Vice Versa? Netnography Study on a Virtual Community of Mountaineering. *Universal Journal of Educational Research*, *5*(7), 1117-1126.

Kayikci, Y., Subramanian, N., Dora, M., & Bhatia, M. S. (2020). Food supply chain in the era of Industry 4.0: blockchain technology implementation opportunities and impediments from the perspective of people, process, performance, and technology. *Production Planning & Control*, 1-21.

Keogh, J. G., Rejeb, A., Khan, N., Dean, K., & Hand, K. J. (2020). Blockchain and GS1 standards in the food chain: A review of the possibilities and challenges. *Building the Future of Food Safety Technology; Detwiler, D., Ed*.

Keogh, J. G., Rejeb, A., Khan, N., Dean, K., & Hand, K. J. (2020). Data and food supply chain: Blockchain and GS1 standards in the food chain: a review of the possibilities and challenges. *Building the Future of Food Safety Technology*, 145-178. https://doi.org/10.1016/B978-0-12-818956-6.00007-5

Khan, M. A., & Salah, K. (2018). IoT security: Review, blockchain solutions, and open challenges. *Future generation computer systems*, *82*, 395-411.

Khan, P. W., Byun, Y. C., & Park, N. (2020). IoT-blockchain enabled optimized provenance system for food industry 4.0 using advanced deep learning. *Sensors (Switzerland)*, *20*(10), Article 2990. https://doi.org/10.3390/s20102990

Kim, H. M., & Laskowski, M. (2018). Toward an ontology-driven blockchain design for supply-chain provenance. *Intelligent Systems in Accounting, Finance and Management*, *25*(1), 18-27.

Kitchenham, B., & Charters, S. (2007). Guidelines for performing systematic literature reviews in software engineering.

Klein, H. K., & Myers, M. D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS quarterly*, 67-93.

Kniepert, M., & Fintineru, G. (2018). BLOCKCHAIN TECHNOLOGY IN FOOD - CHAIN MANAGEMENT - AN INSTITUTIONAL ECONOMIC PERSPECTIVE. *Scientific Papers-Series Management Economic Engineering in Agriculture and Rural Development*, *18*(3), 183-201. <Go to ISI>://WOS:000448477600025

Köhler, S., & Pizzol, M. (2020). Technology assessment of blockchain-based technologies in the food supply chain. *Journal of Cleaner Production*, *269*, 122193. https://doi.org/https://doi.org/10.1016/j.jclepro.2020.122193

Korpela, K., Hallikas, J., & Dahlberg, T. (2017). Digital supply chain transformation toward blockchain integration. proceedings of the 50th Hawaii international conference on system sciences.

Kouhizadeh, M., Saberi, S., & Sarkis, J. (2021). Blockchain technology and the sustainable supply chain: Theoretically exploring adoption barriers. *International Journal of Production Economics*, *231*, 107831.

Kozinets, R. V. (2002). The field behind the screen: Using netnography for marketing research in online communities. *Journal of marketing research*, *39*(1), 61-72.

Krzyzanowski Guerra, K., & Boys, K. A. (2021). A new food chain: Adoption and policy implications to blockchain use in agri-food industries. *Applied Economic Perspectives and Policy*.

Krzyzanowski Guerra, K., & Boys, K. A. (2022). A new food chain: Adoption and policy implications to blockchain use in agri-food industries. *Applied Economic Perspectives and Policy*, *44*(1), 324-349.

Krzyzanowski, K. (2019). Putting Food on the Blockchain: A Regulatory Overview. *Journal of Food Distribution Research*, *50*(1), 86-86. http://search.ebscohost.com/login.aspx?direct=true&db=bsu&AN=135613358&site=ehost-live

Kshetri, N. (2017). Will blockchain emerge as a tool to break the poverty chain in the Global South? *Third World Quarterly*, *38*(8), 1710-1732.

Kshetri, N. (2018). 1 Blockchain's roles in meeting key supply chain management objectives. *International Journal of Information Management*, *39*, 80-89. https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2017.12.005

Kshetri, N. (2019). Blockchain and the Economics of Food Safety. *IT Professional*, *21*(3), 63-66, Article 8720132. https://doi.org/10.1109/MITP.2019.2906761

Kumar, M. V., & Iyengar, N. (2017). A framework for Blockchain technology in rice supply chain management. *Adv. Sci. Technol. Lett*, *146*, 125-130.

Kuo, T.-T., Kim, H.-E., & Ohno-Machado, L. (2017). Blockchain distributed ledger technologies for biomedical and health care applications. *Journal of the American Medical Informatics Association*, *24*(6), 1211-1220.

Lakhani, K. R., & Iansiti, M. (2017). The truth about blockchain. *Harvard Business Review*, *95*(1), 119-127.

Lamport, L. (1998). The part-time parliament. *ACM Trans. Comput. Syst.*, *16*(2), 133–169. https://doi.org/10.1145/279227.279229

Lee, R. L., & Blouin, M. C. (2019). Factors affecting web disclosure adoption in the nonprofit sector. *Journal of Computer Information Systems*, *59*(4), 363-372.

Leedy, P. D., & Ormrod, J. E. (2019). *Practical research: Planning and design*. ERIC.

Lenzer, G. (2017). *Auguste Comte and positivism: The essential writings*. Routledge.

Li, G., Ooi, B. C., Feng, J., Wang, J., & Zhou, L. (2008). Ease: an effective 3-in-1 keyword search method for unstructured, semi-structured and structured data. Proceedings of the 2008 ACM SIGMOD international conference on Management of data.

Li, K., Lee, J.-Y., & Gharehgozli, A. (2021). Blockchain in food supply chains: a literature review and synthesis analysis of platforms, benefits and challenges. *International journal of production research*, 1-20.

Liang, G., Weller, S. R., Luo, F., Zhao, J., & Dong, Z. Y. (2018). Distributed blockchain-based data protection framework for modern power systems against cyber attacks. *IEEE Transactions on Smart Grid*, *10*(3), 3162-3173.

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., Clarke, M., Devereaux, P. J., Kleijnen, J., & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Journal of clinical epidemiology*, *62*(10), e1-e34.

Lin, X., Chang, S. C., Chou, T. H., Chen, S. C., & Ruangkanjanases, A. (2021). Consumers' intention to adopt blockchain food traceability technology towards organic food products. *International Journal of Environmental Research and Public Health*, *18*(3), 1-19, Article 912. https://doi.org/10.3390/ijerph18030912

Lippert, S. K., & Davis, M. (2006). A conceptual model integrating trust into planned change activities to enhance technology adoption behavior. *Journal of information science*, *32*(5), 434-448.

Liu, W., Shao, X.-F., Wu, C.-H., & Qiao, P. (2021). A systematic literature review on applications of information and communication technologies and blockchain technologies for precision agriculture development. *Journal of Cleaner Production*, 126763.

Liu, Y., Ma, X., Shu, L., Hancke, G. P., & Abu-Mahfouz, A. M. (2020). From Industry 4.0 to Agriculture 4.0: Current status, enabling technologies, and research challenges. *IEEE Transactions on Industrial Informatics*, *17*(6), 4322-4334.

Lockett, A., Thompson, S., & Morgenstern, U. (2009). The development of the resource-based view of the firm: A critical appraisal. *International journal of management reviews*, *11*(1), 9-28.

Longo, F., Nicoletti, L., & Padovano, A. (2020). Estimating the Impact of Blockchain Adoption in the Food Processing Industry and Supply Chain. *International Journal of Food Engineering*, *16*(5-6), Article 20190109. https://doi.org/10.1515/ijfe-2019-0109

Lucas, L. (2018). *From farm to plate, blockchain dishes up simple food tracking*. 6 June, Financial Times, 6 June 2018. 2020, from https://www.ft.com/content/225d32bc-4dfa-11e8-97e4-13afc22d86d4

Lucena, P., Binotto, A. P., Momo, F. d. S., & Kim, H. (2018). A case study for grain quality assurance tracking based on a Blockchain business network. *arXiv preprint arXiv:1803.07877*.

MacDonald, T. J., Allen, D. W., & Potts, J. (2016). Blockchains and the boundaries of self-organized economies: Predictions for the future of banking *Banking beyond banks and money* (pp. 279-296). Springer.

Madichie, N. O., & Yamoah, F. A. (2017). Revisiting the European horsemeat scandal: the role of power asymmetry in the food supply chain crisis. *Thunderbird International Business Review*, *59*(6), 663-675.

Madumidha, S., Ranjani, P. S., Varsinee, S. S., & Sundari, P. S. (2019, 23-25 April 2019). Transparency and Traceability: In Food Supply Chain System using Blockchain Technology with Internet of Things. 2019 3rd International Conference on Trends in Electronics and Informatics (ICOEI). https://doi.org/10.1109/ICOEI.2019.8862726

Maghfirah, A. (2019). Blockchain in Food and Agriculture Supply Chain: Use-Case of Blockchain in Indonesia. *International Journal of Food and Beverage Manufacturing and Business Models (IJFBMBM)*, *4*(2), 53-66.

Malak, J. (2016). *An Analysis of the Technological, Organizational, and Environmental Factors Influencing Cloud Adoption* [Walden University].

Malik, S., Chadhar, M., Vatanasakdakul, S., & Chetty, M. (2021). Factors affecting the organizational adoption of blockchain technology: Extending the technology–organization–environment (TOE) framework in the Australian context. *Sustainability*, *13*(16), 9404.

Manzini, R., & Accorsi, R. (2013). The new conceptual framework for food supply chain assessment. *Journal of food engineering*, *115*(2), 251-263.

Mao, D., Wang, F., Hao, Z., & Li, H. (2018). Credit evaluation system based on blockchain for multiple stakeholders in the food supply chain. *International Journal of Environmental Research and Public Health*, *15*(8), Article 1627. https://doi.org/10.3390/ijerph15081627

Mao, D., Wang, F., Hao, Z., & Li, H. (2018). Credit evaluation system based on blockchain for multiple stakeholders in the food supply chain. *International journal of environmental research and public health*, *15*(8), 1627.

Marketplace, A. (2022). *Global Blockchain IoT Market*. Retrieved 09.07.2022, 2022, from https://aws.amazon.com/marketplace/pp/prodview-gpyox3mrjlmu2#offers

Martinez, V., Zhao, M., Blujdea, C., Han, X., Neely, A., & Albores, P. (2019). Blockchain-driven customer order management. *International Journal of Operations & Production Management*.

Mattke, J., Hund, A., Maier, C., & Weitzel, T. (2019). How an Enterprise Blockchain Application in the US Pharmaceuticals Supply Chain is Saving Lives. *MIS Quarterly Executive*, *18*(4).

McGregor, S. L., & Murnane, J. A. (2010). Paradigm, methodology and method: Intellectual integrity in consumer scholarship. *International journal of consumer studies*, *34*(4), 419-427.

McIntosh, M. J., & Morse, J. M. (2015). Situating and constructing diversity in semi-structured interviews. *Global qualitative nursing research*, *2*, 2333393615597674.

Medeiros, M., & Chau, B. (2016). Fintech-stake a patent claim? *Intellectual Property Journal*, *28*(3), 303.

Mendling, J., Weber, I., Aalst, W. V. D., Brocke, J. V., Cabanillas, C., Daniel, F., Debois, S., Ciccio, C. D., Dumas, M., & Dustdar, S. (2018). Blockchains for business process management-challenges and opportunities. *ACM Transactions on Management Information Systems (TMIS)*, *9*(1), 1-16.

Menon, S., & Jain, K. (2021). Blockchain Technology for Transparency in Agri-Food Supply Chain: Use Cases, Limitations, and Future Directions. *IEEE Transactions on Engineering Management*.

Min, H. (2019). Blockchain technology for enhancing supply chain resilience. *Business Horizons*, *62*(1), 35-45.

Mirabelli, G., & Solina, V. (2020). Blockchain and agricultural supply chains traceability: research trends and future challenges. *Procedia Manufacturing*, *42*, 414-421. https://doi.org/https://doi.org/10.1016/j.promfg.2020.02.054

Mohammed, A., Potdar, V., & Yang, L. (2019). Key Factors Affecting Blockchain Adoption in Organizations. International Conference on Big Data and Security.

Mohanta, B. K., Jena, D., Panda, S. S., & Sobhanayak, S. (2019). Blockchain technology: A survey on applications and security privacy challenges. *Internet of Things*, *8*, 100107.

Mohanta, B. K., Panda, S. S., & Jena, D. (2018). An overview of smart contract and use cases in blockchain technology. 2018 9th international conference on computing, communication and networking technologies (ICCCNT).

Momtaz, P. P., Rennertseder, K., & Schroeder, H. (2019). Token offerings: a revolution in corporate finance? *Available at SSRN 3346964*.

Mondal, S., Wijewardena, K. P., Karuppuswami, S., Kriti, N., Kumar, D., & Chahal, P. (2019). Blockchain inspired RFID-based information architecture for food supply chain. *IEEE Internet of Things Journal*, *6*(3), 5803-5813.

Mordorintelligence. (2018). *Blockchain supply chain market - growth, trends, covid-19 impact, and forecasts (2022 - 2027)*. Retrieved 05.08.22, 2022, from https://www.mordorintelligence.com/industry-reports/blockchain-supply-chain-market#:~:text=Market%20Overview,growth%20factors%20for%20the%20market.

Morkunas, V. J., Paschen, J., & Boon, E. (2019). How blockchain technologies impact your business model. *Business Horizons*, *62*(3), 295-306.

Mytis-Gkometh, P., Drosatos, G., Efraimidis, P., & Kaldoudi, E. (2017). Notarization of knowledge retrieval from biomedical repositories using blockchain technology. International Conference on Biomedical and Health Informatics.

Nagy, D., Schuessler, J., & Dubinsky, A. (2016). Defining and identifying disruptive innovations. *Industrial Marketing Management*, *57*, 119-126.

Nakamoto, S., & Bitcoin, A. (2008). A peer-to-peer electronic cash system. *Bitcoin.–URL: https://bitcoin. org/bitcoin. pdf*, *4*.

Nath, S. D., Khayer, A., Majumder, J., & Barua, S. (2022). Factors affecting blockchain adoption in apparel supply chains: does sustainability-oriented supplier development play a moderating role? *Industrial Management & Data Systems*(ahead-of-print).

Nurgazina, J., Pakdeetrakulwong, U., Moser, T., & Reiner, G. (2021). Distributed ledger technology applications in food supply chains: A review of challenges and future research directions. *Sustainability*, *13*(8), 4206.

Olanrewaju, A.-S. T., Hossain, M. A., Whiteside, N., & Mercieca, P. (2020). Social media and entrepreneurship research: A literature review. *International Journal of Information Management*, *50*, 90-110.

Ølnes, S., Ubacht, J., & Janssen, M. (2017). *Blockchain in government: Benefits and implications of distributed ledger technology for information sharing*. Elsevier.

Opala, O. J. (2012). *An analysis of security, cost-effectiveness, and IT compliance factors influencing cloud adoption by IT managers* [Capella University].

Orlikowski, W. J., & Baroudi, J. J. (1991). Studying information technology in organizations: Research approaches and assumptions. *Information systems research*, *2*(1), 1-28.

Pal, A., & Kant, K. (2019). Using Blockchain for Provenance and Traceability in Internet of Things-Integrated Food Logistics. *Computer*, *52*(12), 94-98, Article 8909921. https://doi.org/10.1109/MC.2019.2942111

Panarello, A., Tapas, N., Merlino, G., Longo, F., & Puliafito, A. (2018). Blockchain and iot integration: A systematic survey. *Sensors*, *18*(8), 2575.

Pandey, G. (2011). India's Immense 'food Theft'Scandal. *BBC News 22*. https://www.bbc.com/news/world-south-asia-12502431

Pandey, V., Pant, M., & Snasel, V. (2022). Blockchain technology in food supply chains: Review and bibliometric analysis. *Technology in Society*, 101954.

Patelli, N., & Mandrioli, M. (2020). Blockchain technology and traceability in the agrifood industry. *Journal of Food Science*, *85*(11), 3670-3678. https://doi.org/10.1111/1750-3841.15477

Patton, M. Q. (1987). *How to use qualitative methods in evaluation*. Sage.

Paulavičius, R., Grigaitis, S., Igumenov, A., & Filatovas, E. (2019). A decade of blockchain: Review of the current status, challenges, and future directions. *Informatica*, *30*(4), 729-748.

Pawlak, M., Guziur, J., & Poniszewska-Marańda, A. (2018). Voting process with blockchain technology: auditable blockchain voting system. International Conference on Intelligent Networking and Collaborative Systems.

Pearson, S., May, D., Leontidis, G., Swainson, M., Brewer, S., Bidaut, L., Frey, J. G., Parr, G., Maull, R., & Zisman, A. (2019). Are Distributed Ledger Technologies the panacea for food traceability? *Global Food Security*, *20*, 145-149. https://doi.org/https://doi.org/10.1016/j.gfs.2019.02.002

Peshkin, A. (1993). *The goodness of qualitative research Educational Researcher, v. 22, n. 2*. mar.

Peters, G. W., & Panayi, E. (2016). Understanding modern banking ledgers through blockchain technologies: Future of transaction processing and smart contracts on the internet of money *Banking beyond banks and money* (pp. 239-278). Springer.

Picoto, W. N., Bélanger, F., & Palma-dos-Reis, A. (2014). An organizational perspective on m-business: usage factors and value determination. *European Journal of Information Systems*, *23*(5), 571-592.

Pierce, T. (2014). *Extending the technology acceptance model: Policy acceptance model (PAM)* [The George Washington University].

Ponterotto, J. G. (2005). Qualitative research in counseling psychology: A primer on research paradigms and philosophy of science. *Journal of counseling psychology*, *52*(2), 126.

Prashar, D., Jha, N., Jha, S., Lee, Y., & Joshi, G. P. (2020). Blockchain-based traceability and visibility for agricultural products: A decentralizedway of ensuring food safety in India. *Sustainability (Switzerland)*, *12*(8), Article 3497. https://doi.org/10.3390/SU12083497

Premkumar, G., Ramamurthy, K., & Nilakanta, S. (1994). Implementation of electronic data interchange: an innovation diffusion perspective. *Journal of Management Information Systems*, *11*(2), 157-186.

Premkumar, G., & Roberts, M. (1999). Adoption of new information technologies in rural small businesses. *Omega*, *27*(4), 467-484.

Preuveneers, D., Joosen, W., & Ilie-Zudor, E. (2017). Trustworthy data-driven networked production for customer-centric plants. *Industrial Management & Data Systems*.

PwC. (2019). *PwC's Global Blockchain survey 2018, Blockchain is here. What's your next move*. Retrieved 30 July 2019, 2019, from https://www.pwc.com/gx/en/issues/blockchain/blockchain-in-business.html

Quaddus, M., & Hofmeyer, G. (2007). *An investigation into the factors influencing the adoption of B2B trading exchanges in small businesses*. Springer.

Queiroz, M. M., Telles, R., & Bonilla, S. H. (2019). Blockchain and supply chain management integration: a systematic review of the literature. *Supply Chain Management: An International Journal*.

Queiroz, M. M., & Wamba, S. F. (2019). Blockchain adoption challenges in supply chain: An empirical investigation of the main drivers in India and the USA. *International Journal of Information Management*, *46*, 70-82.

Ramya, U., Sindhuja, P., Atsaya, R., Bavya Dharani, B., & Manikanta Varshith Golla, S. (2018). Reducing forgery in land registry system using blockchain technology. International Conference on Advanced Informatics for Computing Research.

Rejeb, A., Keogh, J. G., Zailani, S., Treiblmaier, H., & Rejeb, K. (2020). Blockchain Technology in the Food Industry: A Review of Potentials, Challenges and Future Research Directions. *Logistics*, *4*(4), 27.

Research, B. (2018). *Global Blockchain in Healthcare Market: Focus on Industry Analysis and Opportunity Matrix - Analysis and Forecast, 2018-2025*. Retrieved 04.05.2022, 2022, from https://bisresearch.com/industry-report/global-blockchain-in-healthcare-market-2025.html

Revythi, A., & Tselios, N. (2019). Extension of technology acceptance model by using system usability scale to assess behavioral intention to use e-learning. *Education and Information technologies*, *24*(4), 2341-2355.

Rijanto, A. (2020). Business financing and blockchain technology adoption in agroindustry. *Journal of Science and Technology Policy Management*. https://doi.org/10.1108/JSTPM-03-2020-0065

Risius, M., & Spohrer, K. (2017). A blockchain research framework. *Business & information systems engineering*, *59*(6), 385-409.

Rocha, G. D. S. R., de Oliveira, L., & Talamini, E. (2021). Blockchain applications in agribusiness: A systematic review. *Future Internet*, *13*(4), Article 95. https://doi.org/10.3390/fi13040095

Rogers, E. M. (1995). Diffusion of Innovations: modifications of a model for telecommunications *Die diffusion von innovationen in der telekommunikation* (pp. 25-38). Springer.

Rogerson, M., & Parry, G. C. (2020). Blockchain: case studies in food supply chain visibility. *Supply Chain Management*, *25*(5), 601-614. https://doi.org/10.1108/SCM-08-2019-0300

Ronaghi, M. H. (2020). A blockchain maturity model in agricultural supply chain. *Information Processing in Agriculture*. https://doi.org/10.1016/j.inpa.2020.10.004

Rouibah, K., Lowry, P. B., & Hwang, Y. (2016). The effects of perceived enjoyment and perceived risks on trust formation and intentions to use online payment systems: New perspectives from an Arab country. *Electronic Commerce Research and Applications*, *19*, 33-43.

Ruivo, P., Oliveira, T., & Neto, M. (2014). Examine ERP post-implementation stages of use and value: Empirical evidence from Portuguese SMEs. *International Journal of Accounting Information Systems*, *15*(2), 166-184.

Sabah, N. M. (2016). Exploring students' awareness and perceptions: Influencing factors and individual differences driving m-learning adoption. *Computers in Human Behavior*, *65*, 522-533.

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.

Safeena, R., Date, H., Kammani, A., & Hundewale, N. (2012). Technology adoption and Indian consumers: study on mobile banking. *International Journal of Computer Theory and Engineering*, *4*(6), 1020.

Salviotti, G., De Rossi, L. M., & Abbatemarco, N. (2018). A structured framework to assess the business application landscape of blockchain technologies. Proceedings of the 51st Hawaii International Conference on System Sciences.

Samal, A., & Pradhan, B. B. (2019). Boundary traceability conditions in food supply chains using block chain technology. *International Journal of Psychosocial Rehabilitation*, *23*(6), 121-126. https://doi.org/10.37200/IJPR/V23I6/PR190745

Samaniego, M., & Deters, R. (2016). Using blockchain to push software-defined IoT components onto edge hosts. Proceedings of the International Conference on Big Data and Advanced Wireless Technologies.

Sander, F., Semeijn, J., & Mahr, D. (2018). The acceptance of blockchain technology in meat traceability and transparency. *British Food Journal*.

Sarpong, S. (2014). Traceability and supply chain complexity: confronting the issues and concerns. *European Business Review*.

Saurabh, S., & Dey, K. (2021). Blockchain technology adoption, architecture, and sustainable agri-food supply chains. *Journal of Cleaner Production, 284,* 124731. https://doi.org/https://doi.org/10.1016/j.jclepro.2020.124731

Schwandt, T. A. (2001). Dictionary of qualitative inquiry *Dictionary of qualitative inquiry* (pp. xxxiv, 281-xxxiv, 281).

Schwarzbaum, E. (2018). *4 Tech Companies Seeing High Demand For Blockchain Services*. Benzinga.com. 2020, from https://www.benzinga.com/analyst-ratings/analyst-color/18/05/11741312/4-tech-companies-seeing-high-demand-for-blockchain-serv

Scott, B., Loonam, J., & Kumar, V. (2017). Exploring the rise of blockchain technology: Towards distributed collaborative organizations. *Strategic Change*, *26*(5), 423-428.

Sedlmeir, J., Buhl, H. U., Fridgen, G., & Keller, R. (2020). The energy consumption of blockchain technology: beyond myth. *Business & Information Systems Engineering*, *62*(6), 599-608.

Sedlmeir, J., Buhl, H. U., Fridgen, G., & Keller, R. (2021). Recent developments in blockchain technology and their impact on energy consumption. *arXiv preprint arXiv:2102.07886*.

Seebacher, S., & Schüritz, R. (2017). Blockchain Technology as an Enabler of Service Systems: A Structured Literature Review. Cham. https://doi.org/10.1007/978-3-319-56925-3_2

Sengupta, U., Singh, S., & Kim, H. (2019). Meeting Changing Customer Requirements in Food and Agriculture Through Application of Blockchain Technology. *Available at SSRN 3429200*.

Seth, S. (2019). *Worldwide spending on blockchain forecast to reach $11.7 billion in 2022*. Retrieved 08 Sept 2019, 2019, from https://www.investopedia.com/news/blockchain-solutions-grow-75-through-2022-idc/#:~:text=International%20Data%20Corp.has%20released,(CAGR)%20of%2073.2%25

Shen, Y.-C., Huang, C.-Y., Chu, C.-H., & Hsu, C.-T. (2010). A benefit–cost perspective of the consumer adoption of the mobile banking system. *Behaviour & information technology, 29*(5), 497-511.

Sheth, H., & Dattani, J. (2019). Overview of blockchain technology. *Asian Journal For Convergence In Technology (AJCT) ISSN-2350-1146*.

Shew, A. M., Snell, H. A., Nayga Jr, R. M., & Lacity, M. C. (2021). Consumer valuation of blockchain traceability for beef in the U nited S tates. *Applied Economic Perspectives and Policy*.

Shoaib, M., Lim, M. K., & Wang, C. (2020). An integrated framework to prioritize blockchain-based supply chain success factors. *Industrial Management & Data Systems*.

Sicari, S., Rizzardi, A., Grieco, L. A., & Coen-Porisini, A. (2015). Security, privacy and trust in Internet of Things: The road ahead. *Computer networks, 76*, 146-164.

Singh, S., & Singh, N. (2016). Blockchain: Future of financial and cyber security. 2016 2nd international conference on contemporary computing and informatics (IC3I).

Siyal, A. A., Junejo, A. Z., Zawish, M., Ahmed, K., Khalil, A., & Soursou, G. (2019). Applications of blockchain technology in medicine and healthcare: Challenges and future perspectives. *Cryptography*, *3*(1), 3.

Slade, S. (1991). Case-based reasoning: A research paradigm. *AI magazine*, *12*(1), 42-42.

Sofaer, S. (1999). Qualitative methods: what are they and why use them? *Health services research*, *34*(5 Pt 2), 1101.

Stafford, T. F., & Treiblmaier, H. (2020). Characteristics of a blockchain ecosystem for secure and sharable electronic medical records. *IEEE Transactions on Engineering Management*, *67*(4), 1340-1362.

Stranieri, S., Riccardi, F., Meuwissen, M. P. M., & Soregaroli, C. (2021). Exploring the impact of blockchain on the performance of agri-food supply chains. *Food Control*, *119*, 107495. https://doi.org/https://doi.org/10.1016/j.foodcont.2020.107495

Sullivan, C., & Burger, E. (2017). E-residency and blockchain. *computer law & security review*, *33*(4), 470-481.

Tan, A., Gligor, D., & Ngah, A. (2020). Applying Blockchain for Halal food traceability. *International Journal of Logistics: Research & Applications*, 1. https://doi.org/10.1080/13675567.2020.1825653

Tan, A., & Ngan, P. T. (2020). A proposed framework model for dairy supply chain traceability. *Sustainable Futures*, *2*, 100034. https://doi.org/https://doi.org/10.1016/j.sftr.2020.100034

Tan, B., Yan, J., Chen, S., & Liu, X. (2018). The impact of blockchain on food supply chain: The case of walmart. International Conference on Smart Blockchain.

Tayal, A., Solanki, A., Kondal, R., Nayyar, A., Tanwar, S., & Kumar, N. (2021). Blockchain-based efficient communication for food supply chain industry: Transparency and traceability analysis for sustainable business. *International Journal of Communication Systems*, *34*(4), Article e4696. https://doi.org/10.1002/dac.4696

Taylor, P. J., Dargahi, T., Dehghantanha, A., Parizi, R. M., & Choo, K.-K. R. (2020). A systematic literature review of blockchain cyber security. *Digital Communications and Networks*, *6*(2), 147-156.

Thenmozhi, M., Dhanalakshmi, R., Geetha, S., & Valli, R. (2021). Implementing blockchain technologies for health insurance claim processing in hospitals. *Materials Today: Proceedings*.

Tian, F. (2017). A supply chain traceability system for food safety based on HACCP, blockchain & Internet of things. 2017 International conference on service systems and service management.

Ting, S., Tse, Y., Ho, G., Chung, S., & Pang, G. (2014). Mining logistics data to assure the quality in a sustainable food supply chain: A case in the red wine industry. *International Journal of Production Economics*, *152*, 200-209.

Tornatzky, L., & Fleischer, M. (1990). *The process of technology innovation, Lexington, MA*. Lexington Books.

Tornatzky, L. G., Fleischer, M., & Chakrabarti, A. K. (1990). The processes of technological innovation. *(No Title)*.

Tornatzky, L. G., & Klein, K. J. (1982). Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings. *IEEE Transactions on engineering management*(1), 28-45.

Trace, O. (2007). Traceability Backgrounder. Web Page. *On Trace Agri Food*. http://ontraceagrifood.com/Documents/Traceability%20Bkgder-Apr%2007.Pdf

Tractica. (2018). *Enterprise blockchain revenue to surpass $20 Billion by 2025*. 2019, from https://www.businesswire.com/news/home/20180828005038/en/Enterprise-Blockchain-Revenue-to-Surpass-20-Billion-by-2025-According-to-Tractica

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management*, *14*(3), 207-222.

Trautman, L. J. (2016). Is disruptive blockchain technology the future of financial services?

Tsang, E. W. (2014). Case studies and generalization in information systems research: A critical realist perspective. *The Journal of Strategic Information Systems*, *23*(2), 174-186.

Tseng, J.-H., Liao, Y.-C., Chong, B., & Liao, S.-w. (2018). Governance on the drug supply chain via gcoin blockchain. *International journal of environmental research and public health*, *15*(6), 1055.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

Venkatesh, V., Thong, J. Y., Chan, F. K., Hu, P. J. H., & Brown, S. A. (2011). Extending the two-stage information systems continuance model:

Incorporating UTAUT predictors and the role of context. *Information systems journal*, *21*(6), 527-555.

Viriyasitavat, W., Anuphaptrirong, T., & Hoonsopon, D. (2019). When blockchain meets Internet of Things: Characteristics, challenges, and business opportunities. *Journal of industrial information integration*, *15*, 21-28.

Vivaldini, M. (2021). Blockchain in operations for food service distribution: steps before implementation. *International Journal of Logistics Management, The*.

Vu, N., Ghadge, A., & Bourlakis, M. (2021). Blockchain adoption in food supply chains: a review and implementation framework. *Production Planning & Control*, 1-18.

Wahyuni, D. (2012). The research design maze: Understanding paradigms, cases, methods and methodologies. *Journal of applied management accounting research*, *10*(1), 69-80.

Walmart. (2018). *2018 GLOBAL RESPONSIBILITY REPORT*. Walmart. https://corporate.walmart.com/media-library/document/2018-global-responsibility-report/_proxyDocument?id=00000170-ac54-d808-a9f1-ac7e9d160000

Walsh, S. T., Kirchhoff, B. A., & Newbert, S. (2002). Differentiating market strategies for disruptive technologies. *IEEE Transactions on engineering management*, *49*(4), 341-351.

Walsham, G. (1993). *Interpreting information systems in organizations* (Vol. 19). Wiley Chichester.

Walsham, G. (1995). The emergence of interpretivism in IS research. *Information systems research*, *6*(4), 376-394.

Wamba, S. F., & Queiroz, M. M. (2020). Industry 4.0 and the supply chain digitalisation: a blockchain diffusion perspective. *Production Planning & Control*, 1-18.

Wang, Y., Han, J. H., & Beynon-Davies, P. (2018). Understanding blockchain technology for future supply chains: a systematic literature review and research agenda. *Supply Chain Management: An International Journal*.

Wang, Y., Han, J. H., & Beynon-Davies, P. (2019). Understanding blockchain technology for future supply chains: a systematic literature review and research agenda. *Supply Chain Management: An International Journal*.

Wang, Y., & Kogan, A. (2018). Designing confidentiality-preserving Blockchain-based transaction processing systems. *International Journal of Accounting Information Systems*, *30*, 1-18.

Wang, Y., Singgih, M., Wang, J., & Rit, M. (2019). Making sense of blockchain technology: How will it transform supply chains? *International Journal of Production Economics*, *211*, 221-236.

Weber, I., Xu, X., Riveret, R., Governatori, G., Ponomarev, A., & Mendling, J. (2016). Untrusted business process monitoring and execution using blockchain. International conference on business process management.

Werner, F., Basalla, M., Schneider, J., Hays, D., & Vom Brocke, J. (2021). Blockchain adoption from an interorganizational systems perspective–a mixed-methods approach. *Information Systems Management*, *38*(2), 135-150.

Wieringa, R. (2013). Case study research in information systems engineering. Proceedings of the 25th International Conference on Advanced Information Systems Engineering. CAiSE. pp. xii–xii.

WinterGreen. (2019). *Blockchain: market shares, strategies, and forecasts, worldwide*. Retrieved 31 July 2019, 2018, from https://www.prnewswire.com/news-releases/worldwide-blockchain-report-market-shares-strategies-and-forecasts-2018-2024-market-is-anticipated-to-reach-607-billion-with-ibm-microsft--accenture-driving-blockchain-300581333.html

Wong, L.-W., Leong, L.-Y., Hew, J.-J., Tan, G. W.-H., & Ooi, K.-B. (2020). Time to seize the digital evolution: Adoption of blockchain in operations and supply chain management among Malaysian SMEs. *International Journal of Information Management*, *52*, 101997.

Wood, C. (2019). *China goes bullish on blockchain*. Retrieved 15 Nov 2019, 2019, from https://www.businessinsider.com/china-bullish-on-blockchain-xi-jinping-2019-10

Wright, A., & De Filippi, P. (2015). Decentralized blockchain technology and the rise of lex cryptographia. *Available at SSRN 2580664*.

Xin, H., & Stone, R. (2008). Chinese Probe Unmasks High-Tech Adulteration With Melamine. *Science*, *322*(5906), 1310-1311. https://doi.org/10.1126/science.322.5906.1310

Xu, J., Guo, S., Xie, D., & Yan, Y. (2020). Blockchain: A new safeguard for agri-foods. *Artificial Intelligence in Agriculture*, *4*, 153-161.

Xu, X., Pautasso, C., Zhu, L., Gramoli, V., Ponomarev, A., Tran, A. B., & Chen, S. (2016). The blockchain as a software connector. 2016 13th Working IEEE/IFIP Conference on Software Architecture (WICSA).

Yadav, V. S., Singh, A. R., Raut, R. D., & Govindarajan, U. H. (2020). Blockchain technology adoption barriers in the Indian agricultural supply chain: an integrated approach. *Resources, Conservation and Recycling*, *161*, Article 104877. https://doi.org/10.1016/j.resconrec.2020.104877

Yadav, V. S., Singh, A. R., Raut, R. D., & Govindarajan, U. H. (2020). Blockchain technology adoption barriers in the Indian agricultural supply chain: an integrated approach. *Resources, Conservation and Recycling*, *161*, 104877.

Ye, F., Liu, S., Li, Y., Zhan, Y., Cai, Z., & Kumar, A. (2022). Early adopter or follower? The strategic equilibrium of blockchain technology adoption strategy for competing agri-food supply chains. *IEEE Transactions on Engineering Management*.

Yew, M. H., Molla, A., Ramayah, T., Kurnia, S., Ali, M., & Rahim, M. (2020). Exploring blockchain for sustainability in the food supply chain: An affordance approach. *Proceedings of the 24th Pacific Asia Conference on Information Systems: Information Systems (IS) for the Future, PACIS 2020*. 24th Pacific Asia Conference on Information Systems: Information Systems (IS) for the Future, PACIS 2020. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85089129188&partnerID=40&md5=068202b2c32243e81e4008bebe3d21f7

Yiannas, F. (2018). A new era of food transparency powered by blockchain. *Innovations: Technology, Governance, Globalization*, *12*(1-2), 46-56.

Yin, R. K. (2009). *Case study research: Design and methods* (Vol. 5). sage.

Yli-Huumo, J., Ko, D., Choi, S., Park, S., & Smolander, K. (2016). Where is current research on blockchain technology?—a systematic review. *PloS one*, *11*(10), e0163477.

Yontar, E. (2023). Critical success factor analysis of blockchain technology in agri-food supply chain management: A circular economy perspective. *Journal of Environmental Management*, *330*, 117173.

Zhang, A., & Lin, X. (2018). Towards secure and privacy-preserving data sharing in e-health systems via consortium blockchain. *Journal of medical systems, 42*(8), 1-18.

Zhang, C., Gong, Y., & Brown, S. (2023). Cross-Case Analysis *Blockchain Applications in Food Supply Chain Management: Case Studies and Implications* (pp. 213-261). Springer.

Zhang, X., Sun, P., Xu, J., Wang, X., Yu, J., Zhao, Z., & Dong, Y. (2020). Blockchain-Based Safety Management System for the Grain Supply Chain. *IEEE Access, 8*, 36398-36410. https://doi.org/10.1109/ACCESS.2020.2975415

Zhao, G., Liu, S., Lopez, C., Lu, H., Elgueta, S., Chen, H., & Boshkoska, B. M. (2019). Blockchain technology in agri-food value chain management: A synthesis of applications, challenges and future research directions. *Computers in industry, 109*, 83-99.

Zhou, L., Wang, L., & Sun, Y. (2018). MIStore: a blockchain-based medical insurance storage system. *Journal of medical systems, 42*(8), 1-17.

Zhu, K., & Kraemer, K. L. (2005). Post-adoption variations in usage and value of e-business by organizations: cross-country evidence from the retail industry. *Information systems research, 16*(1), 61-84.

Zoubi, M., ALfaris, Y., Fraihat, B., Otoum, A., Nawasreh, M., & ALfandi, A. (2023). An extension of the diffusion of innovation theory for business intelligence adoption: A maturity perspective on project management. *Uncertain Supply Chain Management, 11*(2), 465-472.

APPENDICES

Appendix A Interview Protocol

1. Current project in blockchain in the food supply chain?
2. What are the objectives of this project?
3. What are the advantages of blockchain in the food supply chain (compared to other technological solutions)?
4. What specific challenges did you face during your project?
5. What are the anticipated barriers to blockchain adoption within the Food Supply Chain?
6. How would you estimate the relevance of these challenges?
7. What factors do you think may influence the adoption of blockchain? Why?
8. For example, Technological, environmental, and organizational drivers
9. What kind of government support did you get?
10. Which stakeholders could benefit from a blockchain-based platform in the food supply chain?
11. How much would these stakeholders’’ benefit? What are its advantages?
12. What impacts do you foresee of blockchain adoption in Food Supply Chain?

INTERVIEW BACKGROUND

The interview will be semi-structured and will allow participants to raise and explore issues relevant to the research. The following questions are indicative questions that will act as a question guide for the start of the interview.

No: …………… Date: ….… /.……. / ………

Start Time: .... End Time:

Interviewee:

……………….……….……………………………………………………………………

Organization name:

…………………….…………………………………………………………………………

Job Title:

…………………….……………………………………………………………………….

Experience (no of years):

……………………………………………………………………………………..

Determinants

1. Can you please tell me about your organization's background? (Number of employees/main services industry/Years since establishment)
2. I understand that your organization is considering adopting blockchain; if so, could you elaborate on what you are trying to solve with blockchain?
3. To what extent do you feel your organization is aware of blockchain technology?

4. Did you explore any other technologies? (Example, ERP, CLOUD COMPUTING, RFID etc.)
5. What factors do you think may influence the adoption of blockchain in your organisation? Why?

Probing

- Performance Utility
- Technology usability
- Compatibility
- Cost
- Trust
- Organizational readiness
- Management support
- Organizational Size
- Regulation support
- Uncertainty
- Competitive advantage

6. What benefits do you foresee with blockchain adoption?

In what way would blockchain transform your organization?

How?

Why?

Are there any aspects of blockchain that you want to comment on?

Appendix B Email Invitation

CONSENT FORM FOR RESEARCH PARTICIPANTS

Dear Sir/Madam,

INTERVIEW PARTICIPATION

I am Abubakar Mohammed, currently working on my Doctor of Philosophy in Information Systems at Curtin Business School, Curtin University, Western Australia, under the guidance of Dr Vidyasagar Potdar, Senior Research Fellow in the School of Management.

My broad area of research is blockchain technology adoption and aims to investigate and examine the factors that affect the adoption of blockchain and its consequences in organizations. For this, I am seeking your permission to participate in the interview, as your participation will help me get a deeper understanding of how organizations perceive blockchain technology within their operations. I expect the interview to take 30 minutes of your time.

Whatever information you provide will be kept strictly confidential and will not be shared with another person than myself and my academic supervisor. The information you will provide will not have your name or any other form of your identity as it will be in adherence to Curtin University's research policy.

It is anticipated that the findings from this research will provide a thorough understanding and awareness of blockchain technology adoption issues among individuals, organizations, and government bodies.

This research has been approved by the Curtin University Human Research Ethics Committee (HREC) has approved this study (HRE2019-0230). Your participation in this research will be greatly appreciated.

Yours Sincerely,

Abubakar Mohammed

School of Management, Curtin Business School